OPERA
OCEAN PREDICTION ENHANCEMENT IN REGIONS OF AFRICA

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Funded by the European Union

Ocean Prediction UN DECADE COLLABORATIVE CENTRE

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

MERCATOR OCEAN INTERNATIONAL

TANZANIA METEOROLOGICAL AUTHORITY

OCEAN FORECASTING SYSTEM IN TANZANIA

By

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Contents

1.0 Introduction

Tanzania Meteorological Authority (TMA) is the government Institution.

TMA provides marine meteorological services based on National and International standards

include

1. Manual on marine meteorological services. Volume I, Annex VI 2024 WMO-No. 558,
2. **International Maritime Organization (IMO) through (Safety Of Life At Sea SOLAS-CHAPTER V,**
3. The Intergovernmental Oceanographic Commission of United Nations Educational, Scientific and Cultural Organization (UNESCO-IOC) and others

2.0 Functions of TMA related to marine meteorological services

1. To observe, collect, archive and disseminate meteorological and related information for the United Republic of Tanzania;
2. To provide weather, climate services and warnings for the safety of life and property to the general public and to various users including aviation, marine operation (Transportation, fishing, search and rescue, oil and gas exploitation, research, tourism, etc), agriculture and food security, water resources, disaster management, health and construction industry;
3. To participate in the activities of international organizations and programs, in particular the World Meteorological Organization (WMO) e.g. World Weather Watch (WWW), International Civil Aviation Organization (ICAO), Global Climate Observing System (GCOS), the Global Atmospheric Watch (GAW), International Maritime Organization (IMO), JCOMM, etc;

2.0 Water bodies of United Republic of Tanzania (URT)

TANZANIA

TMA ports marine meteorological office.

Indian ocean Ports

- Zanzibar
- Pemba
- Dar es salaam
- Tanga
- Mtwara

Lakes Ports

- Mwanza - Lake Victoria
- Kigoma and Karema - Lake Tanganyika
- Itungi -Lake Nyasa

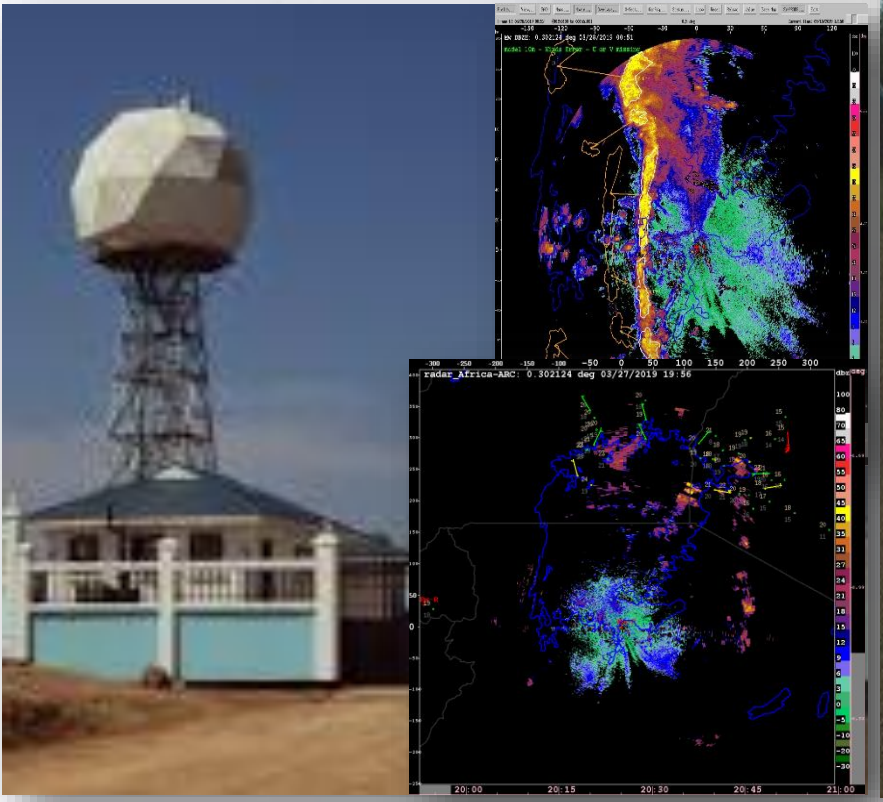
3.0 Marine/ocean forecasting system in Tanzania

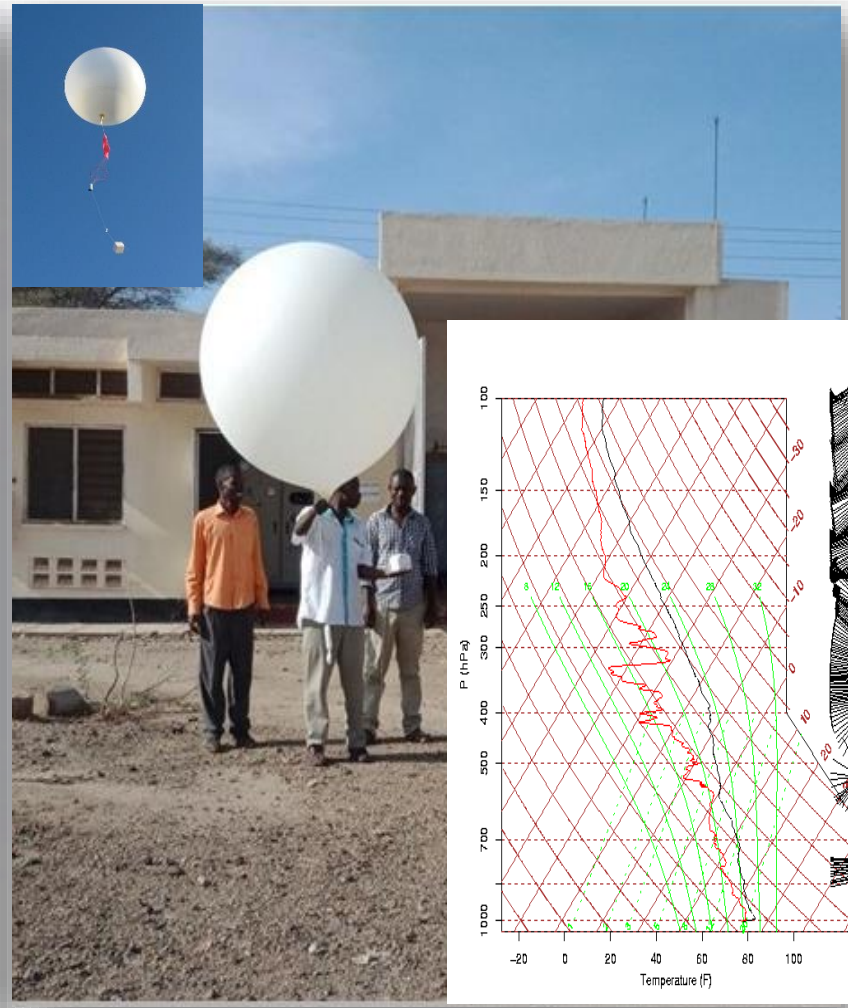
❖The Ocean forecasting process constitutes of:

- Observations
- Telecommunication
- Processing and Analysis
- Interpretation, packaging and dissemination

4.0 The Ocean forecasting process

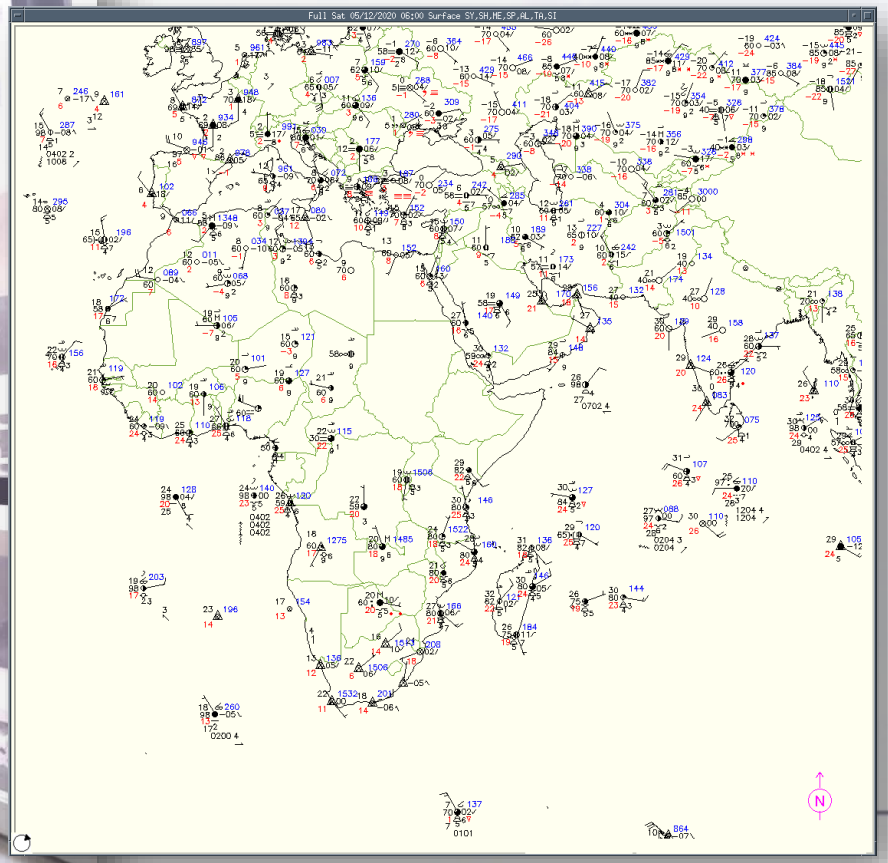
Observations

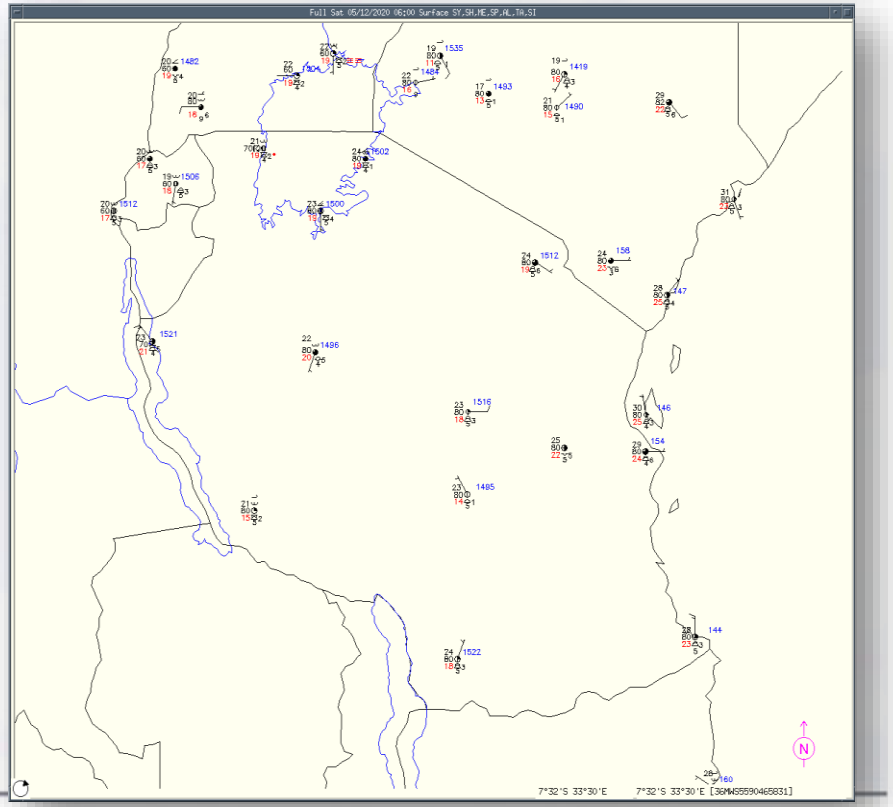




3.0 The Ocean forecasting process

Telecommunication





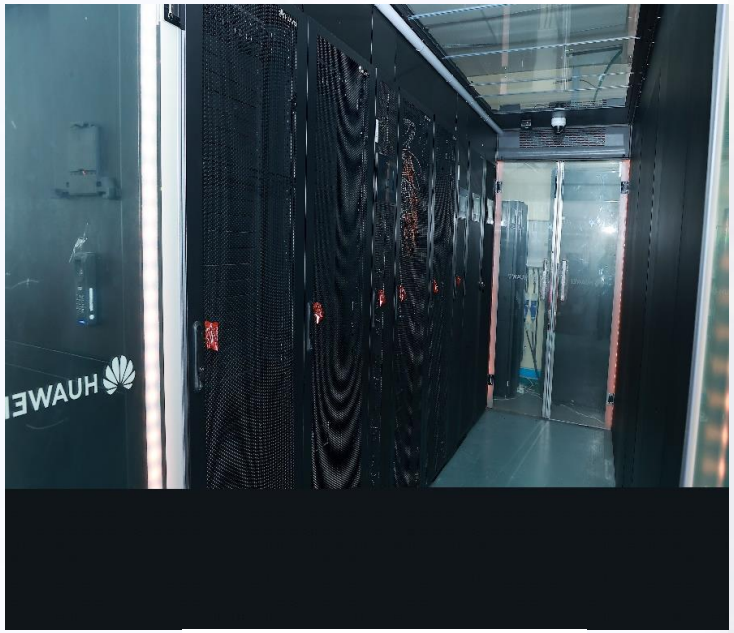
3.0 The Ocean forecasting process

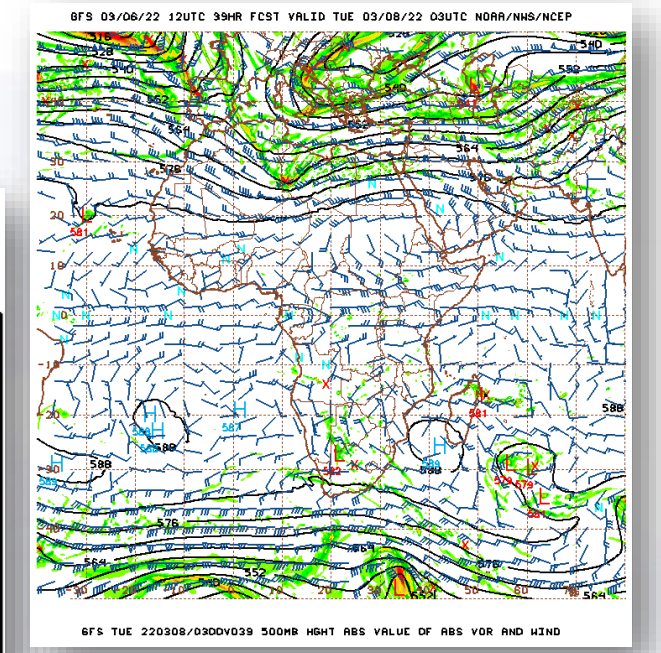
Processing and Analysis: Models

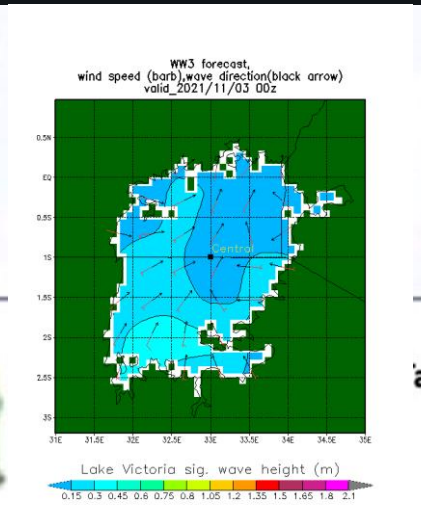
- Tanzania currently operationally runs one atmospheric NWP model (WRF) and one Ocean model, Wave Watch III (WW3)
- A Weather Research and Forecasting of Advanced Research Weather (WRF-ARW) core runs operationally for short range (0 – 72hours), Medium range (3 – 7days) and Long range (1 – 3months).
- The WRF-ARW uses initials and boundary conditions (IC&BC) from Global Forecast System (GFS) models (for short and medium range runs) and Climate Forecast System (CFS) global model (for long range forecast)
- Wave Watch III (WW3) model runs for short and medium range forecasts and get IC&BC from GFS model

3.0 The Ocean forecasting process

Processing and Analysis







Continuity equations (O3.2-O3.3, B2.3,B3.1)

$$\frac{\partial \rho_a}{\partial t} + \nabla \cdot (\rho_a \mathbf{v}_a) \equiv \frac{D_a \rho_a}{Dt} + \rho_a (\nabla \cdot \mathbf{v}_a) = \dot{\rho}_a \quad (1)$$

$$\frac{\partial \rho_c}{\partial t} + \nabla \cdot (\rho_c \mathbf{v}_c) \equiv \frac{D_c \rho_c}{Dt} + \rho_c (\nabla \cdot \mathbf{v}_c) = \dot{\rho}_c \quad (2)$$

$$\dot{\rho}_a = -\dot{\rho}_c \quad (3)$$

Material derivatives

$$\frac{D_a}{Dt} \equiv \frac{\partial}{\partial t} + (\mathbf{v}_a \cdot \nabla); \qquad \frac{D_c}{Dt} \equiv \frac{\partial}{\partial t} + (\mathbf{v}_c \cdot \nabla) \quad (4)$$

Ooyama [2001]

Equations of motion

$$\rho_a \frac{D_a \mathbf{v}_a}{Dt} = \mathbf{F}_{ac} + \rho_a \mathbf{g} - \nabla p \quad (5)$$

$$\rho_c \frac{D_c \mathbf{v}_c}{Dt} = \mathbf{F}_{ca} + \rho_c \mathbf{g} \quad (6)$$

Newton's third law

$$\mathbf{F}_{ac} = -\mathbf{F}_{ca}$$

Momentum equation (O3.6, O3.9)

$$\frac{D_a \rho_a \mathbf{v}_a}{Dt} + \rho_a \mathbf{v}_a (\nabla \cdot \mathbf{v}_a) + \frac{D_c \rho_c \mathbf{v}_c}{Dt} + \rho_c \mathbf{v}_c (\nabla \cdot \mathbf{v}_c) = -\nabla p + (\rho_a + \rho_c)\mathbf{g} \; \underline{-\mathbf{W}\dot{\rho}_a} \quad (9)$$

Condensate acceleration

$$\frac{D_c \mathbf{v}_c}{Dt} = \underline{\frac{D_a \mathbf{v}_a}{Dt}} + (\mathbf{W} \cdot \nabla)\mathbf{v}_a \quad (11)$$

Resulting equation of motion for moist air (O4.7, O4.9)

$$(\rho_a \underline{+\rho_c}) \frac{D_a \mathbf{v}_a}{Dt} = -\nabla p + (\rho_a + \rho_c)\mathbf{g} \; \underline{-\rho_c (\mathbf{W} \cdot \nabla)\mathbf{v}_a} \quad (13)$$

Bannon [2002]

Equations of motion

$$\rho_a \frac{D_a \mathbf{v}_a}{Dt} = \mathbf{F}_{ac} + \rho_a \mathbf{g} - \nabla p \; \underline{+\mathbf{W}\dot{\rho}_a} \quad (7)$$

$$\rho_c \frac{D_c \mathbf{v}_c}{Dt} = \mathbf{F}_{ca} + \rho_c \mathbf{g} \quad (8)$$

Newton's third law

$\mathbf{F}_{ac} = -\mathbf{F}_{ca}$, but what is $\underline{\mathbf{W}\dot{\rho}_a}$?

Momentum equation (B5.2, B5.5)

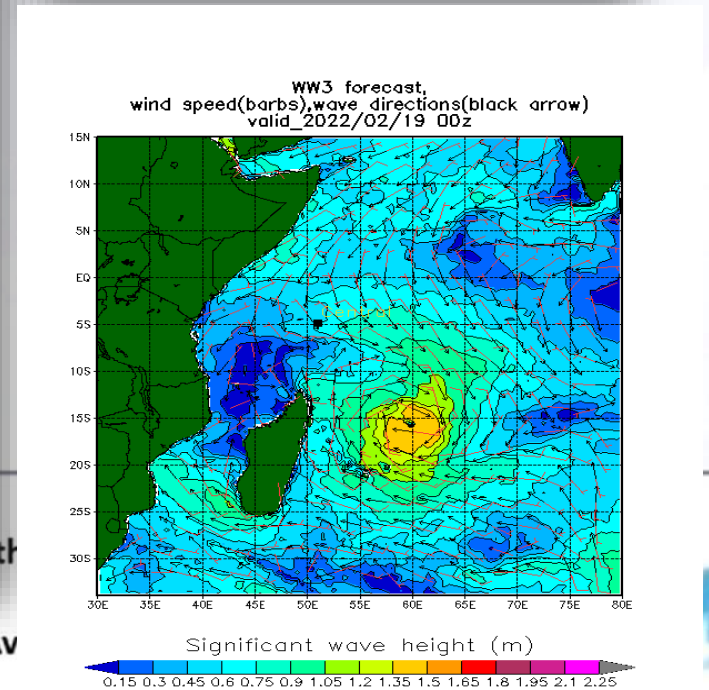
$$\frac{D_a \rho_a \mathbf{v}_a}{Dt} + \rho_a \mathbf{v}_a (\nabla \cdot \mathbf{v}_a) + \frac{D_c \rho_c \mathbf{v}_c}{Dt} + \rho_c \mathbf{v}_c (\nabla \cdot \mathbf{v}_c) = -\nabla p + (\rho_a + \rho_c)\mathbf{g} \quad (10)$$

Condensate acceleration (B5.11)

$$\frac{D_c \mathbf{v}_c}{Dt} = \underline{0} \quad (12)$$

Resulting equation of motion for moist air (B5.18, B5.19)

$$\rho_a \frac{D_a \mathbf{v}_a}{Dt} = -\nabla p + (\rho_a + \rho_c)\mathbf{g} \; \underline{+\mathbf{W}\dot{\rho}_a} \quad (14)$$



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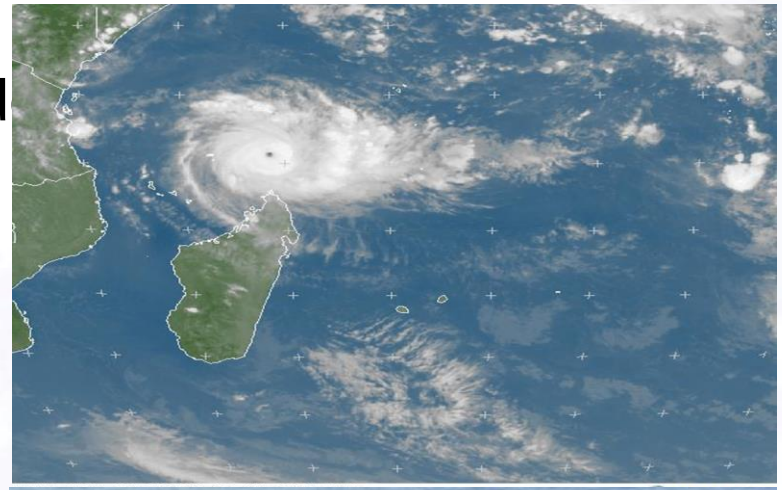
ISO 9001:2015 Certified in Av

4.0 Types of marine meteorological services delivery

Marine weather forecasts issued to end-users includ

- strong winds,
- Swells and sea waves
- Storm surges
- Tropical cyclones
- Tsunamis,
- Costal inundation
- Heavy rains
- Thunderstorms
- Visibility, etc.



Some of users of marine. meteorological services

- Ports and Harbor operations (Ocean and inland water Bodies)
- Transportation (International and Local)
- Fishing and aquaculture (Coastal and Deep Sea)
- Oil and Gas exploration (Coastal and Deep Sea)
- Sports (Coastal)
- Tourism (Coastal)
- Research (Coastal and Deep Sea)
- Ocean Environment Protection (Coastal and Deep Sea)

5.0 Packaging of marine meteorological services

Tanzania Meteorological Authority

Marine Weather Forecast for Coastal Areas

THIS IS MARINE WEATHER FORECAST FOR NORTHERN AND SOUTHERN COAST FOR NEXT 12 HOURS

VALID DATE, TIME: 03/06/2024, 0000Z TO 03/06/2024, 1200Z

Issued on: 02/06/2024 Time: 1045UTC

ADVISORY	NIL	
12 HOURS FORECAST	NORTHERN COAST: (DAR-ES- SALAAM, TANGA, PWANI, MAFIA, UNGUJA AND PEMBA)	SOUTHERN COAST: (MTWARA AND LINDI)
WEATHER	Partly Cloudy conditions and sunny periods.	Partly Cloudy conditions and sunny periods.
WIND (In Knots (KT))	Southerly to South-Easterly at 5-15KT	South-Easterly to Southerly at 5-10KT
SIGNIFICANT WAVE HEIGHT (In meters(m))	1.3 to 1.6m	1.0 to 1.3m
WAVE PERIOD (In Seconds(s))	7.1 to 8.0	7.0 to 8.1sec
STATE OF THE SEA	SLIGHT TO MODERATE	SLIGHT
VISIBILITY	GOOD	GOOD
MAXIMUM WAVE HEIGHT (In meters(m))	1.6m	1.4m
AVERAGE SEA SURFACE TEMPERATURE 30°C OUTLOOK (Next 48 hours): *NO SIGNIFICANT CHANGES.*		

All correspondences should be directed to:
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University of Dodoma, Administration block, College of Informatics and Virtual Education,
1 CIVE Street, P.O. Box 27, 41218 Dodoma; Tel: + 255 26 2962610: Fax: +255 26 2962610
Email; met@meteo.go.tz; Website: www.meteo.go.tz

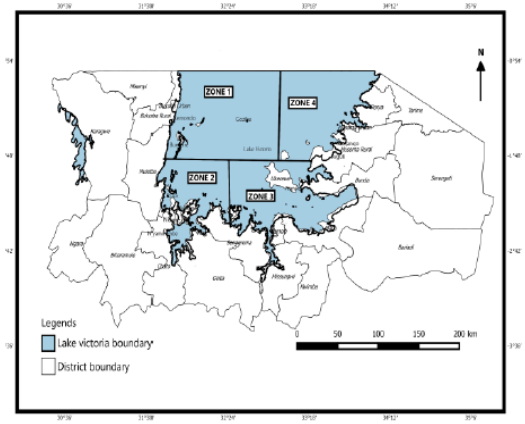
(ISO 9001:2015 Certified in Aviation Services)

722B-1_03/2023

12 Hour Marine Weather Forecast for Lake Victoria

VALIDITY TIME: AT 1800 EALT MONDAY 03rd JUNE, 2024 UNTIL TUESDAY 04th JUNE, 2024 AT 0600 EALT

Issued: At 1500 EALT Monday on 03th June, 2024



Forecasting Zone

ZONE 1:

Bukoba, Goziba, Kemondo, Bumbire.

ZONE 2:

Chato, Nyamirembe, Rubondo, Ikuza

ZONE 3:

Mwanza, Nansio, Ukara, Busisi, Kome, Kamanga, Maisome.

ZONE 4:

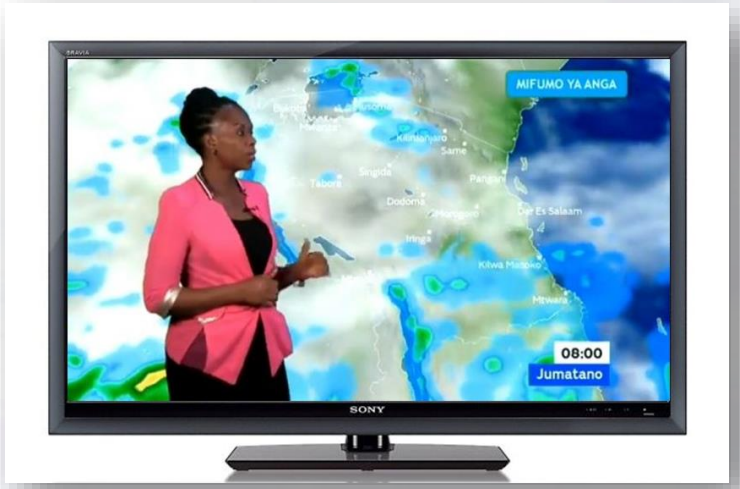
Musoma, Suguti, Mugango, Mori, Majita.

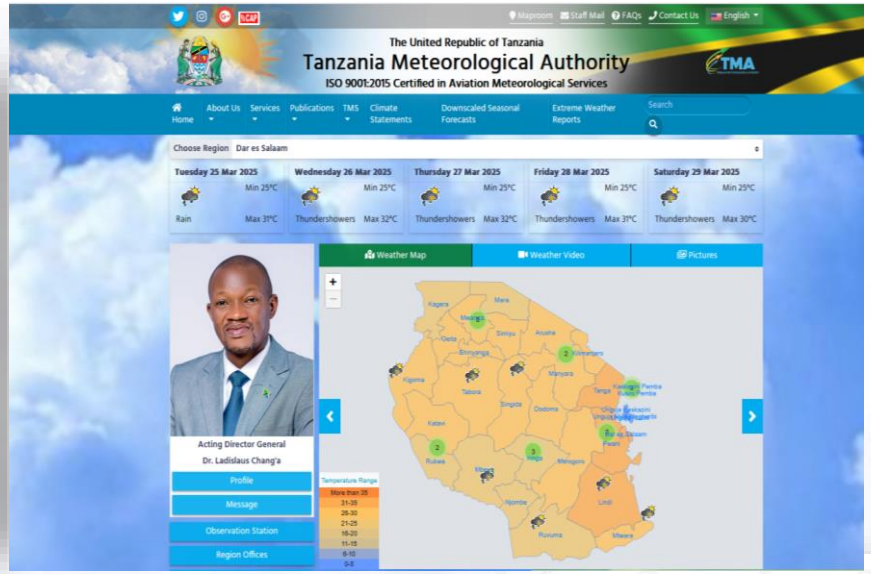
ZONE 1: Bukoba, Goziba, Kemondo, Bumbire.

Monday 03rd June	Wind strength	Wind Direction	Wave height	Weather	Rainfall Distribution	Visibility	Hazards
Night before midnight	Light	South-East	Small waves	Partly Cloud		Good	
Tuesday 04th June Night after midnight	Light	North-West	Small waves	Partly Cloud		Good	
Likely impact			NIL				

8.0 Dissemination methods

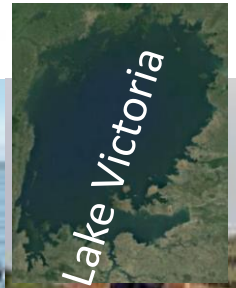
- Marine Rescue Coordination Center (MRCC)
- TV stations
- Private and community radio
- TMA website: www.meteo.go.tz
- Social media, e.g WhatsApp groups
- Emails
- Mobile SMS
- Fax
- Web-portal
- Magazine

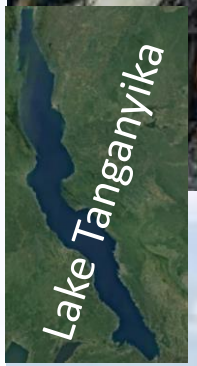


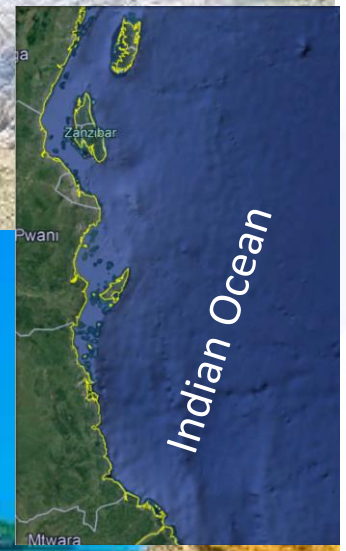


6.0 Some of end-users of marine meteorological services in Tanzania

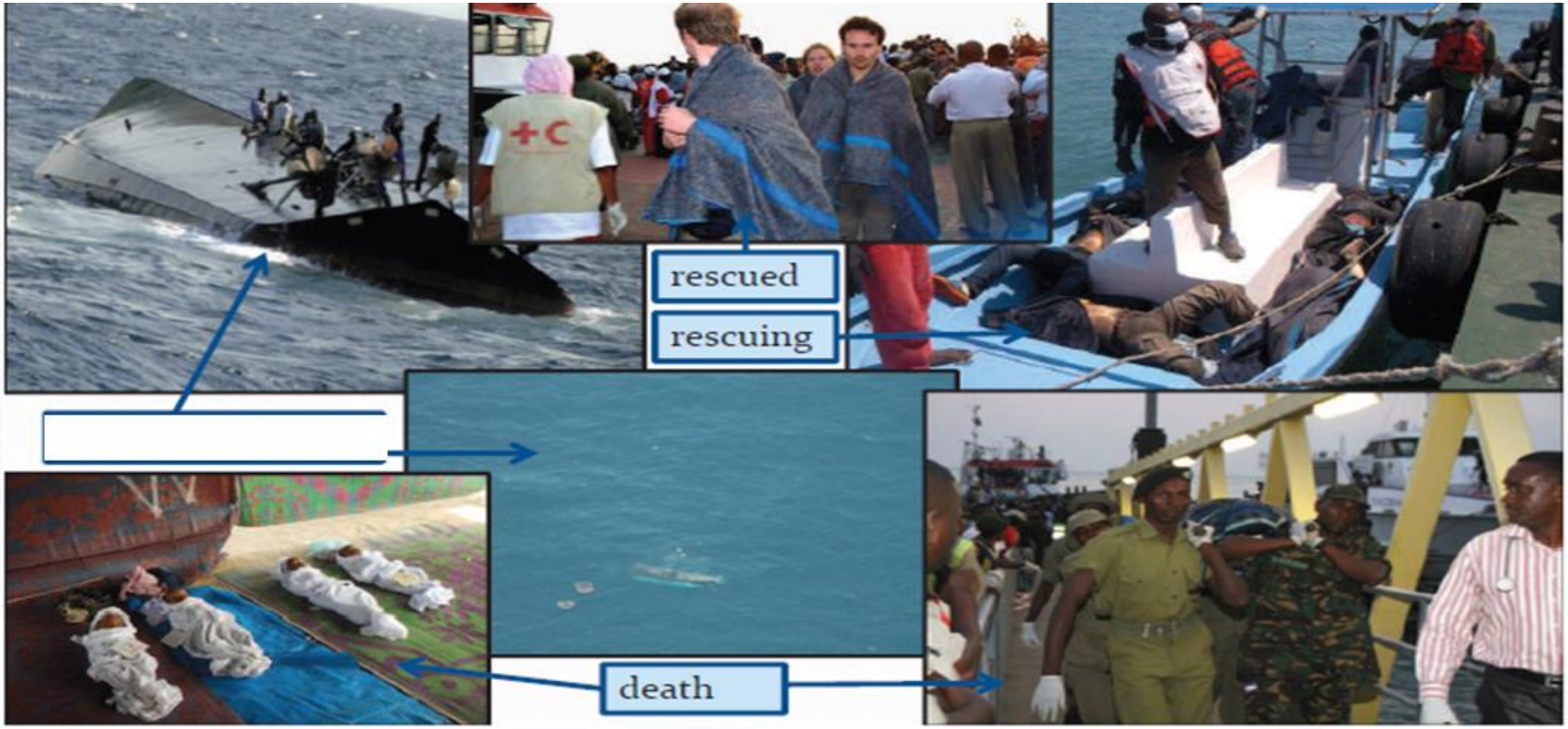
6.0 Some of end-users of marine meteorological services (cont...







7.0 Consequences severe marine weather events



8.0 Gaps and Challenges

- Tanzanian coast in general has limited in-situ ocean observational instruments which hinders the analysis and delivery marine weather forecasts issued to the maritime stakeholders and general public
- Currently we have one Automatic Weather Station (AWS) and two operational tidal gauge stations for sea level measurements at Zanzibar (https://www.ioc-sealevelmonitoring.org/station.php?code=zanz) and Dar es Salaam while Mtwara, Tanga and Pemba are not active
- Inadequate number of experts in marine meteorological field
- Lack of storm surge models and oil spills
- Increased number of marine services users
- Insufficient tools for packaging and dissemination

9.0 Future plans

- Improve marine meteorological observing systems by installing HF-wave radars along the Indian coast
- Installation of three weather buoys in Lake Victoria (done..)
- Improve the Ocean modeling system (set up storm surge models)
- Issue oil spill forecasts over Indian Ocean
- Training more staff in marine meteorology field

THANKS FOR YOUR ATTENTION

AKSANTE SANA!!