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THE UNITED REPUBLIC OF TANZANIA
NATIONAL AUDIT OFFICE

PERFORMANCE AUDIT REPORT ON THE MANAGEMENT OF METEOROLOGICAL SERVICES

CONTROLLER AND AUDITOR GENERAL
MARCH 2025

About the National Audit Office

Mandate

The statutory mandate and responsibilities of the Controller and Auditor-General are provided for under Article 143 of the Constitution of the United Republic of Tanzania of 1977 and in Section 10 (1) of the Public Audit Act, Cap 418.

PREFACE

Pursuant to Section 28 of the Public Audit Act, Cap 418, I am mandated to conduct a Performance Audit (Value-for-Money Audit) to establish the economy, efficiency and effectiveness of any expenditure or use of resources in the Ministries, Departments and Agencies (MDAs), Local Government Authorities (LGAs) and Public Authorities and Other Bodies which involves enquiring, examining, investigating and reporting, as deemed necessary under the circumstances.

I have the honour to submit to Her Excellency, the President of the United Republic of Tanzania, Hon. Dr. Samia Suluhu Hassan, and through her to the National Assembly of the United Republic of Tanzania, the Performance Audit Report on Management of Meteorological Services.

The report contains findings, conclusions, and recommendations directed to the Ministry of Transport and the Tanzania Meteorological Authority. These entities were given the opportunity to review the report and provide comments, and I sincerely acknowledge that their inputs were constructive and valuable.

My Office will carry out a follow-up audit at an appropriate time regarding action taken in implementing the recommendations given in this report.

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I would like to thank my staff for their commitment to preparing this report. I also acknowledge the audited entities for their cooperation with my Office, which facilitated the timely completion of the audit.

Charles E. Kichere
Controller and Auditor General
The United Republic of Tanzania
March 2025

TABLE OF CONTENT

NATIONAL AUDIT OFFICE NAOT ISO 9001:2015 Certified

NATIONAL AUDIT OFFICE
NAOT
ISO 9001:2015 Certified

LIST OF TABLES

ISO 9001:2015 Certified

NATIONAL AUDIT OFFICE
NAOT
ISO 9001:2015 Certified

LIST OF FIGURES

NAOT
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LIST OF ABBREVIATIONS AND ACRONYMS

AWS	-	Automatic Weather Stations
CFO	-	Central Forecasting Office
TMA	-	Tanzania Meteorological Authority
NMTC	-	National Meteorological Training Centre
NWP	-	Numerical Weather Prediction
TMS	-	Tanzania Meteorological Society
TCAA	-	Tanzania Civil Aviation Authority
WMO	-	World Meteorological Organisation
GMSL	-	Global Mean Sea Level
UN	-	United Nations
URT	-	United Republic of Tanzania

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DEFINITION OF TERMS

Agriculture Meteorological station	This means a station that supports agricultural activities by providing weather data pertinent to farming practices.
Automatic Weather Station	Is a meteorological station at which observations are made and transmitted automatically
Bimodal rainfall regime	This is characterized by two distinct rainy seasons: long rains from March to May, bringing substantial rainfall and short rains from October to December, which are often less consistent and variable compared to long rains. This regime predominates in northern and eastern Tanzania.
Downscaled weather forecast	This refers to weather forecasts at a small spatial scale, usually obtained by linking the weather representing a large scale and the weather representing a small scale.
Forecast	This means the statement of expected meteorological conditions for a specified time or period and a specified area or portion of the atmosphere.
Meteorology	Is a study of weather and climate and their interaction with the environment
synoptic weather station	Is a meteorological station that collects and reports meteorological observations at synoptic times and intermediate synoptic hours (UTC)
Unimodal rainfall regime	This refers to a rainfall regime characterized by one primary rainy season that extends from October to April or May and is primarily found in southern, western and central Tanzania.

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EXECUTIVE SUMMARY

Background Information

The Tanzania Meteorological Authority (TMA) is a government institution with a designated authority to provide meteorological services in the United Republic of Tanzania. It collects and processes national meteorological data from stations nationwide, providing climate prediction, weather forecasting information and warnings. The TMA is also responsible for managing meteorological services in the country. Tanzania's diverse climate necessitates accurate weather forecasting for agriculture, fishing, transportation, and disaster management. Accurate weather forecasts help mitigate adverse weather conditions and enhance food security, safety, and socio-economic activities for the population of Tanzania.

This audit assessed whether the TMA adequately manages meteorological services to provide accurate, timely, and reliable climate prediction and weather forecasts to support and safeguard public safety, economic activities, and environmental management. The audit covered the financial years 2019/20 to 2023/24, assessing performance trends of the Tanzania Meteorological Authority and the Ministry of Transport in providing and regulating meteorological services. This period marked significant government reforms in meteorological services, including the enactment of the Meteorological Act in 2019 and technological advancements.

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Main Audit Findings

The Audit noted deficiencies in the management of meteorological services as detailed below:

Overall State to Provision of Meteorological Services

TMA plays a crucial role in ensuring quality and reliable meteorological services that meet stakeholders' expectations by providing and regulating weather and climate services for the safety and sustainable social and economic development of Tanzania. However, the audit noted the inadequacy of weather forecasting, leading to profound and far-reaching consequences across various sectors in Tanzania, as detailed below:

Unsatisfactory Coverage of Weather Forecasting

Unsatisfactory coverage in weather forecasting poses significant challenges for effective decision-making in Tanzania. Limited forecasting parameters, such as insufficient data on wind patterns, humidity levels, and localised rainfall intensity, hinder the accuracy of predictions. Additionally, the lack of precise area coverage and specific location forecasts means many rural and remote regions remain underserved, leaving communities vulnerable to unexpected weather events.

Non-attainment to the Accuracy of Weather Forecasting

TMA did not achieve its targeted accuracy in weather forecasting during the years 2019/20, 2020/21, and 2023/24, with shortfalls of 10%, 20%, and 0.6%, respectively. While the accuracy target for 2022/23 was met after reducing the target by 5%, the overall decline in targeted accuracy levels from 95% in 2019/20 to 87.1% in 2020/21 and 87.5% in 2023/24 reflects a strategic adjustment to achievable benchmarks.

Despite improvements in narrowing the gap between actual and targeted accuracy, the lack of precise, localized forecasts at zonal, district, ward, and village levels resulted in significant consequences, causing loss of life, property, and unplanned government expenditures.

Additionally, TMA's weather forecasting accuracy was primarily measured based on rainfall, with no records for other critical parameters such as wind, temperature, tides, oceanic waves, humidity, pressure, and sunshine. A review of TMA's plans from 2019/20 to 2023/24 highlighted this gap in data collection and planning, as these parameters were not integrated into performance measures. This omission risks obscuring weaknesses in TMA's prediction models, limiting opportunities to refine methodologies and enhance forecasting quality. Consequently, the absence of comprehensive accuracy records undermines TMA's ability to deliver reliable and actionable weather forecasts.

Adequacy of Processing of Weather Information to Ensure the Public Receives Downscaled Weather Forecasting Information

Regarding the processing of weather information to ensure the public receives downscaled weather forecasting information and specialized forecasts for certain sectors, the audit noted the following:

(a) Insufficient Processing of Meteorological Data

The audit revealed that TMA did not adequately integrate weather radar data into forecasting models due to insufficient technical expertise. Additionally, TMA faced challenges in processing data from satellites and global observation centres, as these sources lacked adequate localization. These issues were compounded by a shortage of meteorological stations within the country, limiting the accuracy and effectiveness of weather forecasting.

(b) Insufficient Verification of Processed Weather Data

TMA did not validate the processed weather data other than rainfall parameters while leaving other parameters such as wind, temperature, humidity, evaporation, and atmospheric pressure not considered for verification from the years 2019/20 to 2023/24, and this was contrary to the requirement in Para 3.1.2 of TMA's Organisation structure which required TMA to verify daily, seasonal forecast, Aerodromes forecast, and warnings. Therefore, this lowers the degree of reliance on unverified parameters forecasted by TMA.

Regulation of Weather Forecasting Activities

Regarding the Regulation of weather forecasting activities, the audit noted the following:

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(a) Existence of Unregistered Meteorological Stations in the Country

The presence of unregistered meteorological stations was noted in both meteorological stations under TMA and non-TMA meteorological Stations in the financial year 2023/24. Non-registered meteorological stations under TMA were 628, while the unregistered meteorological stations from non-TMA operators were 353. This was contrary to the requirement of the TMA Act, 2019, requiring TMA to register Meteorological Stations in the Country. This implied the availability of meteorological information not approved by TMA in other users. TMA failed to collect revenue amounting to TZS 105,900,000 as a registration fee from non-TMA unregistered meteorological stations.

(b) Inadequate Collection of Cost Recovery Revenue from Users of Meteorological Services

The audit noted that, the collection revenue from cost recovery declined from 79.6% in the year 2019/20 to 63.2% in the year 2023/24, whereby the average collection per year for five years was 53.6%. Therefore, TMA did not collect revenue of TZS 48,820,804,081 from cost recovery contrary to its annual plans, the requirement of TMA Act No.2, 2019, and the TMA Client Service Charter, 2008.

Coordination of the Provision of Weather Forecasting

In regards to coordination of the provision of weather forecasting, the audit noted the following:

Inadequate Level of Coordination Among Actors and Stakeholders in the Provision of Weather Forecasting

Based on the available Memorandum of Understandings, the Audit noted that there were three MoUs/service level agreements covering three out of the identified 16 stakeholders in Table 2.1 Stakeholder Analysis Matrix in the Strategic Plan for TMA. The three availed MoUs with relevant stakeholders were MoUs with the Ministry of Water, TARI and TAFORI.

The audit revealed gaps in enforcing MoU commitments, such as participation in events and sharing weather information with stakeholders. Due to poor coordination, TMA relied on weather stations from the Ministry of Water and TARI but lacked a register of these stations. Insufficient enforcement and monitoring of MoUs resulted in fragmented data provision, undermining the accuracy and regulation of weather forecasting information, which is TMA's mandated responsibility.

Audit Conclusion

The audit acknowledges the government's efforts in prioritizing the provision of meteorological services, investing in the procurement of radars in regions of Dodoma, Mbeya, and Kilimanjaro and upgrading radar stations in the Mwanza Regions.

The audit concludes that TMA has ineffectively managed and regulated meteorological services to ensure accurate, timely and reliable weather forecasts to support and safeguard public safety, economic activities, and environmental management. This was due to inadequate collection of

meteorological data for weather forecasting, ineffective processing of weather information, ineffective regulation of meteorological services, inadequate dissemination of weather information to the public and coordination with stakeholders in managing meteorological services.

Audit Recommendations

The Management of the Tanzania Meteorological Agency is urged to:

(a) Enhance the network for meteorological observations by considering integrating all weather stations into the National Network of Observations Stations;

(b) Establish a functional system for corrective and preventive maintenance of equipment in meteorological stations;

(c) Ensure the accuracy of all forecasted weather parameters is validated;

(d) Improve the processing of weather data and ensure the provision of downscaled weather forecasts and services;

(e) Improve the regulatory functions, ensure registrations of meteorological services, and issue permits to operate meteorological services;

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(f) Strengthen the dissemination of weather information and awareness about its use; and

(g) Improve coordination with internal stakeholders to enhance regulation and provision of meteorological services.

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Weather forecasting is essential in Tanzania, a country characterized by its diverse topography, which ranges from sea level in the east to an elevation of 1,600 meters in the west. This varied landscape includes notable features such as Africa's highest mountain, Mt. Kilimanjaro, the largest lake in Africa, Lake Victoria, and the deepest lake in Africa, Lake Tanganyika, among others. These topographic elements lead to significant spatial and local variations in weather and climate across the country.

As a result, weather forecasting in Tanzania requires a specific focus on incorporating these topographic features as forecasting parameters to enhance the accuracy of forecasts. The country's economy depends on weather and climate-sensitive sectors such as agriculture, fishing, transportation, energy, tourism, industries, and infrastructure.

With 66 per cent of Tanzania's workforce engaged in agriculture[1], timely and accurate weather information can help mitigate the impacts of adverse weather conditions on crops and livestock, thereby enhancing food security. In addition, accurate weather forecasting and climate prediction are critically essential for sustainable socio-economic development.

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Furthermore, precise weather forecasting and climate predictions are important in addressing climate change that has contributed to challenges of extreme weather events, such as droughts, floods, landslides, mudslides, wildfires, and strong winds in the country. Accurate weather forecasts and climate prediction could help mitigate the loss of life, protect property, and conserve the natural environment, significantly contribute to the production and growth of weather-sensitive sectors, and enhance the sustainable socio-economic of Tanzania.

The Tanzania Meteorological Authority (TMA) is the designated custodian of the national meteorological data collected from all meteorological stations nationwide. The Authority observes, collects, processes, archives, and disseminates weather forecasting information, including data on rainfall,

[1] National Five Years Development Plan 2021/22-2025/26

temperature, humidity, sunshine duration, wind speed and direction, evaporation, visibility, radiation, cloud, and pressure.

TMA disseminates weather forecasts through media, including radio, television, email, and newspaper, to ensure the public has access to timely weather information to stay informed and prepare for any potential weather-related events[2].

The Meteorological data/ weather information can be used effectively to alleviate some of the major problems of humankind related to climate variability and change.[3] TMA issues weather information that can be used for effective planning and decision-making in various sectors, such as agriculture and food security, water resource management, energy, disaster risks management, transport, and public health, and it informs its actions for achieving various national goals.[4]

Despite the importance of weather, TMA faces challenges such as ineffective provision and utilization of weather information, including inadequate meteorological infrastructure, inadequate communication facilities with other stakeholders, human resource development and inadequate and outdated weather and climate forecasting facilities. Inadequate meteorological infrastructure is especially characterized by insufficient meteorological observation stations across the country.[5]

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1.2 Motivation for the Audit

Effective weather forecasting and regulation of meteorological services are crucial to ensure the delivery of weather forecasting services. Thus, the decision to audit the forecasting and regulation of meteorological services was motivated by its importance and the reported weaknesses while providing weather services to the public of the United Republic of Tanzania.

This is despite the significant amount of funds spent on procuring equipment for the observation and processing of weather parameters to improve the provision of weather information and warnings to the public of the United Republic of Tanzania. Details on motivations are presented below:

[2] Tanzania Meteorological Authority (Weather and Climate Forecasting Activities) Regulations, 2021
[3] https://www.meteo.go.tz/
[4] Statement on status of Tanzania Climate of 2019-2023
[5] National framework for climate services 2018 – 2025

(a) Sustainable Development Goals to be Attained by 2030

Weather forecasting and provision of meteorological services relates to Sustainable Development Goal (SDG) 13: Climate Action. Accurate and timely weather forecasts are crucial for adapting to climate change and mitigating its impacts. They help understand and prepare for climate-related hazards, reduce the risk of natural disasters, and strengthen resilience. Further, weather forecasts support agricultural productivity (SDG 2), manage health risks from extreme weather (SDG 3), ensure better water resource management (SDG 6), optimize renewable energy production (SDG 7), enhance urban resilience to extreme weather events (SDG 11), and aid in the conservation of marine and terrestrial ecosystems (SDGs 14 and 15).

Based on these facts, effectiveness and efficiency in the collection, processing and distribution of weather information will enhance initiatives to attain SDG goals.

(b) Fatalities and Loss of Properties Noted in the Country from Uncollected Weather Information

The TMA statement on the status of Tanzania's Climate in 2023, reported on March 2024, indicates the occurrence of fatal weather events whose forecasting information was not adequately executed by TMA but had significant impacts in history. These weather events include the rainfall-induced landslides in Hanang, which led to the loss of properties and claimed the lives of 85 people;[6] flooding in Rufiji, which claimed the lives of 49 people [7] and Flooding in Lindi, which claimed the lives of 14[8] people.

(c) Less Coverage from the Collection of Weather Forecasting Information

According to the Performance audit report on flood control measures issued in March 2021, TMA presented generalised rainfall forecasts while not considering the geographical coverage of the country. For instance, forecasts are found to cover the entire zone, region, or district but are not

[6] https://www.mwananchi.co.tz/mw/habari/kitaifa/idadi-ya-vifo-hanang-yafika-85-4459096
[7] https://www.mwananchi.co.tz/mw/habari/kitaifa/watano-wafariki-mafuriko-morogoro-4503982
[8] https://www.tanzaniaweb.live/TanzaniaHomePage/NewsArchive/Waliokufa-kwenye-mafuriko-Lindi-wafikia-14-494545?gallery=1

specific to the catchment level. From the generalised forecasts, the impact of the use of weather forecasts is not realised as per the intention.

(d) Significant Amount of Funds Invested to TMA

From the fiscal year 2022/23 to 2024/25, the Government of Tanzania, through the budget for the Ministry of Transportation, allocated funds to TMA totalling TZS 33 billion for the purpose of financing radar projects, weather forecasting equipment and infrastructures to enhance efficiency in delivering its services. Therefore, it is vital to assess whether there is effectiveness in collecting, controlling, processing, and disseminating weather forecasting information to realize the value of money for the allocated funds.

1.3 Design of the Audit

1.3.1 Audit Objective

The objective of the audit was to assess whether TMA adequately manages meteorological services to provide accurate, timely and reliable weather forecasts to support and safeguard public safety, economic activities, and environmental management.

Specific Objectives of the Audit

Five specific objectives were used to address the main audit objective. These specific objectives assessed the following:

a) Adequacy of the processes and procedures for the collection of meteorological data to enhance the accuracy and reliability of weather forecasting;
b) Adequacy of processing of weather information to ensure the public receives downscaled weather forecasting information;
c) Regulation of weather forecasting activities to enhance the accuracy and reliability of weather forecasts that meet national and international standards;
d) Effectiveness of procedures for dissemination of weather information to the public, government agencies and other key stakeholders; and
e) Coordinate the provision of weather forecasting activities between ministries, private sectors, and TMA.

Specific audit questions and sub-audit questions were prepared to operationalize the above objectives clearly, as presented in ***Appendix 2***.

1.3.2 Scope of the Audit

The Ministry of Transport (MoT), through the Tanzania Meteorological Authority (TMA), was the main audited entity. The TMA is an authority responsible for regulating, coordinating, and providing meteorological services to the public, institutions, and individual users of tailor-made services for socio-economic development. The Authority is also responsible for issuing warnings and advisories on severe weather events to protect life and properties. The MoT is responsible for formulating and enforcing policies related to meteorological services in the country. The Ministry is also responsible for monitoring the performance of TMA in terms of the provision and regulation of meteorological services in the country.

In addition, the audit also covered the Ministry of Water and the Ministry of Agriculture. The two ministries were considered because they own meteorological stations and provide meteorological services in terms of meteorological data observations, for which TMA was to ensure the data observations conducted by ministries are of the required quality and meet the required meteorological standards.

The audit assessed adequacy in the provision of weather forecasting services and regulation of meteorological services as detailed below:

Regarding the collection of meteorological data from observation stations, the audit assessed the processes and procedures for collecting meteorological data from observation stations. It evaluated whether the observation network was adequate to ensure accuracy and reliable weather forecasting, timely transmission of data from observation stations to the central forecasting office and the implementation of corrective and preventive maintenance at the observation stations. Additionally, the audit assessed how well the meteorological observation stations were integrated into the National observation Network.

On the adequacy of processing weather information, the audit assessed the sufficiency of down-scaling weather forecasting and the effective use of modern data processing facilities to obtain accurate weather forecasts.

Furthermore, the audit assessed the regulation of meteorological services in enhancing the accuracy and reliability of weather forecasting. This included assessing the registration of meteorological stations in the country, issuance of permits to operators of meteorological services, inspection of meteorological stations, and assessing the adequacy of the collection of cost recovery revenue from users of meteorological services.

Also, the audit assessed the procedures for disseminating weather information to the public, government agencies, and other key stakeholders. The assessment included timeliness in disseminating weather forecasting, adequacy of dissemination channels for weather forecasting, awareness of the use of weather forecasting information in socio-economic activities, public safety and environmental management in the country and adequacy of using resources allocated for disseminating weather forecasting information.

Lastly, assessing the coordination among actors in the provision of weather forecasting activities involved assessing the established process for weather forecasting data and information sharing, incorporation of meteorological services in different government undertakings and level of coordination among actors and stakeholders to enhance the provision of weather forecasting.

The audit covered five financial years, from 2019/20 to 2023/24, to establish performance trends and draw sound conclusions about the performance of the Tanzania Meteorological Authority and the Ministry of Transport regarding providing weather forecasting services and disseminating weather information. This period was considered since the government made great changes in meteorological services, including enacting the act for meteorological services in 2019 and investing in new technologies by procuring five (5) weather radars.

1.3.3 Assessment Criteria

To assess the performance of MoT and TMA in weather forecasting and regulation of meteorological services, assessment criteria were drawn from different sources such as policies, legislations, guidelines, standards, good practices, and strategic plans from TMA.

Below are the assessment criteria used for each specific audit objective:

(i) Accuracy of Weather Forecasting and Status of Registration of Meteorological Stations

According to Regulation 13 (1) of the Tanzania Meteorological Authority (Meteorological stations) Regulations 2021, the meteorological operator shall inspect and maintain a high standard of observations and correct functioning of instruments.

According to Regulation 13 (1-2) of The Tanzania Meteorological Authority (Weather and Climate Forecasting Activities) Regulations, 2021, A person who observes a weather event which may affect the locality may inform the Authority immediately through any available means. The regulation further requires TMA to analyse such information and provide advice upon receipt of the information on the occurrence of weather events.

Also, Section 23(1) of the TMA Act, 2019 requires TMA to register all meteorological stations in the country.

(ii) Sufficient Processes and Procedures for Collecting Meteorological Data Sufficient to Ensure the Accuracy and Reliability of Weather Forecasting

According to section 5(2) of the TMA Act,2019, TMA shall organize and administer efficient surface and upper air station networks necessary to establish accurate records of the weather and climatic conditions. Also, sections 16 (3,4 & 5) of the Act give standard times of observations from meteorological stations: hourly observations and 6-hour intervals.

Regulation 26 of the Tanzania Meteorological Authority (Meteorological Equipment and Instrument) Regulations, 2021, requires that the meteorological station operators ensure the traceability of calibration of meteorological instruments through recognized national and international institutions dealing with standards.

Regulation 14 of the Tanzania Meteorological Authority (Meteorological Stations) Regulations, 2021 requires TMA that where a meteorological station operator establishes a station, the station shall be recognized as part of the national networks of observing stations.

(iii) Adequately Processes of Weather Information

Section 5 (g) of the Tanzania Meteorological Authority Act, 2019 requires TMA to process meteorological data and related information. In support of that, the TMA Strategic plan 2017/18 to 2021/22 indicated that TMA's Data

Processing and Forecasting System (DPFS) uses statistical and NWP techniques. SYNERGIE is also widely used to visualize weather systems and model outputs from various centres worldwide. It further indicates that, TMA was running two Numerical Weather Prediction models, Weather Research and Forecasting (WRF) and High-Resolution Model (HRM), for weather forecasting.

(iv) Effective Regulation of Weather Forecasting Activities to Meet National and International Standards

Sections 15 (1) and 16 (1) of the TMA Act of 2019 require persons intending to engage in any meteorological observations to apply for a permit to TMA. The permit shall be valid for one year and subject to removal.

Section 14(2) of the TMA Act, 2019 requires the regulation of TMA that shall include approval and registration of Meteorological stations. Furthermore, Section 23(1) of the TMA Act, 2019 requires TMA to register all meteorological stations in the country, including approval and registration of meteorological stations.

Section 32 (1) (b&c) of TMA Act No. 2, 2019 requires TMA to inspect and examine land, buildings, and equipment of meteorological stations and inspect and examine records and other information required to be kept by meteorological stations. Moreover, according to Regulation 13 (3) of the TMA (Meteorological Station) Regulations, the inspection frequency shall depend on the station type and shall be carried out according to the inspection timeframe.

Section 5(2)(i) of TMA Act No. 2, 2019 requires TMA to recover costs for meteorological services to ensure service sustainability. Also, Clause 6.2 (ii) of the TMA Client Service Charter, 2008, requires TMA's customers to pay for services.

(v) Procedures for Disseminating Weather Information to the Public, Government Agencies, and Other Key Stakeholders

According to Regulation 12 (2) (b) of The Tanzania Meteorological Authority (Weather and Climate Forecasting Activities) Regulations, 2021, media shall disseminate regular weather and climate forecasts.

According to Regulation 12 (1) of The Tanzania Meteorological Authority (Weather and Climate Forecasting Activities) Regulations, 2021, TMA is

supposed to issue forecasts and warnings to the media, including radio, television and newspaper, for dissemination to the public.

Regulation 11 (b) of The Tanzania Meteorological Authority (Weather and Climate Forecasting Activities) Regulations, 2021, requires TMA to issue accurate and timely weather forecasts and warnings to the public.

Para 5.1.2 goal 5 objective 2 of the goal Strategic Plan for Tanzania Meteorological Agency of 2017/18-2021/22 required TMA to inform the public to realize the social and economic benefits of weather and climate services by promoting awareness and sensitization of the public on the use of weather and climate services for safety and socio-economic benefit.

(vi) Effective Coordination Among Actors in Activities for the Provision of Weather Forecasting

Section 21 *(1&2)* of the Tanzania Meteorological Authority Act, 2019 requires TMA to prescribe the weather and climate for sectoral activities, including aviation, defence, finance, agriculture, construction works, environment, industries, marine, natural disaster, and relief management, water resources, health, power and steel, transport, science and technology, minerals, oil and gas, livestock, natural resources, tourism and any other sector as may be prescribed by the minister.

Section 22 of the Tanzania Meteorological Authority (Weather and Climate Forecasting Activities) Regulations, 2021, requires TMA to conduct a consumer consultative forum on meteorological services and products at least once every two years to discuss and share experiences and challenges.

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1.3.4 Sampling Techniques, Data Collection and Analysis Methods Used

Various methods for sampling, data collection and analysis were used by the Audit Team, as presented below:

(a) Sampling Techniques

Non-probability sampling was used to select the meteorological observation stations, key stakeholders of weather information and regions to be visited during the audit. The multi-stage and purposive sampling techniques were implied, as discussed below.

Based on the Strategic Plan for TMA 2017/18-2021/22, TMA operates several weather station categories, including synoptic, Automatic Weather Station

(AWS), rainfall, agrometeorological, upper air, and weather radar stations. **Table 1.1** gives a brief description of the meteorological stations.

Table 1.1: Different Categories of Meteorological Observation stations

Category of Weather Stations	Description
Synoptic	Operate on a regular schedule to provide comprehensive weather data
AWS	It is a self-operating system designed to collect and record meteorological data without requiring manual intervention.
Rainfall	Designed specifically to measure and record precipitation, including rainfall and sometimes snowfall
Agrometeorological	Support agricultural activities by providing weather data pertinent to farming practices.
Upper air station	Radiosonde observations are conducted, which involve launching weather balloons equipped with instruments that measure various atmospheric parameters as they ascend. These parameters typically include wind speed, temperature, humidity and temperature.
Weather radar station	They provide essential data for weather forecasting, severe weather monitoring, and climate research. Their advanced technologies enhance the understanding of atmospheric conditions and improve public safety.

***Source*:** Auditors' Analysis of information meteorological stations from TMA Strategic Plan 2017/18-2021/22, 2024

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A purposive sampling method was used to select regions to be included in the audit. To ensure adequate coverage of the country, the sampling began by considering the seven geographical zones: Southern, Northern, Southern Highlands, Eastern, Western, Central and Lake Zones, as shown in **Table 1.2.**

Table 1.2: Clustering of Regions Based on Geographical Zones

Geographic Zone	Regions Included
Eastern Zone	Dar es Salaam, Pwani
Western Zone	Kigoma, Tabora, Katavi
Northern Zone	Arusha, Tanga, Kilimanjaro, Manyara
Southern Zone	Mtwara, Lindi
Southern Highlands	Mbeya, Iringa, Rukwa, Njombe, Ruvuma
Lake Zone	Mwanza, Kagera, Geita, Mara,Shinyanga, Simiyu
Central Zone	Dodoma, Singida, Morogoro

***Source*:** Auditors' Analysis on the Sampled Regions, 2024

The selection of regions was based on a combination of criteria, including the type of weather station and the geographical zones.

Based on the database of registered TMA weather stations, synoptic, rainfall and AWS were found in almost every region. Priority of selection was then given to zones and regions with extra stations other than synoptic and AWS. These stations included weather radar stations, agrometeorological stations and upper air stations.

Five out of seven required weather radar stations were operational. They are in Dar es Salaam, Mwanza, Mtwara, Mbeya and Kigoma regions.

Therefore, selection priority was given to regions with operating weather radar stations in their respective zones, as detailed in **Table 1.3**.

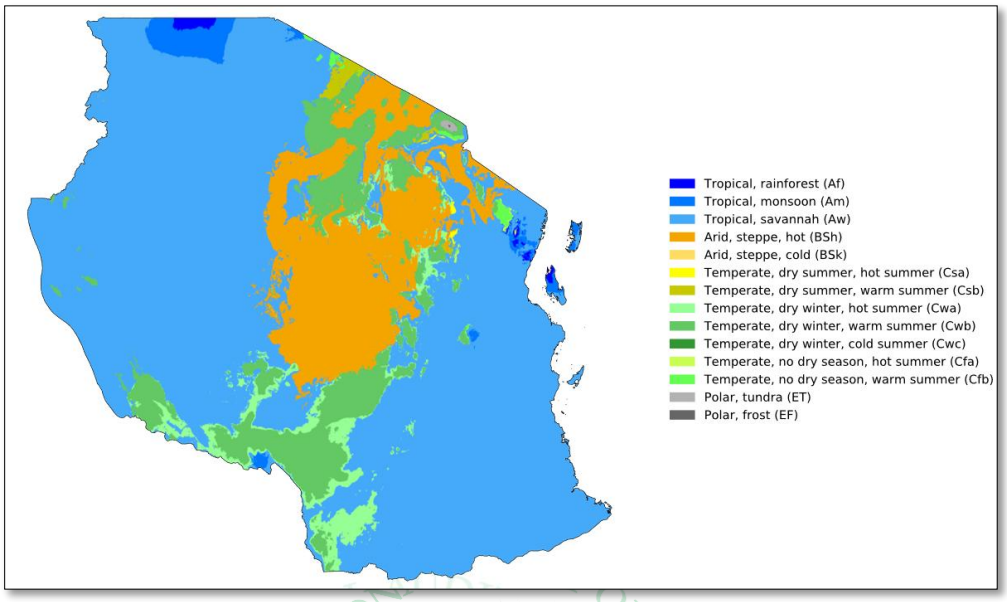
Table 1.3: Selected Regions during the Audit

Geographic Zone	Regions selected	Reason
Eastern Zone	Dar es Salaam	Weather radar, Upper air stations
Western Zone	Kigoma	Weather radar, AWS, Synoptic stations
Southern Zone	Mtwara	Weather radar, Synoptic, and Agrometeorological stations
Southern Highlands	Mbeya	Weather radar, AWS, Synoptic, and Agrometeorological stations
Lake Zone	Mwanza	Weather radar, AWS, Synoptic, and Agrometeorological stations

Source: Auditors' Analysis on the Visited Regions, 2024

Furthermore, based on the climatic classification described in **Figure 1.1**, four regions, Dar es Salaam, Mwanza, Dodoma and Mbeya, were selected for site verifications.

Figure 1.1: Climate Classification Map of Tanzania at 1km Resolution



Source: *Present and Future Koppen-Gigger Climate Classification Map (Beck et al. 2018)*

The Mwanza region was randomly selected to represent Kigoma, as the two regions share the same climatic zone (Tropical). Dar es salaam was also randomly selected to represent Mtwara, as the two regions almost share the same climatic zone (Tropical savannah).

Mbeya was selected to represent temperate regions as well as southern highland regions.

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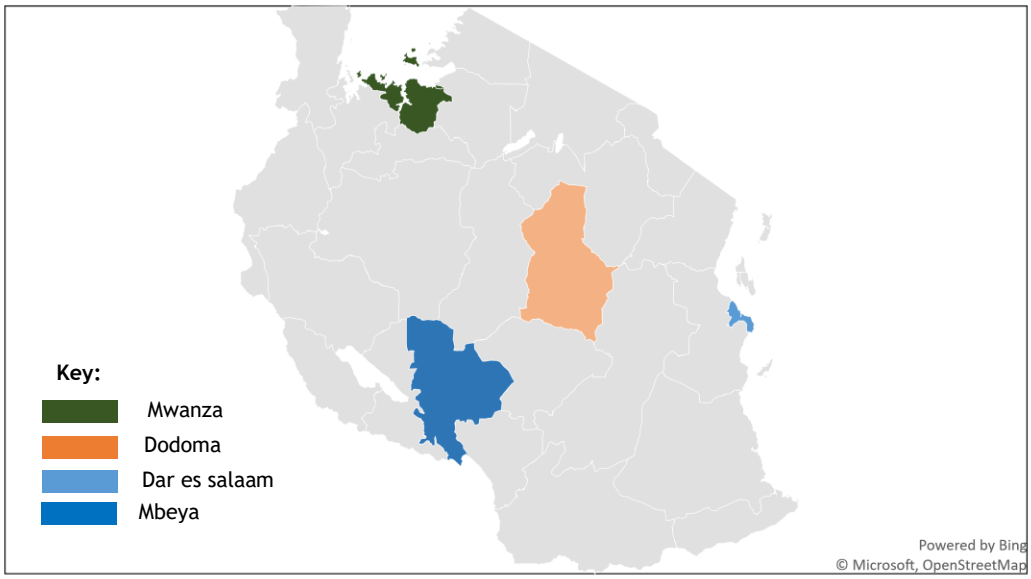
Despite Dodoma not having a weather radar station, it was purposively selected to represent regions with Semi-arid or arid climatic zones**. Figure 1.2** indicates the region chosen for verification purposes.

During verification visits, the focus was to check the functionality and accuracy of the equipment, data consistency, and station maintenance.

Figure 1. 2: Selected Regions for Verification



Source: Auditors' Analysis from the Sampled Regions, 2024

(a) Methods for Data Collection

Both qualitative and quantitative data were collected to provide strong and convincing evidence regarding the performance of MoT and TMA in weather forecasting and the dissemination of weather information in the country. The audit used different methods to collect data and information from the audited entities and other stakeholders.

These methods include interview, document review and physical verification, as detailed below:

Documents Review

The Audit Team reviewed documents from MoT and the TMA Office to get comprehensive, relevant, and reliable information on the performance of TMA and MoT in weather forecasting and the dissemination of weather information.

The reviewed documents from the audited entities were within the period under the audit, i.e., 2019/20 to 2023/24. The list of documents reviewed and the reasons for their review is presented in **Appendix Three**.

Interviews

Interviews were made with officials from MoT and TMA HQs. This enabled the Audit Team to get comprehensive, relevant and reliable information on weather forecasting and dissemination of weather information in the country. Furthermore, the interviews were used to validate information from the reviewed documents. The list of Officials interviewed and the reason for the interview is presented in **Appendix Four.**

Physical Verifications

As part of the data collection methods, the Audit conducted physical observation by visiting different meteorological observation stations and observing equipment and infrastructure. This enabled the collection of data that was used to substantiate or corroborate information obtained from interviews and document reviews.

During the site visit, the Audit team observed the provision of weather services processes. From the stations visited, the audit team was able to assess the compliance of operation requirements and compliance to standards and frameworks guiding the meteorological services both nationally and internationally.

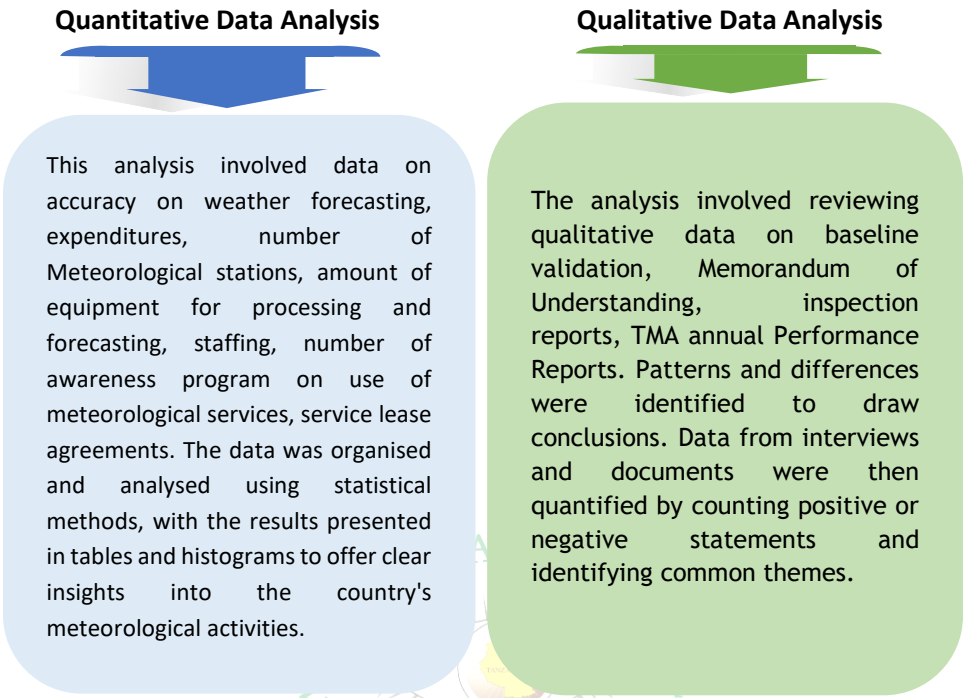
The audit used the following methods to record meteorological station site visitation results.

i. Taking photos of areas, machinery and equipment used in weather data observation;
ii. Noting (writing) all responses from interviewed personnel on-site; and
iii. Scanning of relevant documents found on site to get digital copies for enhanced analysis and evidence documentation.

(b) Methods for Data Analysis

The data analysis involved examining, categorizing, tabulating, and recombining both quantitative and qualitative evidence to address the audit objective, as discussed below in **Figure 1.3**.

Figure 1.3: Method for Data Analysis



1.4 Data Validation Process

The Ministry of Transport and TMA were given the opportunity to go through the draft report and comment on the information and figures presented. MoT and TMA confirmed the accuracy of the information and figures presented in this audit report.

The information was crosschecked and discussed with experts in the field of Meteorology to confirm the validity of the information and facts presented in the audit report.

1.5 Standards Used for the Audit

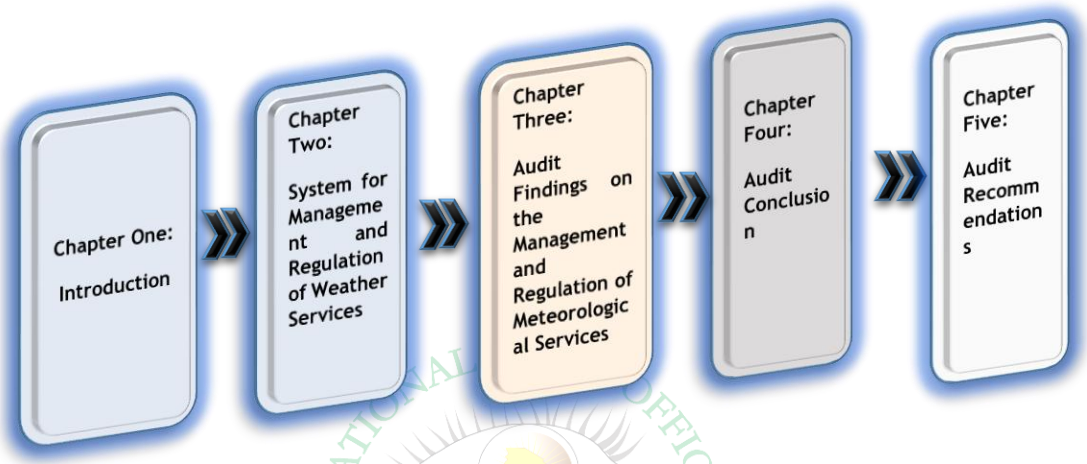
The audit was done in accordance with the International Standards of Supreme Audit Institutions (ISSAIs) on performance audit issued by the International Organization of Supreme Audit Institutions (INTOSAI).

These standards require that an audit is planned and performed to obtain sufficient and appropriate audit evidence to provide a reasonable basis for the findings and conclusion based on audit objectives.

1.6 Content and Structure of the Audit Report

The main parts of this report cover the following areas, as presented in **Figure 1.4**.

Figure 1.4: Content and Structure of the Audit



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CHAPTER TWO

SYSTEMS FOR THE MANAGEMENT OF METEOROLOGICAL SERVICES IN TANZANIA

2.1 Introduction

This chapter describes the system for the management of meteorological services in the country. It presents policies and legislations, strategies and plans governing the management and regulation of meteorological services in the country. It also presents the roles and responsibilities of key actors, funding arrangements, and the processes for managing and regulating meteorological services in the country.

2.2 Governing Policies, Legislations and Strategies

This part describes the policies, laws, and regulations that govern the collection, control, processing, and distribution of weather forecasts in the country.

2.2.1 Governing Policies

There is no specific policy governing meteorological services. However, the National Transport Policy of 2003 aimed at improving port capacity through the inclusion of meteorological information in maritime transport planning. The policy further states that adherence to meteorological forecasts, advisories, and warnings is of critical importance to marine transport safety.

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The policy also recognises the World Meteorological Organisation (WMO), which is the basis for the country's regulation of air transport infrastructure development and management.

Other Policies

TMA has no specific policy for the provision of meteorological services; however, its roles and functions are recognised by several policies such as the National Agriculture Policy, 2013; Construction Policy, 2003; National Health Policy, 2017; National Water Policy, 2002; National Disaster Management Policy, 2004; and the National Environmental Policy, 1997,2021. Since meteorological services crosscut various sectors in the country, implementing meteorological services will contribute to the achievement of different policies in the country. These policies are as detailed in **Table 2.1.**

Table 2.1: Descriptions of Policies Related to Meteorological Services

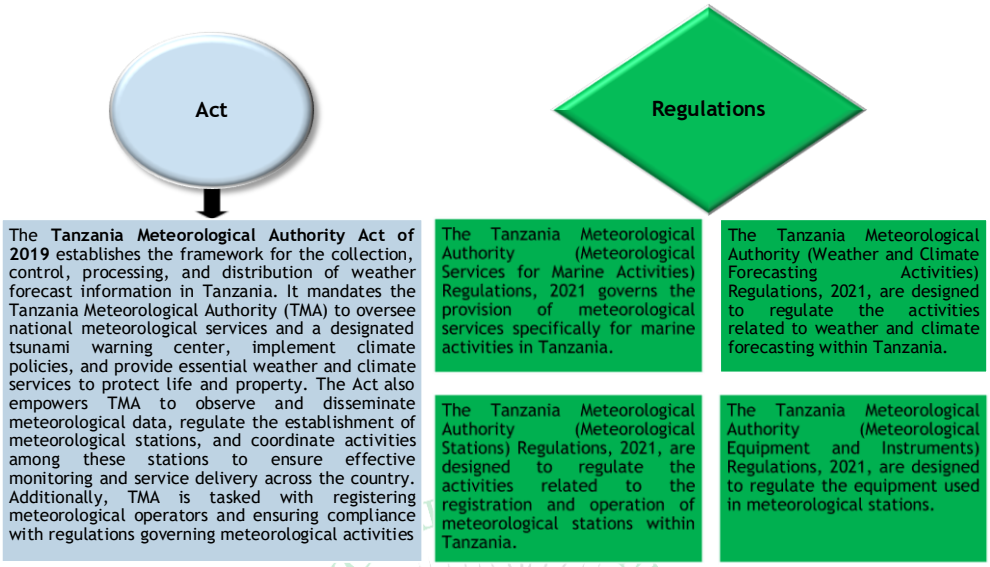
Policies	Statement in the policy on weather services
National Agriculture Policy, 2013	The policy underscores the necessity of accurate and timely weather and climate information to improve agricultural productivity and decision-making. It aims to enhance the capacity of farmers to access and utilize weather information for better planning and management of agricultural activities.
Construction Policy, 2003	The policy encourages the integration of climate and weather considerations into the planning and design stages of construction projects. This includes assessing the potential impacts of extreme weather events on construction activities and infrastructure longevity, such as heavy rainfall, strong winds, and temperature fluctuations.
National Health Policy, 2017	The policy aims to enhance the capacity of health services to respond promptly to weather-induced health emergencies and disasters.
National Water Policy, 2002	Emphasise the utilization of weather data to manage water resources effectively, ensuring sustainable water supply and addressing issues related to draught and flooding.
National Disaster Management Policy, 2004	Stress the need for timely weather forecasts and early warning to enhance disaster preparedness.
The National Environmental Policy, 1997,2021	The policy aimed at ensuring sustainable and equitable use of resources without degrading the environment or risking health or safety, preventing and controlling degradation of land, water, vegetation, and air, which constitute the essential life support systems. This necessitates the mainstreaming of meteorological services while implementing the National environmental policy.

Source: Auditors' Analysis from the Policies related to Meteorological Services, 2024

2.2.2 Governing Legislation

There are various governing legislations that provide for the management and regulatory framework of meteorological services in the country. **Figure 2.1** provides details regarding specific legislation governing the management of meteorological services in the country.

Figure 2.1: Specific Legislations Governing the Management of Meteorological Services in Tanzania



Source: Auditors' Analysis from Legislations Governing the Management of Meteorological Services, 2024

Plans and Strategies

This subsection outlines the available national strategies for meteorological services in the country.

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❖ **Strategic Plans for Tanzania Meteorological Agency**

This subsection outlines the available national strategies for meteorological services in the country.

(i) Strategic Plan for Tanzania Meteorological Agency 2017/18-2021/22

Goal number one for the strategic plan was to meet the efficient functioning of the organization realized to deliver quality and reliable services through establishing policy and strengthening of the legal framework for effective weather and climate services, strengthened quality assurance for quality and efficient weather and climate services, and enhancing monitoring and evaluation system.

Also, Goal 5, the strategic plan aimed at the Public and other stakeholders informed to realise social and economic benefits of weather and climate services, was by strengthening the capacities for generation of tailor-made weather and climate services to promote awareness and sensitization of the public and other stakeholders on the use of weather and climate services for safety and socio-economic benefits; and develop and implement a framework for service delivery.

(ii) Medium-Term Strategic Plan I 2021/22-2025/26

Objective C of the strategic plan is to improve the quality of meteorological services by improving the real-time data monitoring, data exchange, processing, and forecasting systems, strengthening marine and meteorological services for all climate-sensitive sectors.

Objective D of the strategic required quality assurance and regulation of meteorological sector players is enhanced to ensure compliance with meteorological services provision standards by sector players and the percentage of sector players regulated.

(iii) National Five-Year Development Plan 2021/22-2025/26

One area of intervention for the plan was to ensure the improvement of meteorological infrastructures and services by June 2025, and this is through:

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- Procuring and installing two weather radars by the year 2025 and upgrading the other two weather radars by June 2022/23;
- Marine observation systems installed at the Indian Ocean and major lakes;
- Acquisition and installation of lighting detectors across the country;
- Central forecasting Office building with required facilities in place by June 2025; and
- Rehabilitation of 12 meteorological stations

2.3 Roles and Responsibilities of Key Actors in the Management of Meteorological Services

This section provides information on key actors responsible for controlling, collecting, processing and distributing weather forecast information in the country. The actors are presented as follows:

2.3.1 Key Actors

The following are key actors in the provision of Meteorological Services.

The Ministry of Transport

The Ministry is also responsible for preparing the meteorological policy and managing its implementation, as well as managing and facilitating the development of weather and climate services using existing policies, laws, and guidelines for sustainable social and economic development.

Tanzania Meteorological Authority

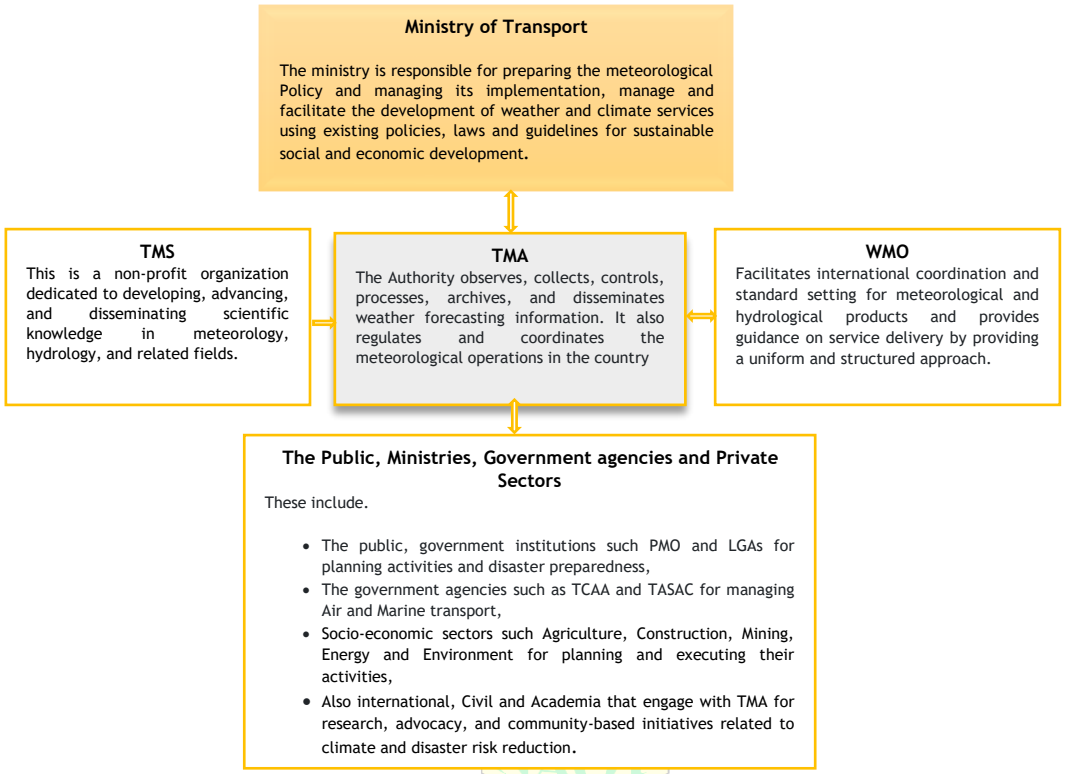
The Tanzania Meteorological Authority (TMA) was established under the Tanzania Meteorological Authority Act No. 2 of 2019 to make better provisions for the management, control, provision, coordination, and regulation of meteorological services and to provide for related matters.

The Authority observes, collects, processes, archives, and disseminates weather forecasting information, including data on rainfall, temperature, humidity, sunshine duration, wind speed and direction, evaporation, sea levels, thunders, fog, visibility, radiation, cloud and pressure. Also, regulate and coordinate meteorological activities in the United Republic of Tanzania.

2.3.2 Other Stakeholders

The management and regulation of meteorological services involve other stakeholders such as ministries, government agencies, departments (MDAs), local government authorities and non-government institutions. The roles and their responsibilities are described in **Figure 2.2.**

Figure 2.2: Relationships between Actors in the Management and Regulation of Meteorological Services



Source: Auditors' Analysis Institutional Set-up for Provision of Weather Services in the Country, 2024

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2.4 Categories of Meteorological Services and Data

Meteorological services refer to the activities and services provided to collect, analyse, and disseminate weather and climate information. Meteorological data refers to the information collected about atmospheric conditions, including temperature, humidity, wind speed and direction, atmospheric pressure, precipitation, cloud cover, and solar radiation. This data is gathered using a variety of meteorological instruments, such as thermometers, hydrometers, rain gauges, and hygrometers, as well as satellites, weather radars and weather balloons.

Meteorological Services and Data are crucial for forecasting weather, predicting climate, and supporting sectors like agriculture, transportation, and disaster management. These services provide accurate weather information for daily and long-term planning. Details on categories for

Meteorological Services and Data are presented in the subsequent subsections.

2.4.1 Meteorological Services

The Tanzania Meteorological Authority (TMA) provides a wide range of meteorological services aimed at supporting national development, disaster management, agriculture, aviation, and other sectors that rely on accurate weather and climate data for effective operations of daily activities. **Table 2.2** briefly describes key meteorological services provided by the TMA.

Table 2.2: Categories of Meteorological Services Offered by TMA

Service Area	Service Offered
General Weather Forecasting:	• Daily, weekly, and seasonal weather forecasts covering temperature, rainfall, and wind patterns for informed decision-making; and • Early warnings for severe weather events like cyclones, droughts and floods to enhance public safety and disaster preparedness.
Aeronautical Meteorological Services	TMA provides services at different stages of aircraft operations, such as take-off, cruising, and landing stages, as well as flight planning stages. The products and services provided are to enable smooth operations of the aircraft.
Climate Services	• TMA Monitors long-term climate trends in Tanzania, collecting data on rainfall and temperature to monitor climate variability; • Provides information to monitor climate change and its impacts across sectors and offers adaptation advice for sectors such as agriculture and urban planning; and • Generates seasonal climate predictions, particularly for agriculture, detailing expected rainfall and temperature patterns.
Agricultural Meteorological Services	TMA issues agrometeorological information and advisories, which are very useful to farmers and other users for planning purposes, irrigation scheduling to save water/energy, and choosing the optimum timing for spray of pesticides, application of fertilizers, animal husbandry and fishery.

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Service Area	Service Offered
Marine Services	• TMA delivers weather forecasts for coastal and lake areas to ensure the safety of fishermen and shipping activities; and • Provides tidal patterns and sea state information essential for maritime navigation.
Hydrometeorological Services	TMA provides hydrometeorological services to stakeholders through the provision of information on rainfall intensity that is useful in detecting storms and probable maximum precipitation occurrences, which are important for engineers in the construction industry. Common uses of the services are management of water resources for domestic, agricultural, hydropower planning, construction, tourism, commercial, industrial and recreational uses, health sector and environmental sectors.
Public Weather Services	• Disseminates weather information through multiple platforms, including radio, TV, newspapers, and mobile apps for real-time access by the public; and • Conducts public awareness campaigns to educate communities on weather-related risks.
Research and Development	• TMA is responsible for conducting and coordinating research in meteorology, climatology, agrometeorology and other related fields for the purpose of advancing meteorology and its applications, including the provision of services to various socio-economic sectors; and • Provides training programs for stakeholders to enhance expertise in weather observation and data analysis.
Tsunami Warnings	As a warning centre for tsunamis in Tanzania, TMA monitors and issues warnings for tsunami threats across Tanzania's coastal regions when necessary.
Regional Forecasting Supporting Centre	TMA has the regional responsibility of providing forecast guidance and Numerical Weather Prediction model outputs to the National Meteorological and Hydrological Services for the Lake Victoria Basin countries and the surrounding areas.

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Service Area	Service Offered
Technical Services	• TMA offers consultancy services on activities for designing, Building and Maintaining Meteorological Infrastructure; and • Install and perform corrective and preventive maintenance on all meteorological equipment and instruments.

Source: Auditors' Analysis of TMA Website and Forecasting Reports, 2024

2.4.2 Meteorological Data Provided

The Tanzania Meteorological Authority (TMA) provides a broad range of meteorological data and information essential for various sectors such as agriculture, disaster management, aviation, water resources, and more.

The main types of meteorological data and information provided by TMA are presented in **Table 2.3**.

Table 2.3: Meteorological Data provided at TMA

Data Category	Description
Weather Data	
Temperature Data	Collection of daily, monthly, and seasonal temperature patterns, including maximum, minimum, and average temperatures for sectors like agriculture and health.
Rainfall Data	Detailed rainfall data over various periods to assist in water resource management and agricultural planning.
Wind Data	Information on wind speed and direction for aviation, marine navigation, and agriculture.
Humidity and Dew Point Data	Humidity levels and dew points for climate services and irrigation management.
Pressure Data	Atmospheric pressure data for weather forecasting in aviation and storm prediction.
Climate Data	
Historical Climate Data	Long-term climate data for understanding trends and variability in rainfall, temperature, and wind.
Climate Change Projections	Future climate scenarios based on models predicting temperature and rainfall patterns.
Agricultural Meteorological Data	
Agro-Meteorological Information	Tailored weather information for farmers on planting, irrigation, pest control, and harvesting based on weather patterns.

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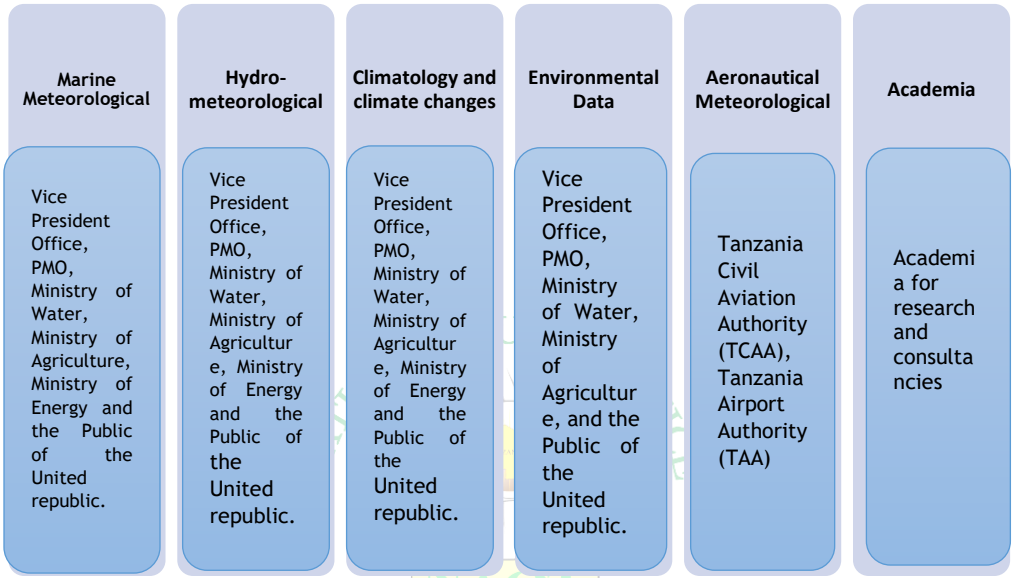
Data Category	Description
Crop-Weather Advisory Services	Advisory services to optimize crop yields by aligning agricultural activities with favourable weather conditions.
Hydrological Data	
River and Lake Water Levels	Tracking water levels in rivers/lakes for flood forecasting and irrigation planning.
Flood Forecasting Data	Real-time flood data predictions based on rainfall and river flow conditions.
Marine and Coastal Data	
Sea Surface Temperature	Data on sea surface temperatures affecting weather patterns and marine ecosystems.
Wave and Tide Data	Information on wave height and tide levels for coastal navigation, fisheries, and tourism.
Marine Weather Forecasts	Forecasts on marine conditions affecting fishermen and shipping activities.
Aviation Meteorological Data	
Airport Weather Information	Specific weather data for airports impacting flight safety, including visibility and wind conditions.
Aviation Route Forecasts	Detailed forecasts for air traffic routes to avoid adverse conditions during flights.
Severe Weather and Disaster Risk Data	
Cyclone and Storm Data	Information on tropical cyclones, including trajectories and expected impacts for disaster preparedness.
Tsunami Warnings	Early warnings on tsunami threats are useful to disaster risk reduction agencies, communities at risk, and the media so as to make sure that disasters related to tsunamis are minimal.
Remote Sensing and Satellite Data	
Satellite-Based Observations	The utilization of satellite data to monitor weather systems, cloud cover, etc., is crucial for tracking large-scale weather events.
Geospatial Weather Mapping	Remote sensing technologies to generate current condition maps displaying rainfall distribution, wind patterns, etc.
Public Weather Information	
Weather Alerts and Bulletins	Regular updates through public channels like radio/TV/digital platforms, including severe weather alerts.
Mobile and Online Access	Availability of weather data via mobile apps, websites, and social media for real-time updates to the public.
Severe Weather Warnings	Early warnings on extreme weather events like thunderstorms and floods, detailing location, intensity, and duration.

Source: Auditors' Analysis of TMA Website and Forecasting Reports, 2024

2.4.3 Key Users of Weather Information

Weather forecasting information is crucial to many sectors in the planning and implementation of their activities. The information disseminated by TMA with the respective users is detailed in **Figure 2.3.**

Figure 2.3: Key Users of Weather Information



Source: Auditors' Analysis of Information from TMA, Acts, SPs and Regulations, 2024

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2.5 Resources for the Management of Meteorological Services

Management and Regulation of Meteorological Services requires both financial and human resources. In realising so, the Government has allocated both financial and human resources to TMA as detailed hereunder:

2.5.1 Resources Allocated at TMA

Financial Resources at TMA

The TMA's operational budget mainly comes from three different sources: internal revenue generated from fees and charges, allocation from the Government budget for employee salaries, and financial support from other Development Partners.

TMA receives financial resources for the collection, controlling, processing and distribution of weather forecast information, as detailed in **Table 2.4.**

Table 2.4: Budgeted Fund for Collection, Controlling, Processing and Distribution of Weather Forecast Information at TMA

Financial Year	Total Estimates (TZS)	Disbursement (TZS)	Variation (TZS)	Percentage of variation (%)
2019/20	25,878,786,909	25,878,786,909	-	0
2020/21	33,647,861,966	16,040,032,880	17,607,829,086	52
2021/22	25,881,677,025	19,493,709,576	6,387,967,449	25
2022/23	29,485,931,025	22,862,843,233	6,623,087,792	23
2023/24	27,558,234,592	27,558,234,592	-	0

Source: Auditors' Analysis of Data Collected from TMA Annual Budgets and Implementation Reports 2019/20 to 2023/24, 2024

Table 2.4 shows that, for five financial years, the TMA received 100% of the budgeted amount for the financial years 2019/20 and 2023/24. Also, TMA received a budget deficit of 23% to 52% of budgeted funds for 2020/21 to 2022/23, respectively.

Human Resources for Managing and Regulating Meteorological Services in the country

For five years, TMA has allocated staff required to collect, control, process, and distribute weather forecasting information. This is shown in **Table 2.5**.

Table 2.5: Human Resources at TMA

Financial Year	Required Number of Staff	No. of Available Staff	Staff Gap	Percentage of Staff Gap (%)
2019/20	765	553	212	28
2020/21	765	546	219	29
2021/22	765	532	233	31
2022/23	765	513	252	33
2023/24	765	536	229	30

Source: Auditors' Analysis of Data Collected from TMA, 2024

Table 2.5 shows that, from 2019/20 to 2023/24, the TMA had a staffing deficiency average of 30.2%.

2.6 Key Processes for the Management and Regulation of Meteorological Services

The key processes and activities for meteorological services in the country are provided by the Tanzania Meteorological Authority (TMA) under the

Ministry of Transport. The key activities of TMA are derived from the power of the authority given by the Tanzania Meteorological Authority Act of 2019 and are summarized as follows:

2.6.1 Key Processes and Activities for Forecasting Weather Information

The key processes and activities for forecasting weather information can be categorised into four categories based on the analysis of the functions of TMA as per the Tanzania Meteorology Act of 2019. The key processes and activities are:

Registration and Issuing of Permits for weather observations and meteorological activities: This process aims to ensure that the observation stations meet the required quality standards in providing weather data and other meteorological activities.

Weather Observations: This activity is aimed at obtaining actual weather data in a specified time and transmitting it to the central forecasting office in a timely manner through emails, Faxes, phones, and other prescribed methods. The main standard times of observations of weather are 0000, 0600, 1200 and 1800 UTC. Details on weather observation stations are presented in **Appendix 5**.

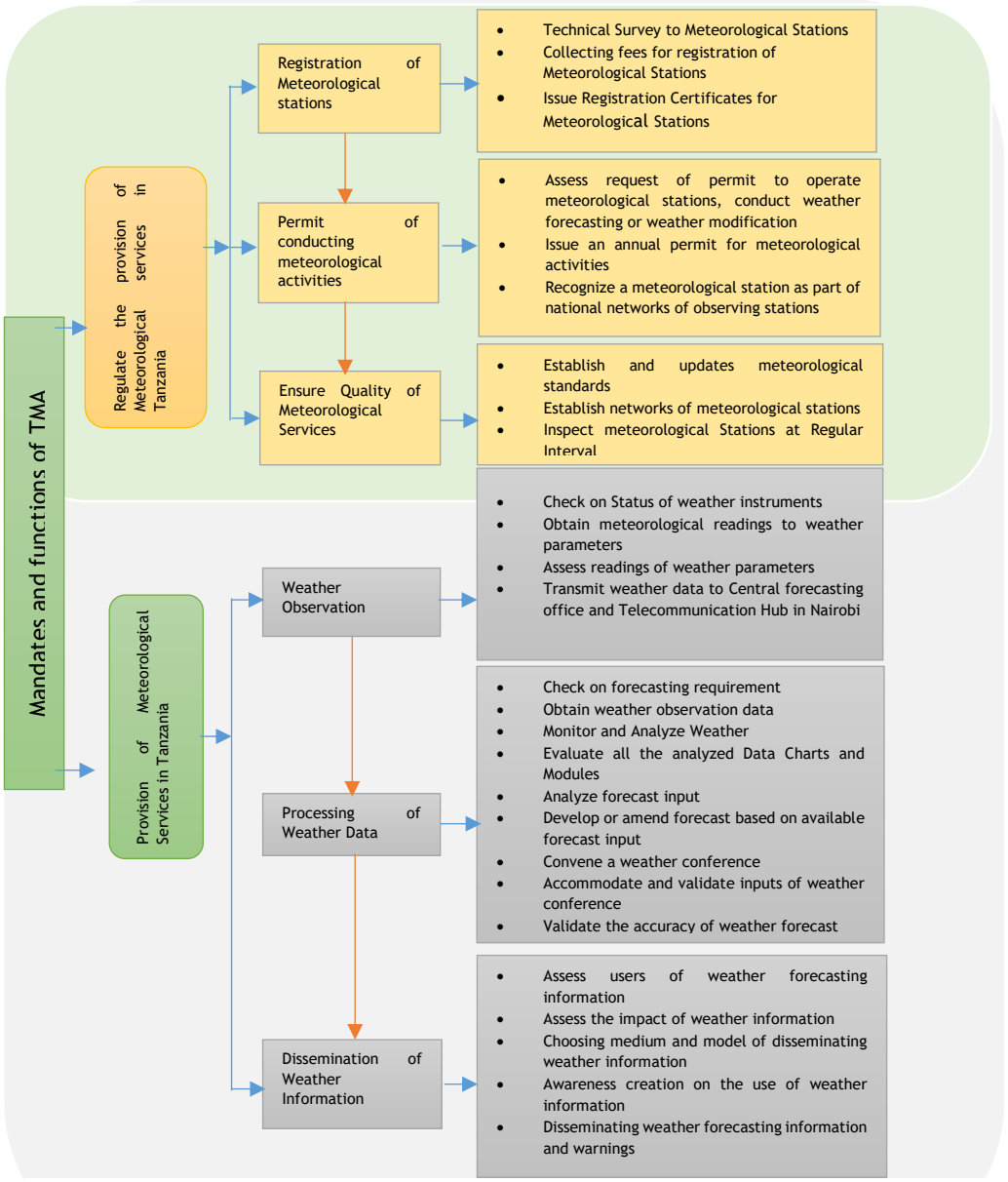
Processing of Weather Data: This activity is aimed at either obtaining weather forecasting information or amending it. It also aimed at obtaining information on the accuracy of weather forecasting.

Dissemination of Weather Information, Forecasting and Warnings: this involves informing the targeted population, government or private entities or the general public about the forecasted weather events and informing the necessary actions to benefit the weather event or minimize loss in case of bad weather events.

Regulation and Coordination of Meteorological Activities: this activity is aimed at ensuring that TMA and other Meteorological Services providers in the country provide quality and reliable weather services through accreditations to ensure the meteorological services provided are regularly inspected.

Details of the categories and respective sub-activities in the provision of meteorological services are detailed in **Figure 2.4.**

Figure 2.4: Key Process for the Collection, Controlling, Processing and Distribution of Weather Forecasting Information



Source: Auditors' Analysis of Process for Collection, Control, Processing, and Dissemination of Weather Forecasting Information from TMA Act,2019 and its Regulations, 2024

CHAPTER THREE

AUDIT FINDINGS

3.1 Introduction

This chapter presents findings on the management of meteorological services. Specifically, this chapter focuses on the findings related to the absence of downscaled weather forecasts and the inadequate accuracy of weather forecasting.

It also presents findings on the adequacy of collected meteorological data for weather forecasting (observation), processing of weather data, regulation of activities on provision of meteorological services, dissemination of weather information and coordination among actors in providing weather forecasting activities. Below are the detailed findings.

3.2 Overall State to Provision of Meteorological Services

TMA plays a crucial role in ensuring quality and reliable meteorological services that meet stakeholders' expectations by providing and regulating weather and climate services for the safety and sustainable social and economic development of Tanzania. However, the audit noted the inadequacy of weather forecasting, leading to profound and far-reaching consequences across various sectors in Tanzania, as detailed in the subsequent subsection.

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3.2.1 Unsatisfactory Coverage of Weather Forecasting;

The audit noted unsatisfactory weather forecasting coverage in terms of precise area coverage and limited coverage of sector demands. This poses challenges for effective decision-making in Tanzania. For instance, limited coverage in weather forecasting led to the absence of accurate forecasts for specific areas and locations, resulting in many rural and remote regions being underserved and making communities more vulnerable to unforeseen weather events. The details of unsatisfactory coverage of weather forecasting are as follows:

i. Inadequacy in Downscaling of Weather Forecast

A review of disseminated weather information indicated that the downscaled forecast was based on seasonal weather outlook and was

cascaded to the district level as TMA has been providing seasonal rainfall forecasts for 149 districts in the country, of which 86 Districts are for the bimodal rainfall regime, and 63 districts are for the unimodal rainfall regime.

Additionally, it was observed that TMA provided specific weather forecasts for specific areas, such as storms, humidity, and waves, upon request. This was evidenced by institutions such as TBA, TANROADS, TANESCO, and construction companies like FABEC, ON AFRICA, and Tanzania Gender and Sustainable Energy Network (TANGSEN), which requested weather forecasts for various locations across the country to optimize their operations affected by weather conditions.

However, in the review of the general weather forecasting, TMA downscaled the general weather forecasting to the regional level, oceans and lakes, which is contrary to the TMA set a target of reaching at least 70% of weather forecasts disseminated are downscaled to the district level by 2026 as to refer to page 73 of the National Climate Change Response Strategy 2021 to 2026. as detailed in **Table 3.1.**

Table 3.1: Status of the TMA Downscaling of Weather Forecasting

Year	Rainfall (Clouds, shower, Rain, thunder)	Wind (speed /Direction)	Tides	Temperature (Maximum)	Air Quality	Pressure
2019/20	Regional level	3 Lakes and Indian Ocean	3 Lakes and Indian Ocean	Regional level	Not Reported	Not Reported
2021/22	Regional level	3 Lakes and Indian Ocean	3 Lakes and Indian Ocean	Regional level	Not Reported	Not Reported
2022/23	Regional level	3 Lakes and Indian Ocean	3 Lakes and Indian Ocean	Regional level	Not Reported	Not Reported
2023/24	Regional level	3 Lakes and Indian Ocean	3 Lakes and Indian Ocean	Regional level	Not Reported	Not Reported

Source: Auditors' Analysis from Daily Weather Forecasting Report from 2019/20 to 2023/24, 2024

Table 3.1 indicates that TMA weather forecasting for rainfall and Maximum temperature was generalised over the regional levels, while wind speed was

provided in 3 Lakes and the Indian Ocean, therefore not downscaled to the district level or beyond as of June 2024.

The generalized weather forecasting at the regional level (without downscaling to districts, wards, or villages) was primarily driven by the high demand for model running time and the constraints imposed by limited computing resources necessary for downscaling forecasts to these specific areas. Additionally, TMA did not cascade the plan for attaining downscaled weather forecasting to the district level in either its annual targets or strategic plans.

This generalized presentation limits the relevance and applicability of forecasts for specific areas, such as rural communities, farming regions, or urban areas, which require more detailed, localized data to make effective decisions.

This gap in forecasting capability impacts key sectors like agriculture, transportation, and disaster *management*, emphasizing the need for improved meteorological infrastructure and localized forecasting systems to address these shortcomings effectively.

ii. Limited Coverage of Sectors Demand on Weather Forecasting

TMA is mandated in the provision of weather and climate services, particularly in regulating, coordinating, and providing meteorological services to the general public, institutions, and individual users for socio-economic development. The audit noted unsatisfactory coverage of sectorial demands in weather forecasting due to inadequate sharing of meteorological data by TMA, contrary to Section 3 of the Tanzania Meteorological Authority Act of 2019.

The audit noted that, TMA only provided meteorological and climate forecasts to aviation, marine, mining and construction sectors through tailormade forecast services, leaving other sectors unserved. **Table 3.2** provides an analysis of sector coverage on the expectations regarding meteorological services from TMA**.**

Table 3.2: Sector Coverage on the Expectations on Weather Forecasting

Sector Coverage	Expectations	Remarks
Aviation Sector	• Accurate and reliable weather forecasts and information for economic and safety aspects. • Safety oversight on aeronautical meteorological services. • Compliance with ISO 9001:2015.	TMA provides good meteorological services for aviation due to its accurate forecasts, sound processes, and investment in modern equipment. This has resulted in ISO 9001:2015 certification, which TMA continues to maintain.
Marine Sector	• Accurate weather forecasts in the ocean and lakes for safety aspects. • Compliance with International standards on marine weather services. • Calibration of marine meteorological instruments.	• Lack of reliability of weather forecast in oceans and lakes due to lack of validation of weather information. • Noncompliance and absence of calibration of the meteorological instruments in the marine sector due to the lack of marine weather stations
Mining Sector	• Accurate weather forecasts, data and climate information; and • Sectorial tailor-made information. • Calibration of meteorological instruments	• TMA provides sectorial tailor-made forecast • Inadequate calibration of meteorological instruments
Construction Sector	• Accurate and reliable weather and climate information • Downscaled weather forecast	TMA provides downscaled weather forecasts to the construction sector
Agriculture Sector	• Timely, accurate and wide coverage of weather information; and • Calibration services of meteorological instruments.	• Inadequate accurate weather information due to the presence of un-downscaled weather information • Inadequate calibration of meteorological instruments

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Sector Coverage	Expectations	Remarks
Industrial Sector (Construction Companies/ Institutions and Manufacturing Companies)	• Accurate and reliable weather and climate information	Inadequate accurate weather information due to the presence of un-downscaled weather information
Tourism Sector	• Sectorial tailor-made information • Calibration of instruments owned by National Parks	Inadequate calibration of meteorological instruments for National Parks
Energy, Gas and Oil exploration Sectors	• Accurate weather forecasts, data and climate information; and • Sectorial tailor-made information. • Calibration of meteorological instruments	Inadequate provision of accurate weather forecast. Inadequate calibration of meteorological instruments
Defence and Security	• Timely and accurate weather information. • Information on severe weather warnings for evacuation and rescue purposes.	Inadequate accurate weather forecasting information due to lack of data validation
Water and Environment Sectors	• Accurate weather information, forecasts and climate data for planning. • Maintenance and calibration of hydrometeorological stations	• Despite the presence of weather stations under the Ministry of Water, there was a lack of validation for the forecast weather information provided • Inadequate provision of accurate weather forecasting information
Media Sector	• Timely sharing of accurate information. • Use of understandable weather forecast information.	Inadequate timely sharing of weather forecasting information due to limited airtime for weather dissemination

Source: Auditors' Analysis from TMA Strategic Plan 2021/22 to 2025/26, 2024

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From **Table 3.2**, the audit noted inadequate achievement of sector expectations on weather forecasting and accuracy to meet the sectorial demands. Unsatisfactory sectors' demand for weather forecasting led Government institutions (such as the Ministry of Water, Ministry of Agriculture, Ministry of Energy and Ministry of Natural Resources and Tourism) to own and operate meteorological stations to support specific sector needs. The mode of operation (frequency and data format) of these stations and sensors used did not meet the required standards to support the Global Basic Observing Network[9] (GBON).

3.2.2 Inadequacy Provision of Early Warning on Extreme Weather Conditions

A review of the GBON National Contribution Plan of the United Republic of Tanzania indicated that despite TMA getting financial and technical support from external development partners through the "Climate Information and Early Warning Systems Project, which UNDP implemented with funds from the Global Environmental Facilities, indicated most of the procured 36 Automatic Weather Stations and integrated into the TMA observation Stations were nearing the end of their life span of service.

A review of the mid-term review's final report for Strengthening Climate Information and Early Warning Systems in Tanzania for Climate Resilient Development and Adaptation to Climate Change Project indicated that the TMA early warning system and monitoring were ineffective due to unreliable short-range and medium and long-range weather forecasting.

This was contrary to the requirement of the National Climate Change Response Strategy 2021-2026, which required TMA to improve monitoring and early warning systems through the installation of 2 monitoring and surveillance systems by 2026, and at least 70% of coastal communities with timely access to accurate and reliable climate services by 2026.

Inadequate provision of early warning resulted in unpreparedness and, hence, loss of life and properties in different parts of Tanzania, such as Lindi, Morogoro and Hanang. This resulted in delayed and misled early warning that led to the loss of lives of people, the death of hundreds of

[9] GBON National Contribution Plan of WMO, February 2024 on the assessment of national government and private organizations of relevance for the operation and maintenance of GBON

livestock, damage to houses and infrastructures and high cost of maintenance and repair of damages.

3.3 Non-attainment to Accuracy of Weather Forecasting

The accuracy of weather forecasts plays a critical role in supporting decision-making across various sectors, including agriculture, disaster management, transportation, and energy. Inaccurate weather predictions disrupt planning and resource allocation and increase vulnerability to climate-related risks.

The review of the weather forecast accuracy at TMA noted that, TMA did not attain a set target on the accuracy of weather forecasting. Also, TMA did not have a record of the accuracy of weather forecasts of all parameters except for rainfall, as detailed below:

3.3.1 Inadequate Accuracy of Weather Forecasting

According to the TMA annual performance reports for the financial year 2019/20 to 2023/24, the audit noted that TMA only attained the target for the accuracy of weather forecasting in the year 2022/23, while in the rest of the years, TMA did not attain its targeted levels to the accuracy of weather forecasts, this was contrary to the requirement of the accuracy of weather forecasting indicated in the Strategic Plan of TMA of 2017/18 to2021/22 and the TMA Medium Term Strategic Plan I of 2021/22 to 2025/26, TMA planned to maintain the accuracy of 90%, 95% in weather forecasting for the years of 2019/20 and 2020/21 whereas, for the years 2021/22 and 2023/24, TMA planned to attain an accuracy of weather forecasting of 87.1%, and 87.5% respectively.

In the financial year 2022/23, TMA abnormally lowered the target from the planned weather accuracy to 82%. The details of TMA attainment to the accuracy of weather forecasting are detailed in **Table 3.3.**

Table 3.3:Accuracy of TMA weather forecasting from 2019/20-2023/24

Financial Year	Planned Accuracy Level (%)	Achieved Accuracy Level (%)	% Addition (+), Reduction of Target (-)
2018/19	**85**		
2019/20	90	80	+5
2020/21	95	75	+5
2021/22	87.1	86.5	-7.9
2022/23	82.0	89.4	-5.1
2023/24	87.5	86.9	+5.5

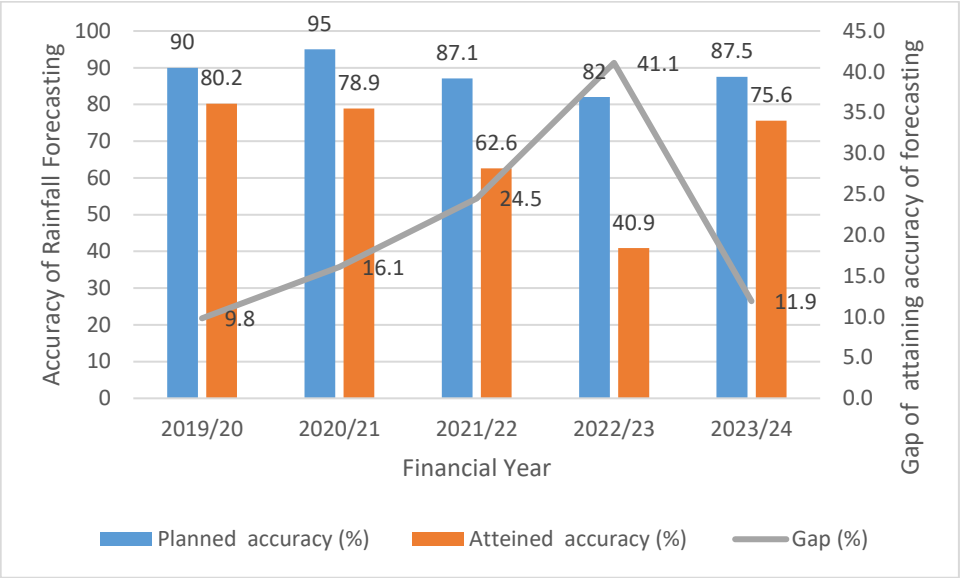
Source: Auditors' Analysis of Accuracy on Weather Forecasts as Reported in Strategic Plan for Tanzania Meteorological Agency (2017/18-2021/22) and TMA Medium Term Strategic Plan I 2021/22-2025/26 and TMA Annual Performance Reports 2019/20-2023/24, 2024

Table 3.3 shows that TMA did not achieve its goals of accuracy in weather forecasting for the years 2019/20, 2020/21 by 10% and 20%, respectively and by 0.6% in years 2023/24, in the year 2022/23 it was noted that the target for the accuracy in weather forecasting was achieved after TMA reduced the target by 5%. Also, the decrease in the gap in accuracy signifies an improvement in weather forecast accuracy despite the decline in targeted accuracy levels from 95% to 87.1% and 87.5% in the years 2020/21 and 2023/24.

The non-attainment of the accuracy of weather forecasting was contrary to Regulation 11 (1) (b) of the Tanzania Meteorological Authority (Weather and Climate Forecasting Activities) Regulations of 2021, which requires TMA to issue accurate weather forecasting and warnings to the public.

Furthermore, the audit noted that, TMA did not attain the accuracy of rainfall forecasting for 2019/20 to 2023/24. The accuracy of rainfall forecasting is presented in **Figure 3.1.**

Figure 3.1: The Accuracy of Rainfall Forecasting



Source: Auditors' Analysis of TMA Data on the Accuracy of Weather Forecasting for Rainfall (24 hours) for Years 2019/20-2023/24, 2024

From **Figure 3.1**, the data indicates that the accuracy of rainfall forecasting for the year 2022/23 was the lowest, with a shortfall of 46.2% from the target accuracy level. In contrast, the best performance in rainfall forecasting occurred in 2019/20, with a deviation of 9.8% from the TMA established target for the year.

The audit noted that, the reason for not attaining the intended accuracy level of weather forecasts was the limited number of meteorological observation stations available to represent all parts of the country as presented in **Table 3.10**, shortage in equipment for the processing of weather forecasting, and existence of inadequately regulated meteorological stations.

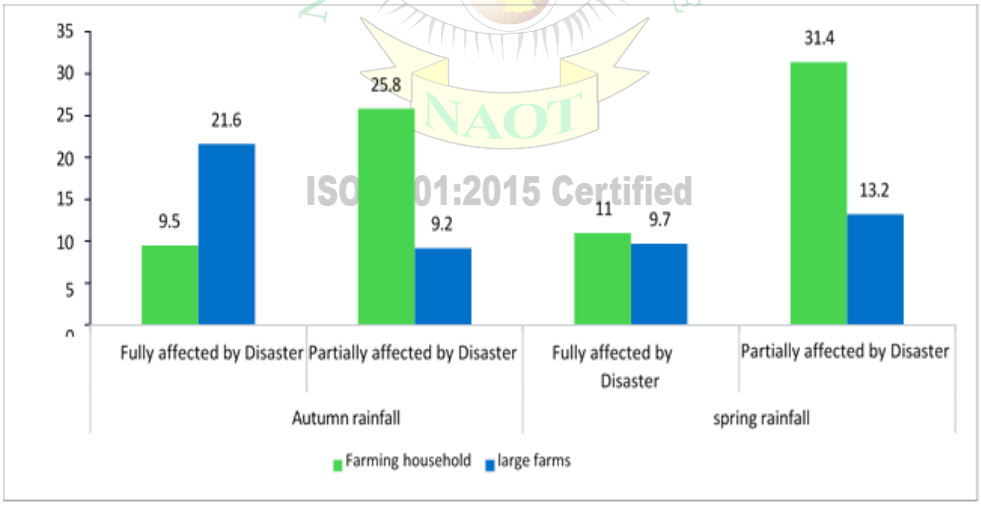
The lack of accuracy of weather forecasting resulted in generalized and non-down scaled weather forecasting information at zonal levels with no actual representation of weather situation to a specified area such as districts, wards, and villages. Further, inaccuracy in weather forecasting leads to the loss of life and properties and unexpected utilization of government funds. Details of the noted impact of inaccuracy weather forecasting in agricultural sectors are as detailed below:

Impact of Weather Forecasting in the Agricultural Sector

Agriculture, as the backbone of Tanzania's economy, is highly dependent on accurate weather predictions for planting, harvesting, and mitigating risks of droughts or floods. Poor forecasting can lead to crop failures, food insecurity, and economic instability. Furthermore, the agricultural sector has faced significant challenges due to extreme weather events between 2019 and 2024, leading to substantial economic losses and food insecurity.

In the 2022/23 agricultural rainfall season, during the short rains, 9.5% of the total area planted by farming households was fully affected by abnormal rainfall (disasters), and 25.8% was partially affected. While for large farms, 21.6% were fully affected, while 9.2% were partially affected. During the long rains, 11.0% of the area planted by farming households was fully affected, and 31.4% was partially affected. In the same season, 9.7% of the total area planted by large farms was fully affected, and 13.2% was partially affected (**Figure 3.2**).

Figure 3.2: Percentage of Affected Area Planted by Crops Due to Disasters During the 2022/23 Agricultural Year



Source: National Census of Agriculture, National Report, 2022

Moreover, in the 2019-2020 agricultural season, severe floods resulted in considerable losses for farmers in key crop-producing regions, including Manyara, Morogoro, and Mbeya. These floods were among the primary challenges reported by approximately 18% of agricultural households, highlighting the impact of climate change on farming activities[10]. For

[10] P4Arm Statista

example, abnormal rainfall in 2022/23 from the Local Government Authorities in the Morogoro region affected the affected area's food crops, as detailed in **Table 3.4.**

Table 3.4: Assessment of the Area Affected by Food Crops in the Local Government Authority

Local Government Authorities	Targeted Area (Ha)	Planted Area (Ha)	Affected Area (Ha)	Percentage of Affected (%)
Gairo DC	79,527.65	55,195.85	23,894.4	43
Ifakara TC	39,295.60	26,322	490.2	2
Mlimba DC	148,279.00	143,067.8	32,190.26	22
Kilosa DC	190,191.00	162,447	61,442	38
Malinyi DC	69,104.00	66,313	17,241.38	26
Morogoro DC	168,710.00	112,948	28,719.2	25
Morogoro MC	5,792.16	5,075.61	2,537.8	49
Mvomero DC	163,254.00	114,278	53,253.5	46.6
Ulanga DC	74,294.89	61,021	5,383.24	9
Total	**938,448.30**	**746,668.26**	**225,151.98**	**30.2**

***Source*:** Morogoro Region website, https://morogoro.go.tz/hifadhi-ya-mikumi,2024

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Table 3.4 shows that overall, 30.2% of the targeted area was affected by abnormal rainfall that misled farmers who planted crops in December 2022 due to increased rainfall, which stopped in February 2023, leading to affected crops due to the prolonged dry season.

Furthermore, during the 2023-2024 season, El Niño-induced rains caused floods that destroyed 240,709 metric tons of crops valued at TZS −17.6 billion (equivalent to $69 million). Around 90,000 livestock worth TZS 15.8 billion (equivalent to $62 million) were also lost across 14 affected districts. These losses represent a substantial setback to the country's agricultural sector and economy, considering that the crop sector contributes about 25% to Tanzania's GDP and the livestock sector around 7%.[11]

[11] East African Herald Xinhua News

The frequency of natural disasters has also been notable. Between 2014 and 2020, Tanzania reported 34 natural disasters, such as floods and storms, with 2019 witnessing multiple events, including a cyclone, flash floods, and a hailstorm within two months.

These statistics underscore the critical need for improved weather forecasting and climate adaptation strategies to mitigate the adverse effects of climate variability on Tanzania's agriculture and food security.

3.3.2 Absence of Records for the Accuracy of Weather Forecasting on Wind, Temperature, Tides, Oceanic Waves, Humidity, Pressure, and Sunshine

A review of TMA accuracy data on weather forecasting noted that, TMA validated weather forecasting for aviation as per ICAO standards Annex 3. However, TMA did not validate the accuracy of weather forecasts in other areas, such as marine and general weather, for parameters such as oceanic waves, sunshine, wind, and temperature (maximum and minimum), contrary to its target of attaining accuracy weather forecasting of 90%, 95%,87.1%, 82% and 87.5% for the year 2019/20 to 2023/24 as presented in **Table 3.5.**

Table 3.5: Status of TMA Records for Accuracy of Weather Forecasting

Status on Records of Accuracy	Weather Parameter
No records at TMA	Humidity
No records at TMA	Oceanic waves
No records at TMA	Pressure
No records at TMA	Sunshine
No records at TMA	Sunshine
No records at TMA	Temperature
No records at TMA	Wind
No records at TMA	Other Parameters
Records Available at TMA	Rainfall

Source: Auditors' Analysis of Weather Forecasting Information from TMA for the Financial Year 2019/20 to 2023/24, 2024

Table 3.5 indicates that, the accuracy of weather forecasting at TMA was based solely on rainfall parameters, as TMA did not validate the other parameters.

A review of TMA's plans for the accuracy of weather forecasting for the years 2019/20 to 2023/24 revealed that the absence of records on forecast

accuracy was due to gaps in TMA's planning for achieving accurate weather forecasting. The plans did not specify the parameters that would be considered to measure their forecasting accuracy. Additionally, the focus on accuracy fluctuated across different years without a clear rationale. Furthermore, discrepancies were observed between the strategic plan and the annual plans concerning the accuracy of weather forecasting, as detailed below.

(a) The Plan for the Accuracy of Weather Forecasting was not Specific on Parameters and or Periods of Weather to be Considered.

The audit noted that TMA plans for weather forecasting did not specify the parameters to be considered for assessing the accuracy of weather forecasts. Also, the plans lacked detailed targets for weather forecasting accuracy across different categories, including short (nowcasting) range, medium range forecasting and seasonal weather forecasting.

(b) The Plan for the Accuracy of Weather Forecasting was Deflected Without Rationale

The audit noted that TMA plans on the accuracy of weather forecasting changed over different years without any stated justification for the adopted changes, as detailed in **Table 3.6.**

Table 3.6: Changes in Plans of the Accuracy of Weather Forecasting as per the TMA Strategic Plans

Year	Target for Accuracy of Weather Forecasting	Differences in Target for the Accuracy of Weather Forecasting	Comment (No Reason for Change(N)
2019/20	90	0	Not Applicable
2020/21	95	+5	N
2021/22	87.1	-7.9	N
2022/23	82	-5.1	N
2023/24	87.5	5.5	N

Source: Auditors' Analysis of Plan for Accuracy of Weather Forecasting from TMA Strategic Plans, 2024

Table 3.6 indicates that, the plan for the accuracy of weather forecasting changed by 5 to 7.9%. The largest change was noted in the financial year 2021/22, where the plan for accuracy of weather forecasting declined by 7.9%.

Further, the changes were noted in the annual plans for the accuracy of weather forecasting in the financial year 2019/20 to 2023/24, as presented in **Table 3.7.**

Table 3.7: Changes in Plans of the Accuracy of Weather Forecasting as per the TMA Annual Plans

Year	Target for Accuracy of Weather Forecasting	Differences in Target for the Accuracy of Weather Forecasting	Comment (No reason for change/target(N)
2019/20	90	0	N
2020/21	90	0	N
2021/22	81	-9	N
2022/23	81	0	N
2023/24	81	0	N

***Source*:** Auditors' Analysis of Plan for Accuracy of Weather Forecasting from TMA Annual Plans, 2024

Table 3.7 shows that, TMA reduced the target for the accuracy of weather forecasting in the financial year by 9%. However, no bases were stated for such a significant change from the annual target on the accuracy of weather forecasts.

(c) Conflicting TMA Plans on the Accuracy of Weather Forecasting

The review of TMA Strategic plans and TMA annual plans for the year 2019/20 to 2023/24 indicated that, TMA planned for the accuracy of weather forecasting with a noted conflicting target in both the strategic plan and the TMA annual plans as presented in **Table 3.8.**

Table 3.8: TMA Conflicting Target on the Accuracy of Weather Forecasting

Financial Year	Planned Accuracy of Weather Forecasting (%)		Discrepancies
	TMA Strategic Plans	TMA Annual Plans	
2019/20	90	90	0
2020/21	95	90	-5
2021/22	87.1	81	-6.1
2022/23	82	81	-1
2023/24	87.5	81	-6.5

***Source*:** Auditors' Analysis of the planned accuracy of weather forecasting from the TMA Strategic Plans and Annual Plans, 2024

Table 3.8 reveals that, the TMA strategic and annual Plans had discrepancies ranging from 1 to 6.5% for 2019/20 to 2023/24. The discrepancies in these documents were attributed to TMA's failure to thoroughly review its plans in both the strategic plan and annual plans.

Therefore, TMA tends to conceal its actual performance from the unrecorded accuracy of weather forecasting, with a risk that TMA does not identify weaknesses in prediction models to provide insights for improvement and refining methodologies and enhancing forecast quality.

3.4 Collection of Meteorological Data for Weather Forecasting

The Audit noted that TMA managed to increase the availability of meteorological data by upgrading the existing radar stations in Dar es Salaam and Mwanza and installing automatic weather stations (AWS).

However, the audit noted deficiencies in the network for the collection and transmission of weather information from weather observation stations, maintenance of weather observation stations, and integration of non-TMA weather observation stations into the national network of observation stations.

This was contrary to Goal Number 2 of the Strategic Plan for Tanzania Meteorological Agency 2017/18 to 2021/22, which required TMA to expand the network of meteorological stations and maintain an optimal number of stations by increasing the number of modern meteorological observation stations, fixing buoyancy operating in the Indian Ocean, strengthening radar networks and establishing meteorological satellite receiving by June 2021 as detailed in the subsequent sub-sections:

3.4.1 Insufficient TMA Network for Collection of Meteorological Data

A review of the GBON National Contribution Plan of the United Republic of Tanzania for the Systematic Observations Financing facility of February 2024 indicated that all TMA Observations Stations are not GBON-compliant as they did not meet the minimum observation requirements in terms of areas coverage, whereas according to the gross areas of Tanzania of 947,323 km2 indicated that a total of 27 surface stations required as GIBON compliant to at least meet the minimum requirement of resolution of 200km by 200km. Five upper air stations have a minimum requirement of 500km by 500km to cover the territory of the country.

This was contrary to Section 5(2)(c) of the TMA Act 2019, which requires the TMA to organize and administer efficient surface and upper air station

networks necessary to establish accurate weather and climatic conditions records. The details on the gap of observation stations are presented in **Table 3.9.**

Table 3.9: Gap of Weather Observation Stations as per the Global Basic Observing Network Requirement

GBON Requirements	Target (Number of Stations)	GBON Compliant Stations	Gap
Surface Stations Horizontal resolutions: 200km Variables: SLP, T, H, W, SD Observation Cycle: 1h	27	0	27
Upper -air Stations Horizontal resolution: 500Km Vertical resolution 100m Variables: T, H, W Reporting cycle: Twice a day	5	0	5

Sources: Auditors' Analysis WMO GBON National Gap Analysis, 2024

Key: T-Temperature, H- Humidity, P- Precipitation, SD-Snow Depth, SST- Sea Surface Temperature, ALP-Atmospheric Pressure, SLP-Sea Level Pressure, W-Wind.

Table 3.9 indicates that, TMA did not fulfil the basic requirements of weather observation networks for both 200km and 500km surface station horizontal resolution and upper-air stations horizontal resolution resolutions, respectively. Therefore, the weather observation coverage does not comply with the minimum requirements under GBON.

Furthermore, the review of the TMA Guide to the Establishment of Meteorological Stations 2018, as updated in 2024, indicated a gap in the network for meteorological data collection, as detailed in **Table 3.10**.

Table 3.10: Status of TMA Gap on National Meteorological Observation Stations

Year	Required Number of Meteorological Observation Stations	Available Number of Operational Meteorological Observations Stations	Gap in the Number of Observation Stations at TMA
2019/20	4201	884	3,353
2020/21	4,201	884	3,353
2021/22	4,201	884	3,353
2022/23	4,201	884	3,353
2023/24	2,613	764	1,838

***Source*:** TMA Guide to the Establishment of Meteorological Stations 2018 as Updated in 2024

From **Table 3.10**, it can be noted that TMA had a gap of 79.8% of the required meteorological observation stations in financial years 2019/20 to 2022/23 and improved to a gap of 70.3% in the financial year 2023/24, the improvement on a gap of meteorological observation stations was noted from the reduced number of the required meteorological observation station in the updated TMA Guide to the Establishment of Meteorological Stations of 2024.

The insufficient network for meteorological observation stations was attributed to the presence of non-operational TMA meteorological observation stations. According to the TMA Guide for the Establishment of Meteorological Stations 2018, TMA had 2,057 non-operational meteorological observation stations. Furthermore, the TMA determination of the required number of meteorological observation stations contributed to the gap in their availability, as evidenced by a shortfall of 1,588 observation stations between 2022/23 and 2023/24.

The ineffective network for collecting meteorological data resulted in unverified weather forecasting information and limited the coverage and accuracy of weather forecasting information.

3.4.2 Delay in the Transmission of Weather Data from Meteorological Observation Stations to Central Forecasting Office

The review of weather observation data for a year 2019/20 to 2023/24 from the TMA indicated that TMA received observation data for wind, temperature, rainfall, sunshine, and pressure at its central forecasting office from the observation stations on daily basis divergent to Regulation 16 (3,4 & 5) of the Tanzania Meteorological Authority (Meteorological Stations) Regulations, 2021, which requires standard times of observations from meteorological stations, which are hourly and 6-hours intervals.

However, in three of the four regions visited, namely, Mwanza, Dodoma and Mbeya, the audit noted that weather observation data from synoptic and Agro-Met stations were not transmitted to the Central Forecasting Office in Dar es Salaam. Information about maximum and minimum temperatures, soil temperature, soil moisture, sunshine and wind directions were also not transmitted as detailed in **Table 3.11.**

Table 3.11: Status of Transmission of Weather Observations Data from Visited Weather Observations Stations

Regions	Name of Stations	Parameters	Time required for the data to be transmitted	Average time used to transmit the data
Mwanza	Ukiligulu Agro-Met	Soil Temperature	Twice a Day	No records
		Soil Moisture	Twice a Day	No records
Dodoma	Hombolo Agro-Met	Soil Temperature	Twice a day	No records
		Sunshine	Once a Day	No records
		Maximum Temperature	Twice a day	No records
Mbeya	Mbeya Airport (synoptic Station)	Sunshine	Twice a day	No records
	Uyole Agro-Met	Soil Temperature	Twice a Day	No records
	Songwe Airport (synoptic station)	Wind direction	Half an hour	No records

Source: Auditors' Analysis from Visit to TMA Weather Stations in Mwanza, Mbeya, and Dodoma Regions, 2024

Table 3.11 indicates that, five out of nine visited weather observation stations never transmitted weather observation information to the TMA Central Forecasting office in Dar es Salaam for processing and archiving.

These stations did not transmit weather observation information due to defective equipment for gathering meteorological data because of inadequate maintenance, as described in **Section 3.4.3** of this report.

Further, the audit noted that the weather Radar in Dar es Salaam, Mwanza, Mbeya, and Mtwara was not consistently transmitting weather information to the Central Forecasting Office. Meanwhile, radar stations in Dar es Salaam and Mtwara have not been transmitting weather observation information for a period of more than a year. Further information on the status of transmitted weather information from radar stations is detailed in **Table 3.12.**

Table 3.12: Time in Days from the Last Date of Weather Data Transmitted from Radar Stations under TMA

Radar	Date Verified	Last Date the data transmitted to the Central Weather Forecasting Office (CFO)	Duration of data not transmitted to CFO (Days)
Dar Es Salaam Radar	22 September 2024	No records	No records
Mbeya Radar	22 September 2024	20 August 2024	33
Mwanza Radar	22 September 2024	15 September 2024	7
Mtwara Radar	22 September 2024	12 September 2023	376
Kigoma Radar	22 September 2024	22 September 2024	0

Source: Auditors' Analysis of Information from Observation on Transmission of Weather Data from TMA Radars, 2024

Table 3.12 indicates that only 1 out of 5 radar stations was found to be transmitting weather data to the Central Forecasting Office, while the remaining four were not working for a duration ranging from 7 days to more than a year.

The audit noted through interviews with TMA officials that, the gap in transmission of weather data from radar stations was caused by insufficient allocation of funds to cater for the cost of electrical power to operate the radar systems, while the two radars for Mtwara and Dar es Salaam were offline and remained unmaintained for over a year.

The audit noted through the review of the annual plan and performance reports for the financial years 2019/20 to 2023/24 evidence that, TMA did not allocate a budget specific for operating radar stations, even though TMA allocated a budget to improve the real-time availability of data to the Central Forecasting Office as detailed in **Table 3.13**.

Table 3.13: Implemented Activities not in Line with the Availability of Real-time Data from Observation Stations

Financial Year	Target	Budgeted (TZS)	Implemented activities
2019/20	90% of real-time data will be made available to the CFO daily by June 2020	1,353,896,000	Not reported
2020/21	90% of real-time data will be made available to the CFO daily by June 2021	1,467,371,200	Not Reported
2021/22	90% of real-time data will be made available to the CFO daily by June 2022	213,240,000	Preparation of weather forecasting, Procurement of Furniture
2022/23	90% of real-time data will be made available to the CFO daily by June 2023	134,825,000	Preparation of weather forecasting, Procurement of Furniture
2023/24	90% of real-time data will be made available to the CFO daily by June 2023	54,780,000	Preparation of weather forecasting, Procurement of Furniture

Source: Auditors' Analysis of Information from TMA Annual Plan and Performance Reports 2019/20 to 2022/23, (2024)

Table 3.13 shows that TMA planned to increase the availability of real-time data by 90% from weather observation stations to the Central Forecasting Office. However, the implemented activities, such as weather forecasting and the procurement of office furniture, were not directly linked to fulfilling the set targets.

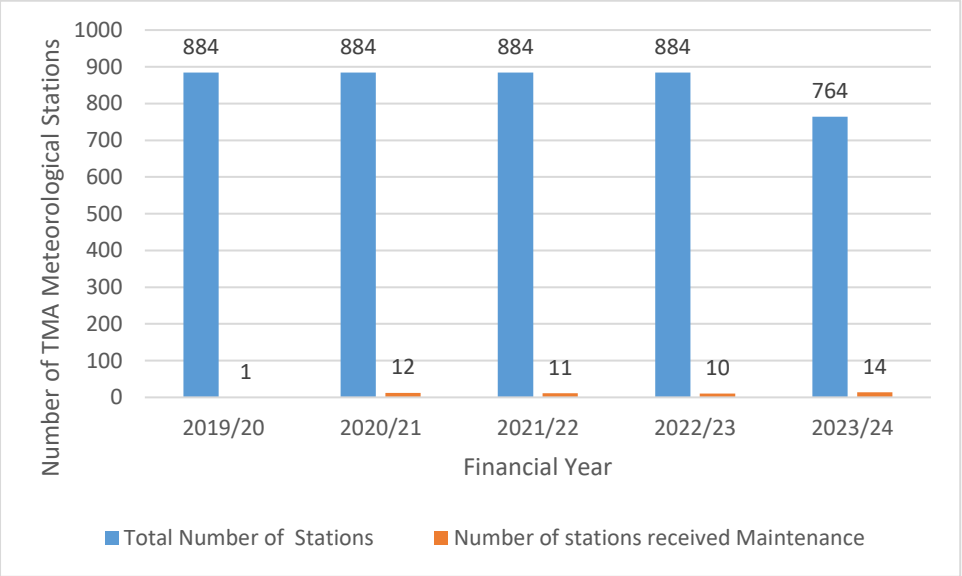
As a result, weather events were not validated to downscaled areas. Also, TMA continued to have limited weather information to process and issue weather forecasts and information.

3.4.3 Inadequate Corrective and Preventive Maintenance on Meteorological Observation Stations

In reviewing TMA's preventive and corrective maintenance reports, as well as calibration certificates, for the financial years 2019/20 through 2023/24, it was observed that TMA successfully conducted preventive and corrective maintenance on only 0.1% to 1.8% of its meteorological stations contrary to Regulation 26 of the Tanzania Meteorological Authority (Meteorological

Equipment and Instrument) Regulations of 2021 and section 3(e) of the Tanzania Meteorological Authority Act, 2019 which requires the meteorological station operators ensure maintenance and traceability of calibration of meteorological instruments through recognized national and international institutions dealing with standards as illustrated in **Figure 3.3.**

Figure 3.3: Status of Maintenance of the TMA Meteorological Stations in the Country



Source: Auditors' Analysis of TMA Reports on Preventive and Corrective Maintenance for the Year 2019/20 to 2023/24, 2024

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Figure 3.3 shows that, there was an increase in the number of TMA meteorological stations receiving maintenance from 1 in the financial year 2019/20 to 14 in the financial year 2023/24. It can be seen further that the total number of stations for maintenance declined from 884 in 2022/23 to 764 in 2023/24 due to updates made by TMA on a number of meteorological stations through the TMA Guide to the Establishment of Meteorological Stations in 2024.

The audit further noted TMA did not attain its plan for the corrective and preventive maintenance of meteorological equipment at meteorological stations, as detailed in **Table 3.14**.

Table 3.14: Implementation of the TMA Plan for the Corrective and Preventive Maintenance

Financial Year	Planned Stations	Stations Received Maintenance	Target Attainment (%)
2019/20	-	1	-
2020/21	-	12	-
2021/22	25	11	44
2022/23	28	10	36
2023/24	28	14	50

***Source*:** Auditors' Analysis of Plans and Reports for the Implementation of Preventive and Corrective Maintenance to Equipment in Meteorological Stations, 2024

Table 3.14 shows that TMA implements corrective and preventive maintenance of meteorological stations, ranging from 36% to 50%. In the financial year 2019/20 and 2020/21, TMA did not plan for the preventive and corrective maintenance of equipment in meteorological stations. However, based on the review of the submitted maintenance logbook, the audit noted that maintenance was mainly done on meteorological stations at airports such as Kilimanjaro Airport, Arusha Airport, Songwe Airport, Mtwara Airport, Dodoma Airport, Kigoma Airport, Zanzibar Airport and JNIA.

Further, the audit verification conducted at weather observation stations in Dar es Salaam, Mbeya, Dodoma and Mwanza regions revealed the existence of un-maintained weather observation equipment, as detailed in **Table 3.15**.

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Table 3.15: Status of Maintenance of Weather Observation Equipment in Visited Regions

Weather Stations	Total Number of Equipment	Unmaintained Equipment	% Unmaintained Equipment (%)
Dodoma Airport	6	3	50
Hombolo Agromet	6	6	100
Dar es Salaam Radar	1	1	100
Mbeya Airport	5	5	100
Uyole Agromet	5	5	100
Mbeya Radar	1	1	100
Mwanza Airport	7	5	71
Ukiliguru Agroment	14	9	64
Mwanza Radar	1	1	100

***Source*:** Auditors' Analysis on the Status of Maintenance of Equipment in Visited Meteorological Stations in Mwanza, Mbeya, Dodoma and Dar es Salaam, 2024

From **Table 3.15**, it was observed that in 6 out of 9 weather stations, all equipment was not maintained, and in the 3 weather stations, the number of unmaintained equipment ranged from 50% to 71%. Further details on the status of the maintenance of equipment are presented in **Appendix 6**.

Through interviews with officials from TMA, it was noted that, the untimely preventive and corrective maintenance was attributed to the generalised plan TMA had in respect to conduction of corrective and preventive maintenance. The plan considered regions to be covered for maintenance instead of specific meteorological stations and equipment requiring maintenance. This is due to the variation in maintenance schedules for each piece of equipment, which depend on the underlying technology and the extent of use. This situation was due to a deficiency in the number of officials responsible for maintenance at TMA, as presented in **Table 3.16.**

Table 3.16: Status of Technical Personnel for the Maintenance of Meteorological Stations as of June 2024

Designation	Required as per TMA Establishment 2023/24	Available Staffs	Deficiency
Principal Engineer II	1	0	1
Senior Engineer	4	3	1
Engineer I	2	2	0
Engineer II	10	3	7
Technician II	5	0	5
Total	**22**	**8**	**14**

Source: Auditors' Analysis of TMA's Schedule of Approved Personal Emoluments - Annual Estimates 2023/2024

Table 3.16 shows that TMA required 14 staff to maintain equipment at meteorological stations, accounting for 64% of the total demand.

As a result, parameters from defective equipment are not disseminated to the Central Forecasting Office for use in weather forecasting and information for meteorological use, as presented in **Tables 3.5** and **3.6** of this report.

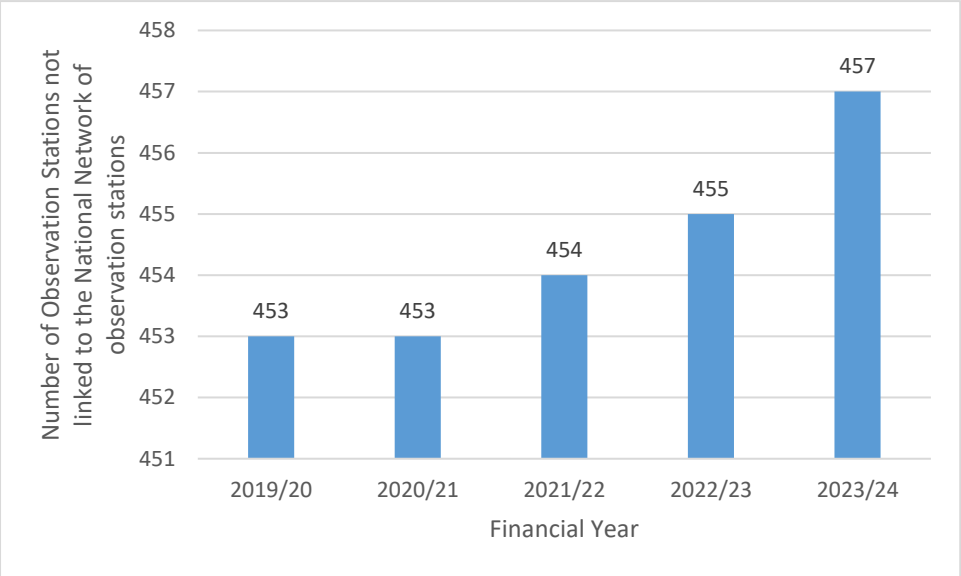
3.4.4 Integration of Weather Observation Stations to the National Observation Network

Regulation 14 of the Tanzania Meteorological Authority (Meteorological Stations) Regulations, 2021, requires TMA that where a meteorological

station operator establishes a station, the station shall be recognized as part of the national network of observing stations.

A review of the TMA Register of Meteorological Observation stations noted that non-TMA weather observation stations were not considered part of the national network of observing stations. From the TMA register of meteorological stations and a review of documents from the Ministry of Water, the following weather observation stations were noted operating without being integrated into the national network of observation stations see **Figure 3.4**.

Figure 3.4: List of Observation Stations not Linked to the National Observation Stations

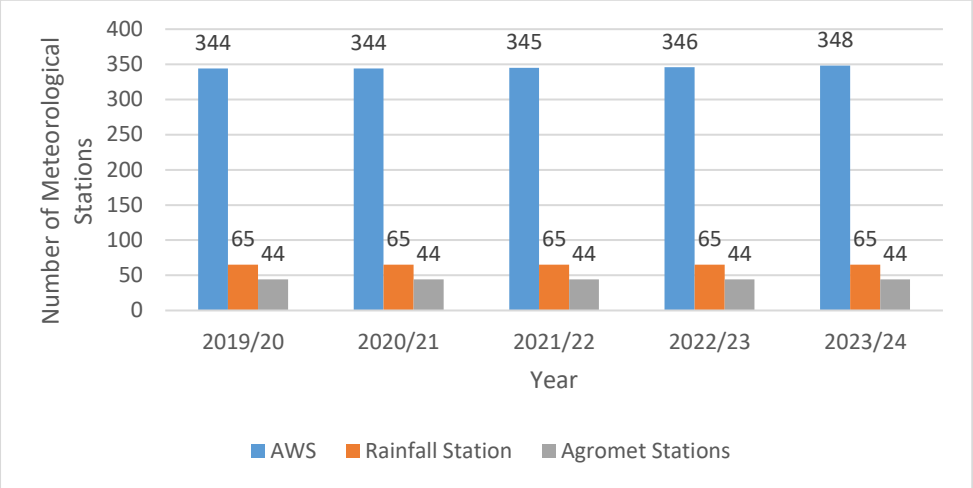


Source: Auditors' Analysis of Weather Observations Information from the TMA Register, Physical Verification at UDSM and Review of Documents from the Ministry of Water, 2024

From **Figure 3.4**, it was noted that the number of observation stations not integrated into the national network observation stations kept increasing from 453 in the year 20219/20 to 457 in the year 2023/24.

Furthermore, non-TMA meteorological stations that were not linked to the national network of observation stations are in three categories: automated weather stations, rainfall stations, and agro-met stations. Their respective numbers are presented in **Figure 3.5.**

Figure 3.5: Non-TMA Meteorological Stations not Linked to the National Network of Observing Stations



Source: Auditors' Analysis of Weather Observations Information from the TMA Register, Physical Verification at UDSM and Review of Documents from the Ministry of Water, 2024

Figure 3.5 indicates that the highest number of meteorological stations not linked to the national network of observing stations are Automatic Weather Stations (AWS), with the highest number of 348.

Through interviews with officials at TMA, it was noted that, the existence of observation stations not linked to the national meteorological stations was due to TMA lacking established procedures and guidance to link other non-TMA weather stations into the National Observation network; further interviews with TMA officials stated that, TMA Act, 2019 is of recent therefore in the past there were no guidelines and procedures in regarding linking non-TMA meteorological stations to the National Observation Network.

The non-integration of meteorological observation stations that do not belong to TMA into the national network of observing stations limited TMA from the control of observation data from the stations and contributed to the TMA existing gap in the number of meteorological observation stations as indicated in Table 3.10 of this report.

3.5 Ineffective Processing of Weather Data at TMA

The Tanzania Meteorological Authority processes weather data to ensure accurate and timely weather forecasting. The audit noted the following regarding the processing of weather data:

3.5.1 Insufficient Processing of Meteorological Data

A review of the district-level observation station networks in the country revealed that coverage was approximately 35%. The audit also noted that most of the data collected from weather stations are being processed using the available processing equipment, tools, and models at the TMA Central Forecasting Office (CFO), as per section 5 (g) of the Tanzania Meteorological Authority Act, 2019 requires TMA to process meteorological data and related information.

However, the audit highlighted a challenge in data assimilation of the weather data from radars as the data were not integrated into the existing weather forecasting models for improved accuracy. Interviews with TMA officials revealed that, the challenge arose from a lack of technical experts in the data assimilation area to facilitate integration of radar data into these models.

Interviews with TMA officials confirmed a shortage of weather data for processing and forecasting, particularly in marine areas. This shortage was attributed to the absence of fully developed marine observation stations in the country.

Further discussion with TMA officials revealed that TMA offers briefings on marine weather using forecasts generated by methodologies like numerical weather prediction models (NWP). This was further corroborated during the physical verification in the selected regions, specifically at Lake Victoria in Mwanza and the Dar es Salaam port. It was observed that the Tanzania Meteorological Authority (TMA) has been providing briefings designed for both the public and tailored purposes for individuals and organizations engaged in activities on water bodies.

These models utilize data from various sources, including satellites, nearby stations, and global observation centres, to generate weather forecasts. However, this approach faces limitations due to the extensive interpolations needed, which result from an inadequate observation network (marine stations), ultimately affecting the accuracy of the forecasts.

Insufficient observation networks were due to the high cost of investment required to establish stations in the country. Despite the government's ongoing investment in weather observation tools, there remains a gap between the approved budget and the funds that have been disbursed. **Table 3.17** gives a summary of the planned development budget against the

disbursed fund to support the implementation of weather instruments and infrastructure projects from the financial year 2019/20 to 2023/24.

Table 3.17: Summary of TMA Approved Development Budget Against the Disbursed Fund

Financial year	Approved budget (TZS)	Disbursed Fund (TZS)	% Disbursed
2019/20	-	673,477,944	N/A
2020/21	30,000,000,000	16,988,318,859	56
2021/22	30,000,000,000	15,515,321,841	52
2022/23	20,000,000,000	11,946,632,158	60
2023/24	13,000,000,000	1,126,839,338	9
Total	93,000,000,000	46,250,590,140	50

Source: Auditors' Analysis of TMA's Annual Performance Reports, 2024

Table 3.17 shows that, only 50 per cent of the total approved budget was disbursed for the financial years 2019/20 to 2022/23 to support the investment in weather instruments and weather infrastructure projects.

As indicated above, an inadequate observation network on land and marine areas has resulted in insufficient data being employed to generate weather forecasts using mathematical models like numerical weather prediction models. This consequently affects the accuracy of the forecasts generated as the more data used as initial conditions for weather forecasting, the more the accuracy of the forecast.

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3.5.2 Insufficient Verification of Processed Weather Data

A review of validation reports of weather forecasts at TMA revealed that verification was carried out for the aviation industry for parameters such as wind (speed and direction), temperature, pressure, and visibility and attained accepted accuracy as per ICAO Annex 3, Twentieth Edition, 2018 standard.

However, for the general weather forecast, TMA only verified rainfall parameters while leaving out other weather parameters, such as wind, temperature, humidity, evaporation and atmospheric pressure for the period from 2019/20 to 2023/24 covered in the audit. This was contrary to Para 3.1.2 of TMA's Organisation Structure, which requires TMA to conduct verification of daily and seasonal forecasts, Aerodromes forecasts, and warnings as may be required under the implementations of the Quality Management System. Additionally, TMA did not verify any weather forecast parameters for marine services.

Since TMA uses model-based predictions in weather forecasts requiring weather observation stations to verify the forecasted results, the limited coverage and absence of marine weather observation stations hamper TMA from verifying weather forecasting information to all parameters for marine services.

The absence of validation for weather parameters such as wind, temperature, pressure, and humidity forecasts hampered the ability to assess the accuracy of model-based forecasts and evaluate the degree of reliance that can be placed on these models.

3.5.3 Insufficient Tools to Run Complex Weather Forecasting Models

A review of the TMA Strategic Plan for the financial years 2017/18 to 2021/22 revealed that, TMA was running two Numerical Weather Prediction models, Weather Forecasting and Research (WRF) and High-Resolution Model (HRM) for weather forecasting. However, due to insufficient computing facilities, TMA opted to generate forecasts for shorter ranges with low horizontal resolution to minimize model run time, contrary to Para 3.4.6.2 (vii) of TMA Strategic Plan, 2017/18 to 2021/22 that emphasized a need for improving the computing capacity for the NWP to enable running of higher resolution models.

The limited computing power resulted in low-resolution models often struggling to capture local weather events because of limited computing power. This lack of detail led to inaccurate temperature, rainfall, and wind predictions, especially in places with complicated landscapes like mountains or areas that do not have many weather stations.

The audit revealed that in February 2024, TMA acquired a High-Performance Computer (Cluster Computer) to enhance its meteorological service delivery. This computer was intended to improve computing capacity for more effective weather forecasting. The computer was used to analyse data and issue weather forecasts using various globally authorized numerical weather prediction models such as WRF, COSMO, and Wave Watch III. The acquisition and subsequent use of the HPC enabled TMA to undertake and strengthen data assimilations and use various parameterization schemes in climate models, leading to improved forecasting skills and accuracy. Also, the capacity of TMA to generate sector-specific customized products is enhanced by using this high-computing computer.

Despite acquiring the high-performance computer, the audit noted that TMA has been providing seasonal rainfall forecasts for 149 districts in the country, of which 86 districts are for the bimodal rainfall regime, and 63 are for the unimodal rainfall regime. The unimodal rainfall regime is characterized by one primary rainy season that extends from October to April or May and is primarily found in southern, western and central Tanzania. The bimodal rainfall regime is characterized by two distinct rainy seasons: long rains from March to May, bringing substantial amounts of rainfall and short rains from October to December, which are often less consistent and variable compared to long rains. This regime predominates in northern and eastern Tanzania.

Downscaled weather forecasts for short - to medium-range weather forecasts were not operational due to the constraints related to insufficient human resources for packaging the downscaled weather forecasts on a daily basis, as well as limitations of short- to mid-range channel airtime for dissemination, affected the provision of downscaled weather forecasts across the country.

3.5.4 Acquisition and Maintenance of Complex Computing in Processing Weather Data

A review of the TMA Strategic Plan for 2017/18 to 2021/22 revealed that the Data Processing and Forecasting System (DPFS) relied on statistical methods and Numerical Weather Prediction (NWP) techniques, with a web-based forecasting software (SYNERGIE) utilized for visualizing weather systems and model outputs from various global centres.

However, the audit noted that the forecasting process at TMA remained semi-automated, requiring manual data plotting and analysis. This was due to inadequate modern meteorological data processing and communication facilities. **Table 3.18** provides a summary of tools for weather data processing.

Table 3.18: Equipment/Tools for Processing and Forecasting

Financial Year	Type of equipment	Available	Requirements	Gap
2019/20	Automatic Message Switching System (AMSS)	1	1	0
	Forecasting System (Synergies)	5	8	3
	Satellite Receiving Station (PUMA)	1	1	0
	Computer Cluster	0	1	1
2020/21	Automatic Message Switching System (AMSS)	1	1	0
	Forecasting System (Synergies)	5	8	3
	Satellite Receiving Station (PUMA)	1	1	0
	Computer Cluster	0	1	1
2021/22	Automatic Message Switching System (AMSS)	1	1	0
	Forecasting System (Synergies)	5	8	3
	Satellite Receiving Station (PUMA)	1	1	0
	Computer Cluster	0	1	1
2022/23	Automatic Message Switching System (AMSS)	1	1	0
	Forecasting System (Synergies)	5	9	4
	Satellite Receiving Station (PUMA)	1	1	0
	Computer Cluster	1	1	0
2023/24	Automatic Message Switching System (AMSS)	1	1	0
	Forecasting System (Synergies)	5	9	4
	Satellite Receiving Station (PUMA)	1	1	0
	Computer Cluster	1	1	0

Source: Auditors' Analysis of TMA's List of Equipment/Tools for Processing and Forecasting from Financial Year 2019/20 to 2023/24, 2024

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Based on **Table 3.18**, there was an observed gap in the number of tools for processing and forecasting weather data, such as the Forecasting System (Synergies) and computer cluster.

This posed a challenge in optimizing the use of available locally observed data and prolonged the analysis time of weather data from various observation centres, contrary to the National Vision 2025, which emphasizes the need to modernize the TMA infrastructure and increase the number of competent human resources.

3.6 Regulation of Operators and Uses of Meteorological Services

TMA was supposed to regulate both operators and uses of meteorological services; however, the audit noted issues such as registration of meteorological stations, issuance of permits, an inspection of meteorological stations and activities and cost recovery as detailed in subsequent sub-sections.

3.6.1 Registration of Meteorological Stations

A review of the registration status of meteorological stations at TMA indicated the presence of unregistered TMA and non-TMA meteorological stations for the period under the audit. As of June 2024, TMA managed to register 17.8% of its own meteorological stations and 12.6% of non-TMA meteorological Stations contrary to Sections 14 (2) and 23 (1) of the TMA Act, 2019, which requires TMA to register Meteorological stations in the country. Details of the TMA unregistered meteorological station are presented in **Table 3.19**.

Table 3.19: Status of Registration of Meteorological Stations Owned by TMA

Financial Year	Number of TMA Stations	Number of TMA Registered Stations	TMA Unregistered Stations	Percentage of registered Stations (%)
2019/20	884	0	884	0
2020/21	884	0	884	0
2021/22	884	92	792	10
2022/23	884	92	792	10
2023/24	764	136	628	18

Source: Auditors' Analysis of Registrations Data from TMA, Guidelines on the Establishment of Meteorological Stations, 2018 and Status of National TMA Meteorological Stations Networks as Updated in 2024, 2024

Table 3.19 indicates that, in the financial year 2019/20 and 2020/21 and 2022/23, TMA did not register its stations, and in the financial year 2021/22 and 2023/24, TMA registered a total of 136 meteorological stations equivalent to 17.8% of all stations under TMA.

Details of unregistered meteorological stations that TMA does not own are presented in **Table 3.20**.

Table 3.20: Status of Registration of Non-TMA Meteorological Stations

Financial Year	Total number of Stations	Number of Registered Stations	Unregistered Stations	Percentage of Registered Stations (%)
2019/20	404	0	404	0
2020/21	404	1	403	0
2021/22	404	7	397	2
2022/23	404	44	360	11
2023/24	404	51	353	13

***Source*:** Auditors' Analysis and Verification of Information from TMA List of Meteorological Stations TMA Internal Audit Reports, Policy Revision of the Ministry of Water and Audit Verification of Meteorological Stations Available at the University of Dar es Salaam, 2024

Table 3.20 indicates that for the financial year 2019/20, TMA did not register non-TMA meteorological stations; the number of registrations of meteorological stations increased from 1 station in the financial year 2020/21 to 51 stations in the financial year 2023/24. Therefore, the number of unregistered meteorological stations decreased from 404 to 353.

A review of the TMA annual plan for the financial years 2019/20 to 2023/24 noted that, TMA did not attain the registration of all meteorological stations due to a lack of plan and the presence of unmeasurable plans not specifying the actual number of meteorological stations targeted for registration as detailed in **Table 3.21.**

Table 3.21: Unmeasurable Plans for the Registration of Meteorological Stations

Financial Year	Approved budget (TZS)	Status on Specified number of meteorological Stations
2019/20	0	Not Specified
2020/21	0	Not Specified
2021/22	54,000,000	Not Specified
2022/23	68,000,000	Not Specified
2023/24	43,100,000	Not Specified

***Source*:** Auditors' Analysis of Information from TMA Annual Plans 2019/20 to 2023/24, 2024

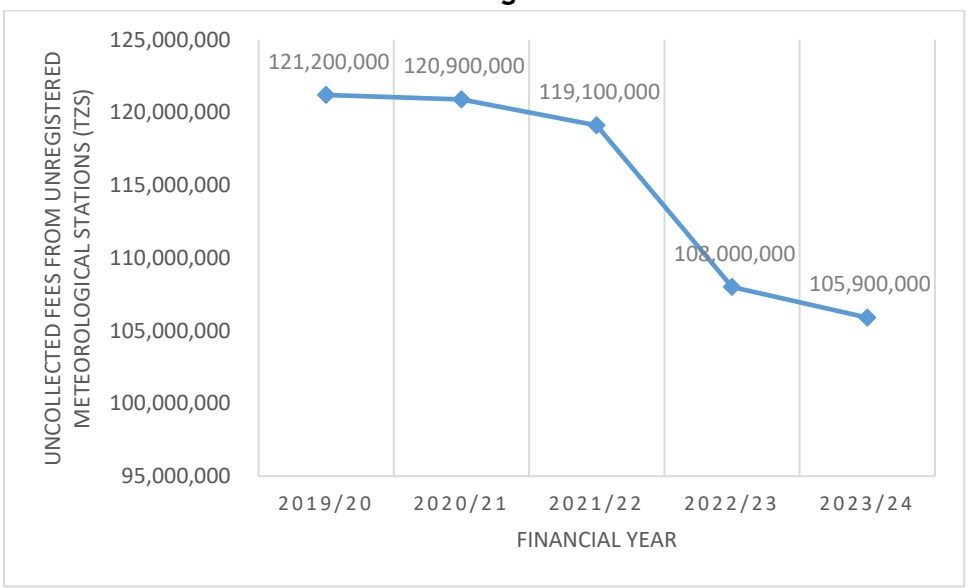
Table 3.21 indicates that, for the financial year 2019/20 and 2020/21, TMA did not plan for the registration of meteorological stations, and in the year 2021/22 to 2023/24, TMA planned for the registration of meteorological stations but did not put a measurable target in place.

Meteorological stations operating without acquiring registration from TMA render their services unreliable and un-credible. This could lead to inaccurate weather readings that could mislead the users. Further, the presence of unregistered meteorological stations led to the non-collection of registration fees amounting to TZS 105,900,000, as detailed in subsequent descriptions.

Non-collection of Registration Fees Amounting to TZS 105,900,000

The audit noted that, for the period of the financial year 2019/20 to 2020/23, there was a presence amount of fees which TMA did not collect from the unregistered meteorological stations not owned by TMA contrary to Regulation 5(2) of the Tanzania Meteorological Authority (Meteorological Stations) Regulations, 2021 which requires a person who intends to register a meteorological station to pay an application fee ranging from TZS 300,000 for rainfall stations to TZS 3,000,000 for upper-air stations, weather radar station, aircraft meteorological stations and special meteorological stations as shown in **Figure 3.6**.

Figure 3.6: Uncollected Fees Registration Fees from Unregistered Non-TMA Meteorological Stations



***Source*:** Auditors' Analysis of Fees of Unregistered Meteorological Stations, 2024

Figure 3.6 indicates a significant decrease from TZS 121,200,000 in 2019/20 to TZS 105,900,000 in 2023/24, with a difference of TZS 11,100,000 of uncollected fees from unregistered meteorological stations that TMA does not own.

Furthermore, the distribution of the uncollected fee of TZS 105,900,000 from unregistered non-TMA is detailed in **Table 3.22.**

Table 3.22: Uncollected Fees from the Unregistered and Existing Meteorological Stations

Institutions/Operators of the unregistered stations	Number of Unregistered Meteorological Stations	Unpaid registration Fees (Minimum rate of TZS 300,000 per station)
University of Dar es Salaam	2	600,000
Ministry of Water	308	92,400,000
Ngwazi Tea Research	1	300,000
Mufindi Tea & Coffee Ltd	5	1,500,000
Mtibwa Sugar Estate	17	5,100,000
Mkomazi national Park	1	300,000
Lupondo Tea Estate	10	3,000,000
Kibena Tea Ltd	9	2,700,000
Total	**353**	**105,900,000**

***Source*:** Auditors' Analysis of Information from TMA Registered Meteorological Stations, TMA Internal Audit Reports, Policy Revision of Ministry of Water and Physical Verification at the University of Dar es Salaam, 2024

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Table 3.22 shows that, the largest amount of fees uncollected from the registration of meteorological stations was from the Ministry of Water, amounting to TZS 92,400,000.

3.6.2 Meteorological Stations Operated without Permits from the TMA

Based on the review of the issuance of permits to engage in meteorological observations or weather forecasting and records of fees for a permit to engage in meteorological activities, it was noted the presence of meteorological stations operating in the country without permits from TMA contrary to Section 19 (1) of the TMA Act of 2019 which requires person engaging in any meteorological observations, weather forecasting activities or weather modification activities to obtains permission from TMA. The number of meteorological stations noted to operate without a permit from TMA is as detailed in **Table 3.23.**

Table 3.23: Number of Meteorological Stations Operated Without Permits

Financial Year	Total Stations	Number of Stations with Permit	Number of Stations Without Permits	Percentage of stations operating without a permit
2019/20	453	0	453	100
2020/21	453	0	453	100
2021/22	454	3	451	99
2022/23	455	16	439	96
2023/24	457	15	442	97

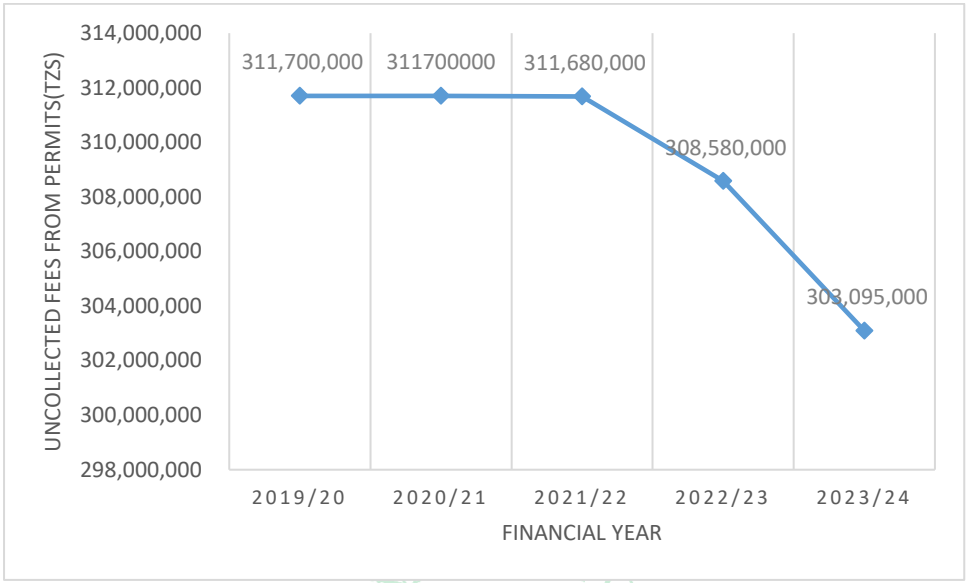
Source: Auditors' Analysis of Information from Permit Fees and List of Registered and Non-Registered-registered Meteorological Stations, 2024

Table 3.23 shows that for the financial years 2019/20 and 2020/21, TMA did not issue permits for activities performed regarding meteorological services. Also, in the year 2022/23, the number of permits reached the highest record. However, it dropped in the financial year 2023/24.

An interview with officials from the Tanzania Meteorological Authority (TMA) revealed that the existence of weather forecasting operations without permits was primarily due to operators' lack of awareness regarding the requirement to obtain and renew permits for operating meteorological stations. This issue was attributed to TMA's failure to enforce its legal mandate to issue permits and lack of prioritization in incorporating permit-related activities, including awareness programs, into its annual plans.

Consequently, as of June 2024, TMA did not collect TZS 303,095,00 from permit fees for the meteorological stations operating without acquiring permits from TMA, as presented in **Figure 3.7**.

Figure 3.7: Permit Fees not Collected from Operators of Non-TMA Meteorological Stations



***Sources*:** Auditors' Analysis of Permit Fees from TMA, 2024

Figure 3.7 indicates that, as of the financial year 2023/24, the amount of fees not collected from permits to operate meteorological services was 303,095,000. This amount decreased from TZS 311,700,000, which was not recorded in 2019/20.

Further, the inadequate issuance of permits led to the existence of unrenewed permits for meteorological stations, as detailed below:

Non-renewal of Meteorological Stations Permits

Based on the reviews of TMA records of permits for the period under the audit, noted that TMA had never issued a renewal of permits to those engaged in meteorological observations, weather forecasting or weather modification activities contrary to Section 16(1) & (2) of the TMA Act, 2019 requires the permit issued for undertaking meteorological activities that to be valid for a period of one year and subject to renewal.

In the financial year 2021/22, 2022/23 and 2023/24, TMA issued permits to operators of meteorological activities to 3, 16 and 15, respectively, but no renewal was made after the expiry of these permits. Details of unrenewed permit areas are presented in **Table 3.24.**

Table 3.24: Status of Non-TMA Meteorological Stations Operating Without Renewal of Permits

Financial Year	Total Stations	Secured Permit	Renewed Permit	Number of unrenewed permits	Percentage of unrenewed Permits
2019/20	453	0	0	453	100
2020/21	453	0	0	453	100
2021/22	454	3	0	451	99
2022/23	455	16	0	439	96
2023/24	457	15	0	442	97

***Source*:** Auditors' Analysis of TMA Records of Permit fees, 2024

Table 3.24 indicates that, no permit was renewed for the financial years 2019/20 and 2020/21, but in the years 2021/22 to 2023/24, operators of 3,16 and 15 stations, respectively, were granted permits which reduced the percentage of unrenewed permits to operate meteorological activities to 97% in the financial year 2023/24.

Interviews with officials from the TMA revealed that the TMA Act, which mandates the TMA to oversee regulatory activities, came into effect while meteorological service operations from operators other than TMA had already been established. Consequently, awareness of the requirement to apply for and renew permits was not adequately communicated to all operators of meteorological services, as TMA did not allocate the budget for this purpose.

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Non-renewal of operation permits to perform meteorological activities by operators of meteorological stations leads to unauthorised provision of meteorological services and TMA loss of revenue from unrenewed permits as detailed below:

TMA did not Collect Permit Renewal Fees Amounting to TZS 577,500,000

Based on the review of permits from TMA, the Audit noted uncollected licence renewal fees amounting to TZS 577,500,000 to operate meteorological stations that TMA did not own for the period from 2019/20 to 2023/24 contrary to Second Schedule (A) of the Tanzania Meteorological Authority (Meteorological Stations) Regulations, 2021 which stipulates annual license renewal fee for operating a meteorological station, based on the type of station.

Further, the license renewal fee for automatic weather stations (AWS), hydrometeorological stations, and agrometeorological stations is TZS

300,000, whereas there are no charges for manned rainfall stations, as detailed in **Table 3.25.**

Table 3.25: Collection of Permit Renewal Fees from Meteorological Stations not Owned by TMA

Year	Projected Revenue (TZS)	Actual Revenue Collected (TZS)	Revenue Gap (TZS)	Remarks
2019/20	116,400,000	0	116,400,000	No Renewal
2020/21	116,400,000	0	116,400,000	No Renewal
2021/22	116,100,000	0	116,100,000	No Renewal
2022/23	114,600,000	0	114,600,000	No Renewal
2023/24	114,000,000	0	114,000,000	No Renewal
Total	**577,500,000**	**0**	**577,500,000**	**-**

***Source*:** Auditors' Analysis of Meteorological Permits and Fees from TMA, 2024

From **Table 3.25,** the decrease in projected revenue from permit renewal fees in the financial years 2021/22, 2022/23 and 2023/24 was caused by new applications for licenses to operate meteorological stations to 3, 16 and 15 stations, respectively.

TMA did not enforce renewal as per reminder letters or invoices to operators of meteorological stations to remind them to renew their licenses for their meteorological activities.

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3.6.3 Inadequate Inspection of the Meteorological Stations

Based on the TMA regular inspection plans and reports of meteorological stations for the five years from 2019/20 to 2023/24, TMA planned to conduct regular inspections in 24 regions. However, a review of TMA inspection reports to Meteorological Stations (2019/20 to 2023/24) shows that the inspection was executed only in six out of 24 regions, which is 21% of the plan prepared, as indicated in Table **3.26.** This contradicts Regulation 7 of the TMA (Meteorological Station) Regulations of 2021, which mandates that the TMA supervise meteorological operators through inspection visits and reports.

Table 3.26: Status of Regular Inspection on Meteorological Stations Based on Regions

Financial year	Planned number of regions for Inspections	Actual Number of Regions Covered	Percentage of Implementation of Inspection Plans (%)
2019/20	6	2	33
2020/21	4	0	0
2021/22	4	1	25
2022/23	5	2	40
2023/24	5	1	20
Total	**24**	**6**	**25**

***Source*:** Auditors' Analysis on TMA Plans and Reports of Inspections of Meteorological Stations in Regions, 2024

Table 3.26 shows that inspections were conducted in not more than two six regions in all the financial years 2019/20 to 2023/24 despite planning for 4 to 6 inspections each year. Further, TMA managed to implement 25% of the planned inspections.

A further review of the inspected meteorological stations for the period 2019/20 to 2023/24 revealed that TMA inspected only nine (9) stations, falling short of the target of inspecting 350 stations set for the same period in accordance with the TMA strategic plan ending in 2025/26. The details of the shortage of inspecting meteorological stations are presented in **Table 3.27.**

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Table 3.27: Number of Meteorological Stations inspected at TMA

Financial Year	Planned Number of Meteorological Stations for Inspection	Number of Meteorological Stations Inspected	Meteorological Stations Inspected (%)
2019/20	0	Not reported	0
2020/21	0	Not Reported	0
2021/22	50	Not Reported	0
2022/23	200	Not Reported	9
2023/24	100	Not Reported	0

***Source*:** Auditors' Analysis of Information from the TMA Strategic Plan and Annual Implementation Reports, 2024

Table 3.27 indicates that, TMA reported the number of meteorological stations inspected in 2022/23, whereas no inspections were reported for the remaining years.

This was attributed to inadequate planning of inspection activities, as stipulated in Regulation 13(3) of the TMA (Meteorological Station) Regulations of 2021. The TMA planned the inspection of meteorological stations without considering the types of stations or the inspection timeframe per station. Also, the inspection plan outlined in the TMA strategic Plan was not reflected in the TMA Annual Plans. The audit noted that the TMA strategic plan was not reflected in the TMA Annual Plans. The audit noted that the Strategic Plan indicated inspections were to be conducted at 350 meteorological stations, whereas the Annual Plan only specified regions targeted for inspections.

This led to insufficient control of the observation station to ensure the quality and quantity of the collected data and the inaccuracy of weather information. Furthermore, inadequate inspection resulted in the presence of 136 meteorological stations under TMA being registered without assurance that they met the requirements for observation stations. This was noted during audit verification at the Dar es Salaam marine meteorological observation station. The station was found situated beneath the shadows of tall buildings.

3.6.4 Insufficient collection of cost recovery revenue from users of meteorological services

A review of TMA's annual performance reports for financial years 2019/20 to 2023/24 indicated that, TMA only collected 53% of expected revenue collection from the aviation industry, media, consultancy, customized meteorological services, and other internally generated sources, contrary to Clause 6.2 (ii) of the TMA Client Service Charter, 2008, requires TMA's customers to pay for services received according to existing standards and procedures as detailed in **Table 3.28**.

Table 3.28: Status of Revenue Collected in TZS from Services Rendered by TMA

Financial Year	Planned Collection (TZS)	Actual Collection (TZS)	Actual Collection (%)
2019/20	13,310,000,000	10,588,636,679	80
2020/21	24,611,947,190	6,005,620,868	24
2021/22	16,090,000,000	8,871,276,393	55
2022/23	18,970,000,000	11,879,335,476	63
2023/24	18,164,798,745	11,475,934,665	63
Total	**91,146,745,935**	**48,820,804,081**	**53**

***Source*:** Auditors' Analysis of Information from TMA Annual Performance Report, 2024

From **Table 3.28**, revenue collection was below target because stakeholders such as TCAA and Marine Authorities did not comply with the TMA cost recovery scheme. This was due to TMA lacking a system of agencies collecting the revenue on its behalf, which was contrary to the requirement of para 2.2.1(1)(i) and 2.1 (v) of the e-Government Guidelines for Development, Acquisition, Operation, and Maintenance of eGovernment applications, eGA/EXT/APA/005, 2020.

3.7 Dissemination of Weather Information to the Public, Government Agencies and Key Stakeholders

Dissemination of weather information is one of the key roles of TMA for the purpose of distributing weather information to the public, government agencies, different committees, and other stakeholders through television, radio broadcasts, online platforms, social media and special packages to ensure that regular weather updates are communicated to users. The following are the issues related to the dissemination of weather information.

3.7.1 Channels for the Dissemination of Weather Information

The review of Performance Reports for the financial years 2019/20 to 2023/24 showed that there was no specific number of announcements in the dissemination of weather forecasts contrary to Regulation 12 (2) (b) of the Tanzania Meteorological Authority (Weather and Climate Forecasting Activities) Regulations, 2021 requires TMA to disseminate regular weather and climate forecasts.

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The audit noted that the frequency of weather announcements by those channels increased when TMA provided a weather warning. This was influenced by not providing enough information on the advantages and disadvantages of weather information to the media and the impact of weather information on daily activities, especially economic activities like fishing, agriculture, transport (marine), and construction. Weather forecasts were disseminated through channels as presented in **Table 3.29.**

Table 3.29: Dissemination of weather Forecasting Through Channels

Financial year	TV broadcast	Radio	Online platforms	Magazine	Social media	SMS Alerts
2019/20	10	10	0	0	0	0
2020/21	3	7	0	0	0	0
2021/22	0	2	0	0	0	0
2022/23	17	74	6	2	0	0

***Source*:** Auditors' Analysis on Performance Reports 2019/20-2022/23, 2024

The audit noted that TMA disseminated the information but excluded the channels that most people can reach. The public can easily obtain information through mobile phones, short messages and social media, and it would be easier for TMA to know the number of people receiving that information daily. By leaving out this method of dissemination of weather information, it becomes difficult to reach the entire population and different sectors. As a result, that information would not benefit the public through use for safety and social and economic development.

Further, the review of media monitoring reports shows the achievement in disseminating the weather forecasts on television, radio stations, magazines and online media through entering into service-level agreements with media, as evidenced in **Table 3.30.**

Table 3.30: Services Level Agreement in Dissemination of Weather Forecast

Financial year	Number of Media service level agreement	Number of Media monitoring reports
2019/20	21	0
2020/21	10	0
2021/22	2	0
2022/23	15	37
2023/24	0	30

***Source*:** Auditors' Analysis on Performance Reports 2019/20-2023/24 and Media Monitoring Reports, 2024

Table 3.30 shows that most dissemination was conducted through media service level agreements with TMA. However, the media monitoring report only covered two financial years. Yet, in the remaining three financial years, from 2019/20 to 2021/22, no monitoring was conducted because monitoring processes had not been initiated. This oversight resulted from inadequate planning, as TMA did not set quantifiable targets, making it difficult to assess their performance. Their annual performance report showed only achievements without measurable targets.

3.7.2 Ineffective Provision of Awareness on the Application of Weather Information to Socio-economic Activities

A review of TMA Annual Performance Reports for the financial years 2019/20 to 2023/24 indicates that, in the financial year 2021/22, TMA did not achieve its target to provide awareness on the potential use of weather forecasting information to benefit the public in their daily activities contrary to Goal number 5 of the Strategic Plan for Tanzania Meteorological Agency of 2017/18 - 2021/22 required TMA to inform the public to realize

the social, economic benefits of weather and climate services by promoting awareness and sensitization of the public.

Further, for the rest of the financial years, the reports indicated that, TMA implemented an awareness programme without any set targets to achieve. More details are presented in **Table 3.31**.

Table 3.31: Status of Implementation of Awareness Programmes as Per Annual Performance Reports

Financial Year	Name of Activity	Number of Activities planned	Number of activities implemented
2019/20	Awareness	Not Specified	1
2020/21	Outreach Programme	Not Specified	16
2021/22	Awareness Programme	18	12
2022/23	Awareness Programme	Not Specified	16
2023/24	Awareness Programme	Not Specified	48
Total			**93**

***Source*:** Auditors' Analysis of Awareness Programme Information from TMA Annual Plans and Performance Reports 2019/20-2023/24, 2024

Table 3.31 presents information on the status of the implementation of the awareness programme and the use of weather information, where the maximum number of activities was noted in the financial year 2023/24 and the least number in the financial year 2019/20.

Further, through reviews of specific event reports regarding the implementation of awareness creation activities on the use of weather information in socio-economic activities, the audit noted that TMA conducted 1 to 3 events each year. However, the implemented events were conducted under the Global Framework for Climate Services Adaptation Program in Africa under WMO; Korea International Cooperation Agency, Co-producing Gender-responsive climate services for enhanced food and nutrition security and health in Ethiopia and Tanzania Project and under the Michelsen Institute of Norway and the World Food Programme (WFP) and budgeted through TMA. The details on the implemented details per year are presented in **Table 3.32**.

Table 3.32: Implementation of the Awareness Program on Use of Weather Information in Social Economic Activities

Financial Year	Name of Activity	Number of Activities planned	Number of activities verified
2019/20	Awareness	Not Specified	2
2020/21	Outreach Programme	Not Specified	1
2021/22	Awareness Programme	18	1
2022/23	Awareness Programme	Not Specified	3
2023/24	Awareness Programme	Not Specified	3
Total			10

***Source*:** Auditors' Analysis of the Plan for the Awareness Programme and Reports of the Implemented Events for the Awareness Programme, 2024

Table 3.32 indicates that, TMA implemented 1 to 3 activities of the awareness campaigns on the use of weather forecasts for social and economic activities each year. In 2021/22, TMA implemented 1 out of 18 planned awareness campaigns.

It was also noted that the implementation of awareness campaigns was impeded by TMA not adequately planning for the awareness campaigns. Instead, for the years 2019/20, 2020/21, 2022/23, and 2023/24, they planned to implement awareness campaigns without setting a target for the same.

Inadequate awareness campaigns are linked directly to the existence of activities in the country that are progressing without consideration of weather information from TMA.

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3.8 Inadequate Inclusion of Needs for Various Sectors in the Provision of Weather Forecasting

Based on the Country Hydromet Diagnostic - Tanzania Peer Review Report of February 2024, TMA has a long range of partnerships with both government and non-government partners. MoUs were in place for some partners, and a formal platform for cooperation has been well-developed. The operationalization of the partnership is challenged by limited funding for coordination unless it has been funded through projects. TMA had a long track record of implementing Hydromet development projects. There is a proactive and vocal partner, and it appears that internationally funded projects are used to support the strategic and long-term development of TMA. However, the following findings were observed during the audit;

3.8.1 Inadequate Setting of Target for Incorporation of Meteorological Services in Government Undertakings

Based on the review of the TMA's Annual Performance Reports from 2019/2020 to 2022/2023, the Audit noted intervention covering specialized weather products for different sectorial activities with inadequacy target set for its achievement contrary to Section 21 of the Tanzania Meteorological Authority Act of 2019 requires TMA to prescribe the weather and climatic requirements for activities covering aviation, defence, finance, agriculture, construction works, environment, industries, marine, natural disaster, and relief management, water resources, health, power and steel, transport, science and technology; minerals, oil and gas, livestock, natural resources, tourism and any other sector as may be prescribed by the Minister as shown hereunder in **Table 3.33.**

Table 3.33: Analysis of the Planning and Implementation of Meteorological Services in Government Undertakings

Financial Year	Plan (Target)	Achievement	Remarks
2019/2020	Tanzania's obligation to regional and international conventions and cooperation was fulfilled and enhanced.	Four (4) International Institutions visited TMA for discussions aimed at forging collaborations that would enhance climate services in the country and the regional and international arena.	The planned target was not quantified. Hence, the achievement is difficult to measure
2020/2021	Accuracy of meteorological forecasts, advisories and warnings improved from an average of 70% to 90% by June 2021	Regional Specialised Centre (RSMC) continued to issue forecasts and guidance products for East African countries over the Lake Victoria Basin. RSMC weather Portal was developed and implemented; Specialized weather products for the Maritime, Mining and Tourism sectors have been produced and made available for use by respective sectors	The target was measurable. However, the output was not quantified to correlate with the set target for the accuracy of meteorologic al forecasts.

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Financial Year	Plan (Target)	Achievement	Remarks
2021/2022	7 other Specialized meteorological services developed by June 2025	7 Specialized weather products for the Maritime, Mining and Tourism sectors have been produced and made available for use by respective sectors.	Achieved as per set targets
2022/2023	Products of specialized meteorological services will be generated by June 2026.	• Specialized weather products for 12 Mining sites, Maritime, water resources and construction sectors were produced; and • Four (4) user engagement meetings were conducted for the construction, water resources and tourism sectors in collaboration with MoWT and MoF.	The target was not measured, whereas the output was measurable. It is difficult to assess if the target was met.

Source: Annual Performance Reports from 2019/2020 to 2022/2023

From **Table 3.33**, the Audit noted that the planned targets in 2019/2020 and 2022/2023 were not quantified and measurable to assess their achievement in the Annual Performance Report. This was a reflection of inadequate planning and setting out measurable targets with performance indicators.

Ineffective planning for incorporating meteorological services in government undertakings led to inadequate assessment of the achievements acquired against the set targets. Moreover, this also led to inadequate monitoring of achievement in the incorporation of government undertaking for all prescribed sectors when delivering meteorological services.

3.8.2 Inadequate Level of Coordination Among Actors and Stakeholders in the Provision of Weather Forecasting

Based on the available Memorandum of Understandings, the Audit noted that there were three MoUs/service level agreements covering three out of the identified 16 stakeholders in Table 2.1 of the Stakeholder Analysis Matrix in the Strategic Plan for TMA. The three availed MoUs with relevant

stakeholders were MoUs with the Ministry of Water, TARI and TAFORI, which is contrary to activity 1.1.3.2 of the Output 1.1.3 of the Action Plan for 2017/18 to 2021/22 on the weather and climate issues mainstreamed into relevant sectors, which TMA is required to establish service level agreement and MoUs with relevant stakeholders.

Furthermore, the audit noted insufficient enforcement of the commitments and requirements of the MoUs, such as involvement in local and international organizations' events and sharing of weather information with relevant stakeholders. Also, it was revealed that TMA depended on weather stations from the Ministry of Water and TARI for the collection of information; however, TMA did not have a register covering the total number of weather stations owned by MoW due to a lack of coordination.

The inadequate level of coordination among actors and stakeholders in the provision of weather forecasting information was caused by a lack of enforcement and monitoring of the MoUs with relevant identified stakeholders in weather forecasting. This led to the disintegration of the provision of data for weather forecasting and inadequate assurance of the accuracy of data provided for weather forecasting since it is not analysed and regulated by TMA as the vested with mandated on weather forecasting.

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CHAPTER FOUR

AUDIT CONCLUSION

4.1 Introduction

This chapter presents conclusions of the audit categorized into two main parts: overall conclusion and specific audit conclusions. The conclusions are based on both the overall and specific objectives of the audit presented in Chapter One of this Report.

4.2 General Audit Conclusion

The audit acknowledges the government's efforts in prioritizing the provision of meteorological services, investing in the procurement of weather radars in regions of Dodoma, Mbeya, and Arusha, and upgrading weather radar stations in the Mwanza Region.

The audit concludes that TMA has ineffectively managed and regulated meteorological services to ensure accurate, timely and reliable weather forecasts to support and safeguard public safety, economic activities, and environmental management. This was due to inadequate collection of meteorological data for weather forecasting, ineffective processing of weather information, ineffective regulation of meteorological services, inadequate dissemination of weather information to the public and coordination with stakeholders in the management of meteorological services.

Therefore, TMA is not achieving its goals in the Strategic Plan and mid-term strategic plan 2017/28-2021/22 and 2020/21-2025/26, respectively, of improving the quality of meteorological services by improving the real-time data monitoring, data exchange, processing, and forecasting systems, strengthening marine services and meteorological services for all climate-sensitive sectors. This is due to an insufficient network of meteorological observations, unmaintained meteorological observation stations, and meteorological operators without permits from TMA.

4.3 Specific Audit Conclusions

4.3.1 TMA Does not Adequately Collect Meteorological Data for Weather Forecasting

TMA does not adequately collect meteorological data for weather forecasting due to the insufficient network of meteorological observation stations, which has less coverage in the country. TMA does not fulfil the basic requirements of weather observation networks for both 200km and 500km surface station

horizontal resolution and upper-air stations horizontal resolution resolutions, respectively. Further, TMA has a shortage of 1838 out of 2613 required meteorological observation stations, which is equivalent to 70%. This is due to the existence of defective equipment for weather observations. This limits the coverage and accuracy of weather observations and forecasting.

Similarly, the observation data from meteorological stations are not received in a timely manner at the Central Forecasting Office due to inadequate maintenance on defective observation equipment, as were noted in visited meteorological stations of Ukiliguru Agro-Met stations, Hombolo Agromet Stations, Mbeya Airport, Uyole Agromet and Songwe airport with defective sensors and equipment for observing soil moisture, soil temperature, sunshine, maximum temperature and wind direction.

Also, corrective and preventive maintenance for meteorological observation stations is not effectively done due to a generalised plan on preventive and corrective maintenance disregarding the actual timing of specific equipment in meteorological stations. This resulted in unmaintained meteorological equipment in 97.2% of 764 TMA meteorological stations.

Moreover, the meteorological observation stations are not sufficiently integrated into the nation's observation network to enhance timely and accurate weather forecasting. The increase of meteorological observations not integrated into the national observation stations was noted from 453 in the financial year 2019/20 to 457 in the financial year 2023/24, and this is because TMA lacks procedures and guidance on linking other non-TMA weather observation stations to the National Observations stations.

4.3.2 TMA does not Adequately Process Weather Information to Ensure Timely and Accurate Forecasting

The audit found that the Tanzania Meteorological Authority (TMA) does not sufficiently process meteorological data to ensure accurate and timely weather forecasting. This shortfall is linked to several factors, such as inadequate input data for forecast generation resulting from an insufficient network of observation stations, insufficient tools for running complex forecasting models and speeding weather data processing. Additionally, the audit noted a technical lack of experts for assimilating weather data from stations like radar into processing models, limiting the opportunity to improve the forecasts' accuracy.

Furthermore, due to an insufficient network of observation stations, TMA does not adequately verify generated forecasts, especially those regarding marine conditions.

The audit noted that inadequate weather data processing significantly increases the risk of unreliable forecasts produced by TMA. As a result, this unreliability can negatively impact sectors that depend on accurate weather forecasting, including agriculture, disaster management, and urban planning. Untimely and accurate weather information can lead to significant consequences, including unpreparedness for extreme weather events.

4.3.3 TMA does not Effectively Regulate Weather Forecasting Activities to Meet National and International Standards

TMA does not adequately register both TMA and non-TMA meteorological stations; 628 out of 764 TMA meteorological stations and 353 out of 404 non-TMA meteorological stations were not registered as of the year 2023/24. This is because TMA plans for registrations of meteorological stations without a clear goal on the expected number of registrations per financial year. This resulted in uncollected revenue of TZS 105,900,000 from registration fees.

TMA does not effectively issue a permit to operate meteorological services; in the financial year 2023/24, 442 meteorological stations operated without a permit from TMA. This was due to TMA inadequately issuing awareness to the operator of meteorological services regarding the requirement of the operator applying for a permit to undertake meteorological services. This was attributed to the uncollected revenue of TZS 880,595,000 from the application and renewal of license permit fees.

4.3.4 TMA does not Adequately Disseminate Weather Information to the Public, Government Agencies, and Key Stakeholders

TMA does not effectively provide awareness for the application of meteorological services to social and economic activities. TMA did not achieve its target on the provision of awareness in the financial year 2021/22, and in the other financial years 2019/20, 2020/21, 2022/23 and 2023/24, TMA implemented the provision of awareness without setting a measurable target. Public awareness campaigns and training for government agencies could also play a crucial role in ensuring that weather forecasts and warnings are understood and acted upon in a timely manner.

4.3.5 The Coordination Among Actors in Providing Weather Forecasting Activities is not Effectively Done

TMA plans for incorporation of the meteorological services in government undertakings are not quantified and measurable to assess the the achievement in the annual performance report. This results in an inadequate assessment of the actual achievement of incorporating meteorological services into different government undertakings and sectors.

The level of coordination among actors and stakeholders does not enhance the provision of weather forecasting. TMA had three (3) coordination frameworks from the Water, Forests and Agricultural sectors. The framework was noted as not enhancing the provision of weather forecasting because the terms agreed between parts did not indicate a clear method of sharing weather information and did not stipulate regal requirements of parties to comply with registrations and apply for permits to operate meteorological activities.

Due to ineffective coordination among actors in weather forecasting service, this led to Government institutions (such as the Ministry of Water, Ministry of Agriculture, Ministry of Energy and Ministry of Natural Resources and Tourism) to own and operate meteorological stations to support specific sector needs. The mode of operation (frequency and data format) of these stations and sensors used did not meet the required standards to support the GBON network.

Effective coordination with these institutions will contribute to the TMA data bank and increase the availability of weather data to be exchanged internationally to contribute to the GBON network.

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CHAPTER FIVE

AUDIT RECOMMENDATIONS

5.1 Introduction

This chapter contains recommendations for the TMA regarding the management of meteorological services in the country.

The National Audit Office believes that based on the principles of the 3Es of Economy, Efficiency and Effectiveness, these recommendations need to be fully implemented to ensure improvements in the Management of meteorological Services in the country.

5.2 Recommendations to the Tanzania Meteorological Authority

The Management of the TMA is urged to:

(a) Enhance the network for meteorological observations by integrating all weather stations into the National Network of Observations Stations;

(b) Establish a functional system for corrective and preventive maintenance of equipment in meteorological stations;

(c) Ensure the accuracy of all forecasted weather parameters is validated;

(d) Improve the processing of weather data and ensure the provision of downscaled weather forecasts and services;

(e) Improve the regulatory functions, ensure registrations of meteorological services, and issue permits to operate meteorological services;

(f) Strengthen the dissemination of weather information and awareness about its use; and

(g) Improve coordination with internal stakeholders to enhance regulation and provision of meteorological services.

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REFERENCES

1) Legal Guide to the Sustainable Development Goals (SDGs) 2021: Advocates for International Development (A4ID)
2) Tanzania Meteorology Authority (2024): Statement on the Status of Tanzania Climate in 2023: Tanzania
3) World Meteorology Organization (WMO) (2023): State of the Global Climate 2023, WMO-No. 1347: Switzerland
4) Tanzania Meteorological Authority Act (2019): Tanzania
5) Tanzania Meteorological Authority (Meteorological Services for Marine Transports) Regulation (2021): Tanzania
6) Tanzania Meteorological Authority (Meteorological Stations) Regulation (2021): Tanzania
7) Tanzania Meteorological Authority (Meteorological Equipment and Instruments) Regulation (2021): Tanzania
8) Tanzania Meteorological Authority (Weather and Climate Forecasting Activities) Regulation (2021): Tanzania
9) Strategic Plan for Tanzania Meteorological Agency (2017/18-2021/22): Tanzania
10) Medium-Term Strategic Plan I (2021/22-2025/26): Tanzania
11) National Five Years Development Plan (2021/22- 2025/26): Tanzania
12) TMA Annual Performance Reports (2019/20-2023/24): Tanzania

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APPENDICES

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Appendix One: Responses from the Audited Entities

This part covers responses from the Audited Entities, the Tanzania Meteorological Authority. The responses are divided into two parts, namely General and Specific comments, as detailed *below:*

Responses from the Tanzania Meteorological Authority

General Comment:

TMA will develop strategies and allocate funds to ensure all observed anomalies are resolved to improve its operations.

Specific Comments

S/N	Recommendation	Comments from TMA	Planned Action (s)	Implementation timelines (s)
1	Enhance the network for meteorological observations by integrating all weather stations into the National Network of Observations Stations.	TMA is in the process of procuring a Universal Data Collection system that will enable the integration of non-TMA weather stations in the National Observation Network.	Procurement and installation of Universal Data Collection System	By June, 2026
2	Establish a functional system for corrective and preventive maintenance of equipment in meteorological stations.	TMA regularly conducts preventive and corrective maintenance of meteorological equipment and instruments. Maintenance of stations includes calibration and preventive and	To enhance the functional system for corrective and preventive maintenance by:- (i) To decentralize preventive and corrective maintenance activities at	By June, 2026

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S/N	Recommendation	Comments from TMA	Planned Action (s)	Implementation timelines (s)
		corrective actions. When performing calibration, maintenance is also undertaken.	the zonal level; and (ii) To increase resources for preventive and corrective maintenance activities for the zonal level by 10 per cent	
3	Ensure the accuracy of all forecasted weather parameters is validated.	TMA validates not only rainfall but also other forecasted parameters such as wind (speed and direction), temperature, pressure, and visibility, and it attained accepted accuracy as per ICAO standards and Annex 3. In addition, strong wind forecasts for the public are also validated on a daily basis and compiled in quarterly reports.	Procurement of meteorological instruments and equipment to facilitate validating weather parameters.	By June 2028
4	Improve the processing of weather data and ensure the provision of downscaled weather	Currently, TMA issues seasonal weather forecasts that are downscaled to the district level. i.e. weather forecasts available for the	Procurement of Forecasting System	By June 2028

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S/N	Recommendation	Comments from TMA	Planned Action (s)	Implementation timelines (s)
	forecasts and services.	public cover every point in the country at all time scales. TMA provides point / tailor-made weather forecasts as appropriate.		
5	Improve the regulatory functions, ensure registrations of meteorological services, and issue permits to operate meteorological services.	According to Regulation 5 of "THE TANZANIA METEOROLOGICAL AUTHORITY (METEOROLOGICAL STATIONS) REGULATIONS, 2021" and the Second Schedule of these regulations, part (B) Fees and Charges for Registration of Meteorological Stations explains fees to be paid according to the type of a Meteorological Station and Class of Observing Station. Generally, there are four classes: Class A: Rainfall Stations, Class B: Manned or Conventional Stations, Class C: AWS Stations, and Class D: Radar and	(i) To enhance awareness and Stakeholder engagements; (ii) To develop software for Streamlining Registration and permit issuance Processes; and (iii) To establish a feedback mechanism.	By June 2027

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S/N	Recommendation	Comments from TMA	Planned Action (s)	Implementation timelines (s)
		Special Stations. Each class is charged differently.		
6	Strengthen the dissemination of weather information and awareness about its use.	i. TMA has been progressively strengthening the dissemination of weather information and awareness programmes, including expanding and increasing the channel of dissemination. ii. Currently, TMA is disseminating weather Information through TV, Radio, newspapers, the Internet, and social media (Facebook, YouTube, Instagram, Online TMA TV, Blog). iii. TMA has also established the TMA Best	To increase 3 communication channels streaming weather and climate information	By June 2027

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S/N	Recommendation	Comments from TMA	Planned Action (s)	Implementation timelines (s)
		Journalist Awards to stimulate and strengthen the participation of journalists in the dissemination of weather information. v. Media Forum is organized three times a year to enhance awareness and disseminate seasonal forecasts.		
7	Improve coordination with internal stakeholders to enhance regulation and provision of meteorological services.	This is a continual process as TMA establishes and develops a regulatory function.	a) To enhance internal communication; b) To develop a list of potential stakeholders requiring meteorological services; c) To enter MoUs with internal stakeholders on the provision of Meteorological services; d) To develop a coordination strategy to improve	By 1June 2028

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S/N	Recommendation	Comments from TMA	Planned Action (s)	Implementation timelines (s)
			internal stakeholder	

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Appendix Two: Main and Sub-audit Questions

This part provides the list of five main audit questions and their respective sub-questions:

Question 1	**To what extent does weather forecasting reflect the actual weather conditions in the country and be regulated?**
Sub Question 1.1	To what extent does weather forecasting at TMA match the actual weather conditions in the country?
Sub Question 1.2	To what extent are unregistered meteorological stations distributed across the country?
Question 2	Does TMA adequately collect the meteorological data for weather forecasting?
Sub Question 2.1	Is the network for the collection of weather information effectively utilized to provide meteorological data?
Sub Question 2.2	Are the observation data from meteorological stations received in a timely manner at the central forecasting office?
Sub Question 2.3	Are corrective and preventive maintenance for meteorological observation stations effectively done?
Sub Question 2.4	Are the meteorological observation stations sufficiently integrated into the nation's observation network to enhance timely and accurate weather forecasting?
Question 3	**Does TMA process weather information to ensure timely and accurate forecasting?**
Sub-Question 3.1	Does TMA ensure sufficient processing of meteorological data?
Sub-Question 3.2	Are the meteorological data processing facilities updated according to technological changes?
Sub-Question 3.3	Has TMA effectively acquired, maintained and used computing power to run complex models for processing weather forecasting information?
Question 4	**Does TMA effectively regulate weather forecasting activities to meet national and international standards?**
Sub-Question 4.1	Are meteorological stations in the country registered to enhance control of meteorological data?
Sub-Question 4.2	Are permits issued to operators of meteorological services in a timely manner?
Sub-Question 4.3	Does TMA regularly inspect meteorological stations based on the agreed standards?
Sub-Question 4.4	Does TMA adequately collect the cost recovery revenue from users of meteorological services?

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Question 5	**Does TMA adequately disseminate Weather information to the public, government agencies, and key stakeholders?**
Sub-Question 5.1	Does TMA disseminate weather information updates in a timely manner?
Sub-Question 5.2	Are the dissemination channels used by TMA effective in terms of reach and impact?
Sub-Question 5.3	Is there an effective awareness provision for the application of meteorological services to social and economic activities?
Sub-Question 5.4	Are the resources allocated for the dissemination of weather information being used effectively?
Question 6	**Is the coordination among actors in the provision of weather forecasting activities effectively done?**
Sub-Question 6.2	Is there an effective incorporation of meteorological services into various government undertakings?
Sub-Question 6.3	Does the level of coordination among actors and stakeholders enhance the provision of weather forecasting?

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Appendix Three: List of Reviewed Documents and Reasons for Reviewing them.

This part presents the lists of documents that were reviewed and the reasons for reviewing them during the execution of the audit.

Category of the documents	Title of the documents	Reasons for reviewing
Register	• Station register database • Permit register database	• To establish a number of registered and unregistered station • To establish a number of stations that operate without a TMA permit
Plan for regular inspection.	• Report of regular and technical inspection	• To analyze the control mechanism adopted by TMA
Station establishment	• Guide for the establishment of meteorological stations	• Special distribution of the meteorological stations and deficiency
Media coverage	• Media monitoring reports	• Awareness coverage to the public
Revenue collection	• Annual performance report	• To analyze revenue collection per year, including cost recovery to some agents
Preventive and corrective maintenance	• Preventive and corrective report • Calibration plan • Calibration certificates	• To know the status of equipment calibration • To establish maintenance status
Reports	• Customer satisfaction report	• To analyse the level of satisfaction of the customer
Memorandum of understanding	• Memorandum of understanding	• Relationship with stakeholders

Source: Auditors' Analysis on the List of Reviewed Documents, 2024

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Appendix Four: Officials Interviewed during the Audit

This part provides the details of the Officials from various entities interviewed during the audit.

Institution Covered	Title of official Interviewed	Reasons for interviewing
TMA	Manager of Meteorological Infrastructure	• To know the reasons why there are still unregistered stations and unauthorized stations. • Why do some station operates without a permit • How often is station inspection carried out, and what reasons are some stations not being inspected per year • Strategies used to identify unregistered and unauthorized station • Challenges in department
TMA	Acting Manager Dodoma Airport (zonal manager)	• Type of parameter observed at the station • Accuracy of the data observed • Existing Number of stations in the zonal • Their relationship with TCAA • How do they operate • Challenges and possible reasons for it • Challenges they face
	Officer on duty (Agromet station Hombolo)	• His duty as an observer • Kind of crops does the station perform in the field • Why do they still use mercury equipment • Education awareness to the citizen
	Marine Manager	• Duties of marine manager • Parameters they observe • Equipment used for marine observation • Why is there no marine station? • Accuracy of the data they observe

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Institution Covered	Title of official Interviewed	Reasons for interviewing
		• Marine tailor-made customer • Consequences for not having a specific station for marine • Relationship with marine stakeholders • Challenges
	Officer on duty (at the port)	• Duties as observer • Observation and reporting time • Parameter observed • Use of mercury equipment • Accuracy of the data • Interval sending weather packages to customer • Challenges faced
	Calibration manager (calibration facility)	• Duties at calibration facilities • Plans for calibration and maintenance • Equipment they calibrate and verify • Reasons for why some station equipment were not calibrated for some years • Relationship with other stakeholders • Reasons for not having other equipment verified • Reasons why radar maintenance took much longer • Training for new equipment • Challenges and their reasons
	Officer (issuing permit)	• Why do some station operates without a permit • Status of permit renewal • Strategies used to unauthorized station • Reason for the low number of permit station • Challenges in department

***Source*:** Auditors' Analysis on the List Interviewed Officials, 2024

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Appendix Five: Status of TMA National Meteorological Observation Stations

SN	Type Of Station		Existing	Plan	
				Required	Deficit
1	Synoptic Stations (conventional)		7	0	0
2	Synoptic Stations (AWS)	Paralleled with Conventional Stations	4	195	145
		Stand alone	46		
3	Aeronautical Meteorological Station (Conventional)*		20	0	0
4	Aeronautical Met station (AWOS)		16	20	4
5	Upper-Air Station		1	6	5
6	Agricultural Meteorological Stations*		13	23	10
7	Ordinary Climatological Stations		40	164	86
8	Principal Climatological Stations		0	6	6
9	Special Climatological Station		0	6	6
10	Reference Climatological Stations		0	4	4
11	Sea /Marine Stations		7	12	5
12	Rainfall Stations (Manual)		450	500	50
13	Automatic Rainfall Station		60	1500	1440
16	Weather Radar stations		5	7	2
17	Radar wind profiler		0	10	10
18	Research Purpose Stations		0	2	2
19	Training Purpose Stations		1	2	1
20	Lightning location Stations		5	21	16
21	Hydro-meteorological Stations		82	100	18
22	Tide-gauge stations		0	24	24
23	Radiation stations		0	2	2
24	GCOS-SURFACE		6	6	0
25	GCOS-UPPER AIR		1	3	2
Total			764	2613	1838

***Source*:** TMA Guide to the Establishment of Meteorological Stations 2018 as updated in 2024

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Appendix Six: Status of Equipment in the visited Meteorological Stations in Dar Es Salaam, Mwanza, Mbeya and Dodoma

Region	Station	Equipment	Status of Maintenance (Yes/ No)					Status if working
			2019/20	2020/21	2022/23	2023/24	Valid Maintenance Tag	
Dodoma	Dodoma Airport	Thermometer	Yes	Yes	Yes	Yes	Yes	Yes
		Barometer	Yes	Yes	Yes	Yes	Yes	Yes
		Rain Gauge	No	No	No	No	No	Yes
		Sunshine Recorder	No	No	No	No	No	No
		Evaporation Pan	No	No	No	No	No	Yes
		Wind Ven	Yes	Yes	Yes	Yes	Yes	Yes
	Hombolo Agromet	Thermometer - Maximum Temperature	No	No	No	No	No	No
		Thermometer - Wet Bulb	No	No	No	No	No	Yes
		Thermometer - Dry Bulb	No	No	No	No	No	Yes
		Thermometer Minimum	No	No	No	No	No	Yes
		Thermometer - Soil Temperature (0C)	No	No	No	No	No	No
		Thermometer - Soil Temperature (5C)	No	No	No	No	No	Yes
		Thermometer - Soil Temperature (10C)	No	No	No	No	No	No
		Thermometer - Soil Temperature (20C)	No	No	No	No	No	No
		Thermometer - Soil Temperature (30C)	No	No	No	No	No	No
		Thermometer - Soil Temperature (50C)	No	No	No	No	No	No
		Thermometer - Soil Temperature (100C)	No	No	No	No	No	No

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		Thermometer -Soil Temperature 0cm-100cm	No	No	No	No	No	No
		Rain Gauge	No	No	No	No	No	Yes
		Evaporation Pan	No	No	No	No	No	Yes
		Sunshine Recorder	No	No	No	No	No	No
		Wind Ven	No	No	No	No	No	Yes
Dar Es Salaam	Marine Station	Wind Ven	No	No	No	No	No	Yes
		Rain Gauge	No	No	No	No	No	Yes
		Barometer	No	No	No	No	No	Yes
	Radar Station	Radar	No	No	No	No	No	No
Mbeya	Uyole Agromet	thermometer - Soil Temperature (0C)	No	No	No	No	No	Yes
		thermometer - Soil Temperature (5C)	No	No	No	No	No	No
		thermometer - Soil Temperature (10C)	No	No	No	No	No	No
		Thermometer - Soil Temperature (20C)	No	No	No	No	No	No
		Thermometer - Soil Temperature (30C)	No	No	No	No	No	No
		Thermometer - Soil Temperature (50C)	No	No	No	No	No	No
		Thermometer - Soil Temperature (100C)	No	No	No	No	No	No
		Rain Gauge	No	No	No	No	No	Yes
		Evaporation Pan	No	No	No	No	No	No
		Wind Ven	No	No	No	No	No	Yes
		Sunshine Recorder	No	No	No	No	No	Yes
	Mbeya Airport	AWS- Rain Gauge Sensor	No	No	No	No	No	Yes
		AWS- Temperature Sensor	No	No	No	No	No	Yes
		AWS-Sunshine Sensor	No	No	No	No	No	No
		AWS- Pressure Sensor	No	No	No	No	No	Yes

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	Radar Station	Radar	No	No	No	No	No	Yes
Mwanza	Mwanza Airport	AWS- Rain Gauge Sensor	Yes	Yes	Yes	Yes	Yes	Yes
		AWS- Temperature Sensor	Yes	Yes	Yes	Yes	Yes	Yes
		AWS - Relative Humidity Sensor	Yes	Yes	Yes	Yes	Yes	Yes
		AWS- Pressure Sensor	Yes	Yes	Yes	Yes	Yes	Yes
		Wind Ven	Yes	Yes	Yes	Yes	Yes	Yes
		Evaporation Pan	No	No	No	No	No	Yes
		Sunshine recorder	No	No	No	No	No	Yes
	Ukiliguru Agromet	AWS- Rain Gauge Sensor	Yes	Yes	Yes	Yes	Yes	Yes
		AWS- Temperature Sensor	Yes	Yes	Yes	Yes	Yes	Yes
		AWS-Sunshine Sensor	Yes	Yes	Yes	Yes	Yes	Yes
		AWS - Relative Humidity Sensor	Yes	Yes	Yes	Yes	Yes	Yes
		AWS- Pressure Sensor	Yes	Yes	Yes	Yes	Yes	Yes
		Evaporation Pan	No	No	No	No	No	No
		Thermometer - Soil Temperature (0C)	No	No	No	No	No	No
		Thermometer - Soil Temperature (5C)	No	No	No	No	No	No
		Thermometer - Soil Temperature (10C)	No	No	No	No	No	No
		Thermometer - Soil Temperature (20C)	No	No	No	No	No	No
		Thermometer - Soil Temperature (30C)	No	No	No	No	No	No
		Thermometer - Soil Temperature (50C)	No	No	No	No	No	No

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		Thermometer - Soil Temperature (100C)	No	No	No	No	No	No
	Radar Station	Radar	No	No	No	No	No	Yes

***Source*:** Auditors' Analysis of the Status of Equipment in the Visited Meteorological Stations, Mwanza, Mbeya, Dar es Salaam and Dodoma, 2024

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Appendix Seven: Implementation of the Awareness Programme on the Implementation of Weather Information in Socio-economic Activities

Financial Year	District	Participants	Financier /programme	Period of the Events
2019/20	Longido DC	0	Global Framework for Climate Services Adaptation Programme in Africa (GFCS-APA) Phase II	21 - 30 October 2019
	Kiteto DC	0		
2020/21	Kibaha TC	18	The Global Framework for Climate Services Adaptation Programme in Africa, GFCS APA Phase II	24 March 2021
2021/22	Muheza DC	30	Korea Meteorological Administration (KMA) Funded Project	13 April 2022
2022/23	Mvomero DC	175	Co GENT Project	23 - 25 February 2023
	Zanzibar	0	Nane Exhibitions	1 - 8 August 2022
	NIT- Dar es Salaam	32	GoT	20 February 2023
2023/24	Karagwe DC	75	PISCA	3 - 4 June 2024
	Kakonko DC	50	PISCA	6 - 7 June 2024
	Morogoro MC	0	Nane Exhibitions	1 - 8 August 2023

Source: Auditors' Analysis of the Plan and Report on the Implementation of Awareness Program, 2024

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