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CLIMATE OUTLOOK FOR THE "LONG RAINS" (MARCH-MAY) 2023 SEASON AND REVIEW OF THE OCTOBER-DECEMBER 2022 "SHORT RAINS" SEASON

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1 HIGHLIGHT

1.1 Outlook for March-April-May (MAM) 2023

Below-average rainfall is expected over the Lake Victoria Basin, Highlands West of the Rift Valley, Central Rift Valley, Highlands East of the Rift Valley (including Nairobi County), Coastal region, most of Northeastern and Southeastern Lowlands, and Western parts of Narok. Generally, near-average rainfall is expected over parts of Northwestern (Central and eastern Turkana), parts of South Rift Valley (Eastern Narok), parts of Southeastern lowlands (Kajiado), and the Western parts of Marsabit.

1.2 Review of the October-November-December (OND) 2022 Rainfall Season

The seasonal rainfall analysis from 1st October to 31st December shows that depressed rainfall was received over the North-western, Coast, most stations over the Southeastern lowlands, and Northeastern, several stations over the Highlands East of the Rift Valley including Nairobi County and a few stations over the Highlands West of the Rift Valley and Central Rift Valley. Kakamega, Kericho, Garissa, Kisii, Narok, Moi Air-base, Thika, Makindu, Nyahururu, Embu, Kisumu, and Kitale are the only stations that recorded near-average rainfall. All the other stations recorded less than 75% of their OND Long Term Means (LTMs) with Lodwar recording the lowest percentage at 15.2%. The start of the seasonal rains (onset) was delayed over most parts of the country, except the western sector where the rainfall season continued from September. The onset criteria were not met in certain regions, including Machakos, Msabaha, and all stations over the northeast and northwest. The rainfall distribution both in time and space was poor throughout the country, especially in the months of October and December.

1.3 Review of January and February

Sunny and dry weather conditions prevailed over most parts of the country in January and February. However, several parts of the country received rainfall at the beginning of January while few areas over the Lake Victoria Basin, Highlands West of the Rift Valley, and Southern Rift Valley had rainfall during the fourth week of February. Temperatures were generally higher than the January and February LTM over most parts of the country.

2 FORECAST FOR MARCH-APRIL-MAY 2023 "LONG-RAINS" SEASON

The March to May period is the major rainfall season (long rains) over most parts of Kenya and much of equatorial Eastern Africa. The highest seasonal rainfall amounts (greater than 300mm) are normally received over the Lake Victoria Basin, the Highlands West of the Rift Valley, the Central and South Rift Valley, the Highlands East of the Rift Valley (including Nairobi County) and the Coastal Strip. ***Figure 1a*** illustrates the rainfall climatology during the March to May rainfall season.

2.1 Climatology

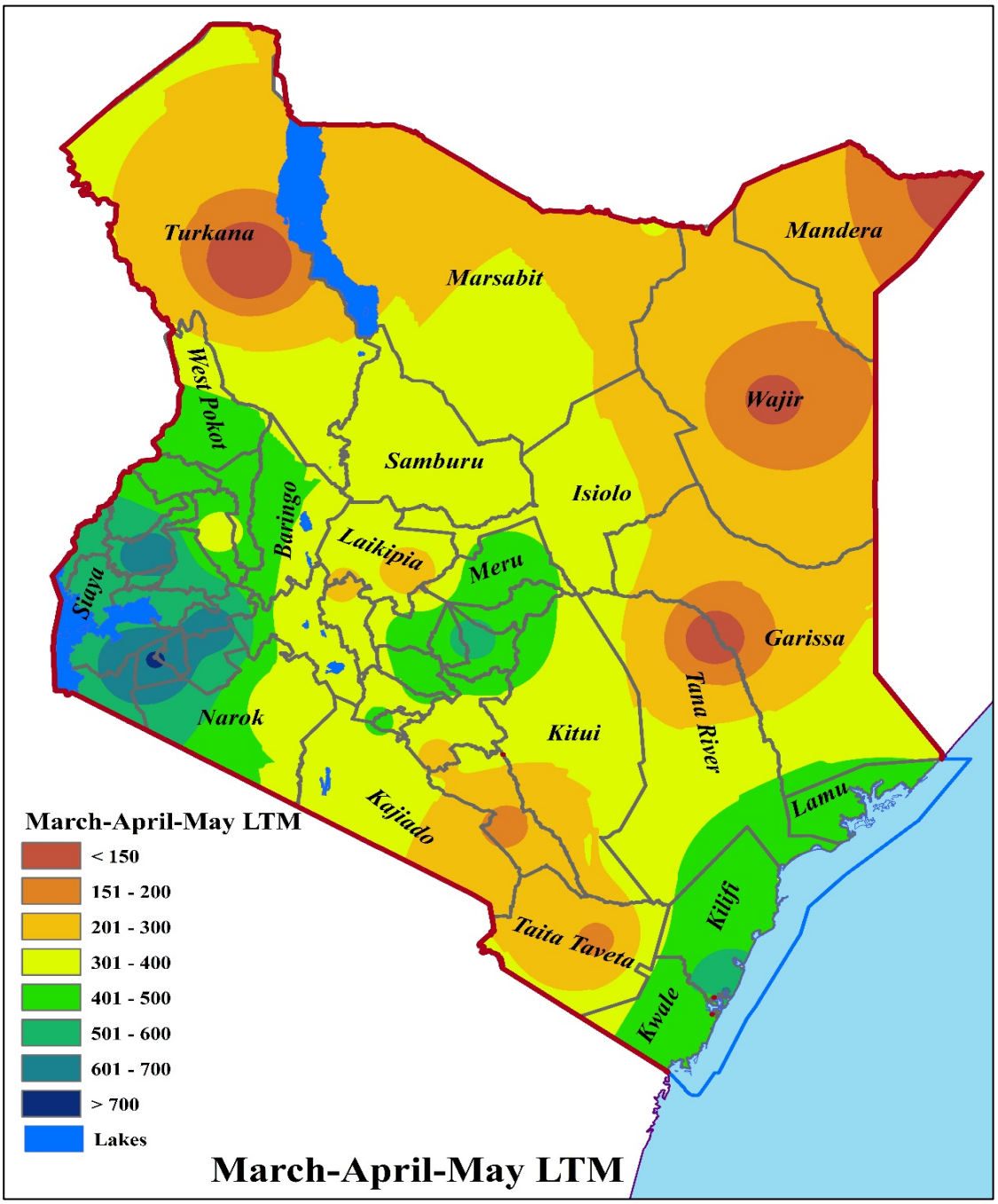

Figure 1a: March-April-May (MAM) "Long-Rains" Season LTM

2.2 Rainfall Outlook for March-April-May 2023 "Long-Rains" Season

The forecast for March-April-May 2023 "Long-Rains" season is based on the prevailing and expected evolution of Sea Surface Temperature Anomalies (SSTAs) over the Pacific, Indian, and Atlantic Oceans as well as the synoptic, mesoscale, and local factors that affect the climate of Kenya. These factors were assessed using various tools including ocean-atmosphere models, statistical models, satellite-derived information, and expert interpretation. The global drivers considered included the Indian Ocean Dipole (IOD), El Niño Southern Oscillation (ENSO), Quasi-Biennial Oscillation (QBO), Western North Pacific (WNP), and Madden-Julian Oscillation (MJO).

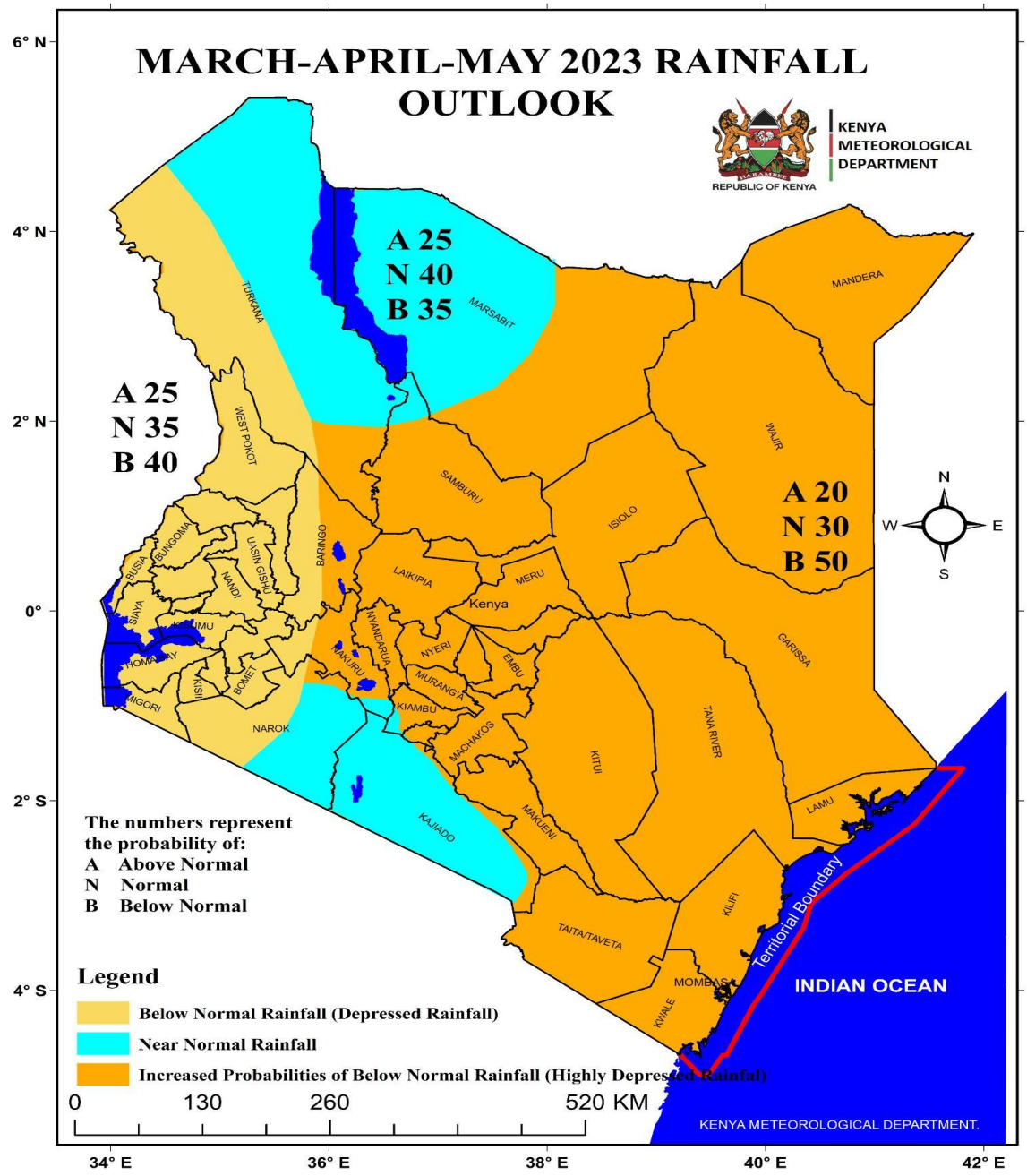

Figure 1b: March-April-May (MAM) 2023 "Long-Rains" Season Outlook

The forecast as shown in ***Figure 1b*** indicates that parts of Northwestern (Central and Eastern Turkana), South Rift Valley (Eastern Narok), Southeastern lowlands (Kajiado) and western parts of Marsabit are likely to experience near-average rainfall. The Lake Victoria Basin,

Highlands West of the Rift Valley, Central Rift Valley, parts of South Rift Valley (Western Narok), and parts of Northwest (Western Turkana) are likely to experience below-average rainfall (depressed rainfall). The Highlands East of the Rift Valley (including Nairobi County), the Coastal region, parts of Northwest (Samburu), and most of the Northeastern and Southeastern Lowlands are likely to receive below-average rainfall (highly depressed rainfall). The peak of the rains is expected to be in April for most regions except over the Coastal Strip where the peak is expected in May.

2.3 Specific Outlook for the March to May 2023 "Long-Rains" Season

The specific outlook for March to May 2023 "Long-Rains" Season is as follows:

2.3.1 The Highlands West of the Rift Valley, Lake Victoria Basin, parts of Central Rift Valley and parts of South Rift Valley and parts of Northwest: (*Trans Nzoia, Uasin Gishu, Elgeyo-Marakwet, West Pokot, Bungoma, Kakamega, Vihiga, Kisii, Kericho, Nandi, Bomet, Nyamira, Western parts of Baringo and Nakuru, Western parts of Narok and Western parts of Turkana)* are expected to receive rainfall that is likely to be below the LTM for the March to May season (depressed rainfall).

2.3.2 Central Rift Valley (*Laikipia, Eastern Nakuru and Baringo***):** are expected to receive rainfall that is likely to be below the long-term average amounts for the season (highly depressed rainfall).

2.3.3 Parts of Northwest, Southeastern lowlands, and South Rift Valley: (*Central and Eastern parts of Turkana, Western Marsabit, Kajiado, and Eastern parts of Narok*), are expected to receive near-average rainfall (normal rainfall).

2.3.4 The Highlands East of the Rift Valley (*including Nairobi County): (Nyandarua, Nyeri, Kirinyaga, Murang'a, Kiambu, Embu, Meru, Tharaka Nithi, and Nairobi)* are expected to receive rainfall that is likely to be below the long-term average amounts for the season (highly depressed rainfall).

2.3.5 The Northeast and parts of the Northwest: (*Wajir, Garissa, Mandera, Isiolo, Samburu and Eastern parts of Marsabit)* are expected to receive rainfall that is likely to be below the long-term average for the season (highly depressed rainfall).

2.3.6 The Southeastern Lowlands: (*Kitui, Makueni, Machakos, and Taita Taveta*): are expected to receive rainfall that is likely to be below the long-term average for the season (highly depressed rainfall).

2.3.6 **The Coastal Strip:** (*Mombasa, Tana River, Kilifi, Lamu, and Kwale counties*) are expected to receive rainfall that is likely to be below the long-term average for the season (highly depressed rainfall).

2.4 Onset, Cessation, and Distribution of Rainfall

2.4.1 Distribution

The predicted onsets, cessations, and distribution of rainfall were derived from 5 Global Climate Models (GCMs) runs as well as statistical analysis of past years which showed similar characteristics to the current year and are as indicated in Table 1. The analogue (similar) years chosen are 2017 and 2021. The season is expected to experience a normal to delayed onset with poor distribution characterized by long dry spells over the areas that are expected to receive below-average rainfall. Occasional localized storms are however still likely to be experienced in some parts of the country.

2.4.2 Onset and Cessation Dates

The expected onset and cessation dates for the various counties are as indicated in ***Table 1***.

Table 1: Onset and cessation dates

	Region	Onset Dates	Cessation Dates	Distribution
1	Counties in Highlands West of the Rift Valley, Lake Victoria Basin, Central, and South Rift Valley: (*Bungoma, Trans Nzoia, Uasin Gishu, West Pokot, Elgeyo-Marakwet, Nandi, Kakamega, Vihiga, Bomet, Kericho, Kisii, Nyamira, Homa Bay, Migori, Kisumu and Busia, Baringo, Nakuru, Western Laikipia and Narok).*	Rainfall is expected in the third to fourth week of March	Rainfall will continue into June	Fair to poor
2	Highlands East of the Rift Valley including Nairobi County: *(Nyeri, Kirinyaga, Murang'a, Embu, Meru, Kiambu, Nyandarua, Nairobi and eastern parts of Laikipia)*	Rainfall is expected in the fourth week of March to the first week of April	Third to fourth week of May	Fair to poor
3	Southeastern Lowlands (*Kajiado, Kitui, Makueni, Machakos, Tana River and Taita Taveta),*	Rainfall is expected in the first to the second week of April	Second to the third week of May.	Poor
4	North Coast region (*Lamu, Malindi, Coastal parts of Tana River, and Kilifi)*	Rainfall is expected from the second to the third week of April	Continues into June	Poor
5	South Coast region *(Mombasa, Kwale)*	Rainfall is expected from the first to the second week of April	Continues into June	Poor
6	The Northwest: (*Turkana, Samburu*)	Undefined	Undefined	Poor
7	The Northeast (*Wajir, Isiolo, Garissa, Mandera and Marsabit*)	Undefined	Undefined	Poor

NB: Undefined means that the onset and cessation criteria are not likely to be met.

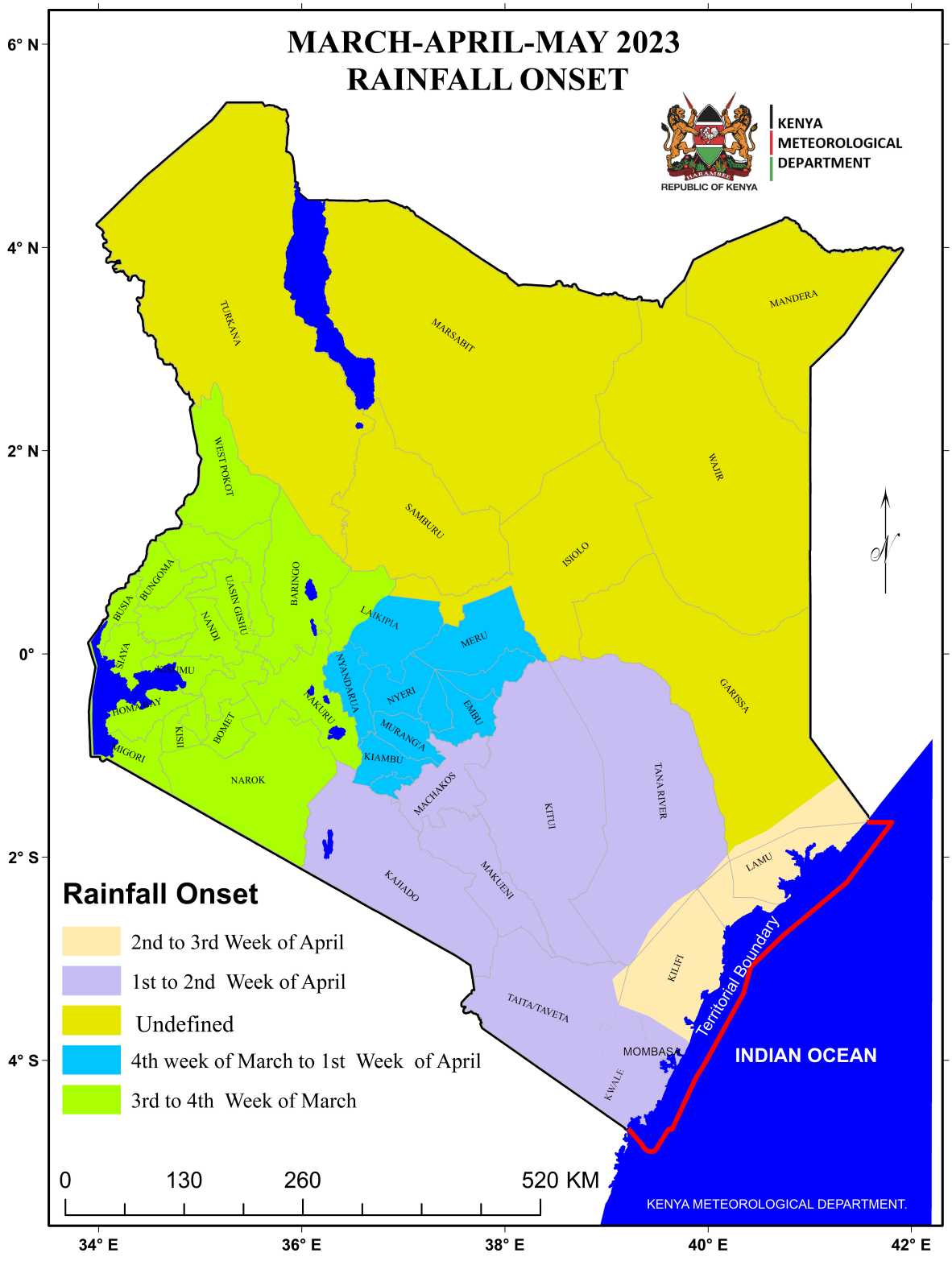

Fig. 1c: MAM 2023 Rainfall Onset

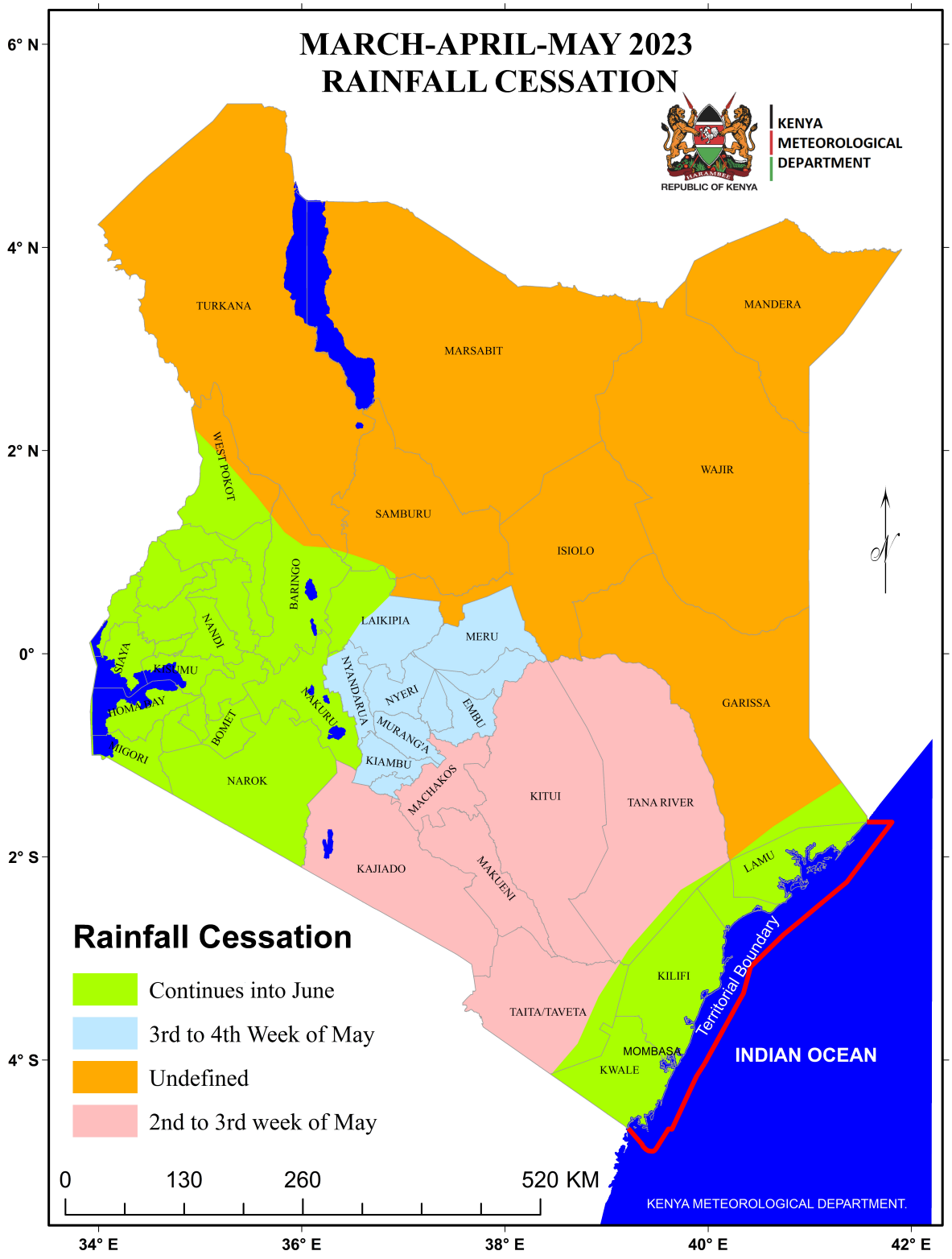

Figure 1d: MAM 2023 Rainfall Cessation

2.5 Temperature Forecast

Above-average temperatures are expected over the whole country with increased probabilities over the Northwestern, parts of the Highlands West of the Rift Valley, and parts of Northeast as shown in ***Figure 2***.

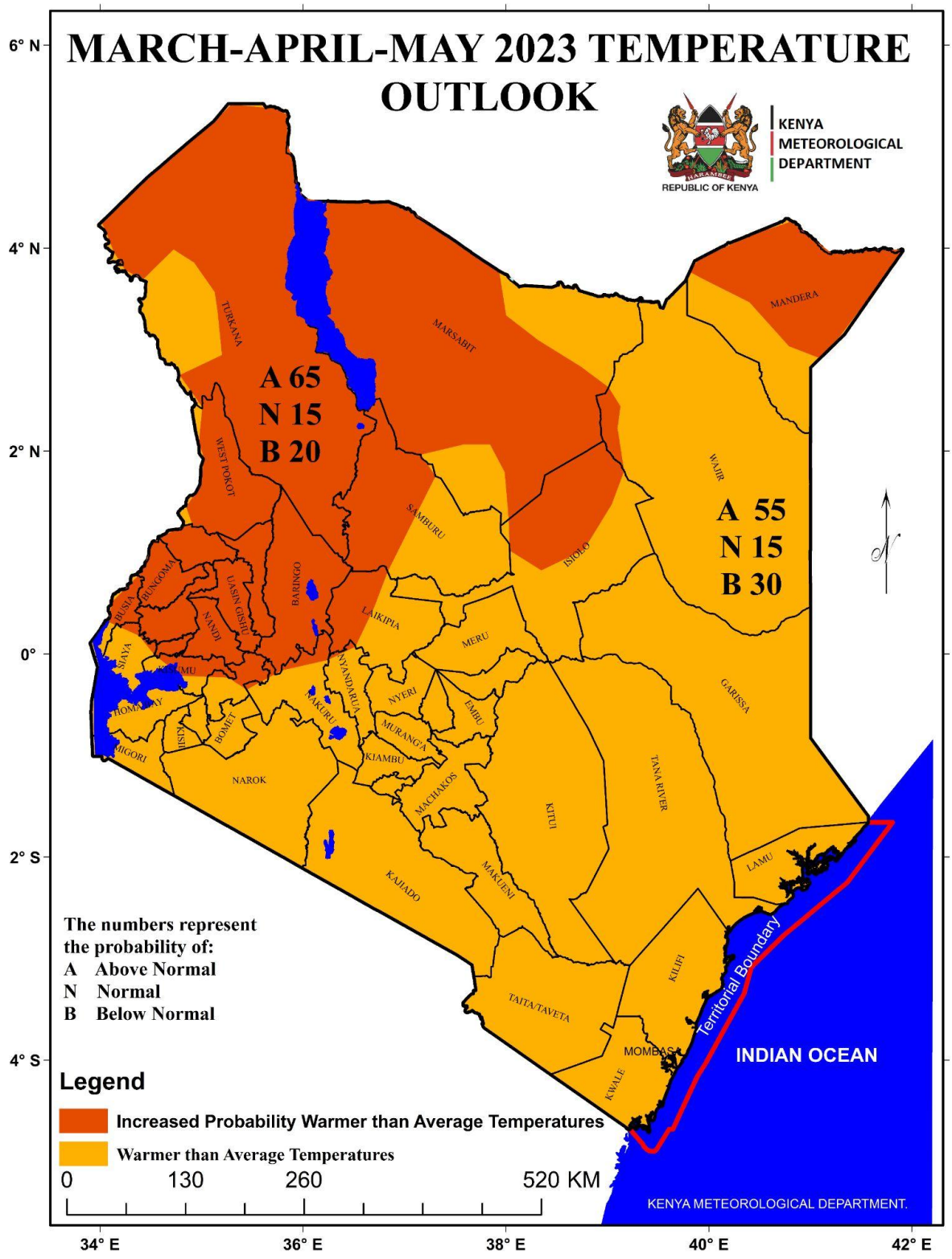

Fig. 2: March-April-May (MAM) 2023 Temperature Outlook

2.6 Potential impacts of the MAM 2023 outlook

The potential impacts likely to be experienced were co-produced with the various sector leads as indicated.

2.6.1 Agriculture, Food Security, and Livestock Sectors

The depressed rainfall over most parts of the country is likely to negatively affect agricultural production, especially over the high potential areas of the Highlands West and East of the Rift Valley, Central, and South Rift Valley, as well as the Southeastern lowlands. Farmers are therefore advised to plant drought-resistant and early maturing crops, fodder, and pasture and liaise with the Ministry of Agriculture and Livestock Development for advice on appropriate land use management practices.

The expected depressed rainfall is expected to worsen food security and nutrition in the ASAL areas. This may also spread to other parts of the country. Food prices are expected to rise further and accessibility to food is also expected to be poor. Relevant authorities and humanitarian institutions are advised to closely monitor the situation and provide food and food supplements to the most vulnerable communities to avert loss of lives.

The projected low rainfall combined with above-average temperatures may have a negative impact on pasture regeneration, particularly in ASAL areas. Thus, recovery from the effects of the current drought is unlikely over most areas. Consequently, the existing pasture and browse scarcity as well as poor animal body condition might persist. There may also be increased livestock mortality rates in pastoral areas as a result of reduced grazing pastures and water shortages for animals. In addition to providing feed supplements to the remaining livestock, relevant authorities are encouraged to provide drought-resistant and fast-maturing grass and pasture seeds to the communities in the affected areas.

There is a likelihood of an increase in crop pests such as fall armyworms and animal diseases as livestock migrates in search of water and pasture. Therefore, integrated pest and disease surveillance, control, and prevention should be enhanced.

2.6.2 Disaster Management Sector

The current drought being experienced over the ASAL areas is expected to intensify and may spread to other parts of the country. Relevant authorities are advised to sensitize and disseminate early warning information for anticipatory action to be taken as well as step-up measures already being implemented to avert loss of lives, livestock, and livelihoods.

Competition for diminishing water, pasture, and browse is expected to increase the ongoing resource-based conflicts among the pastoralist communities as well as the farming community. The government and local leaders are advised to enhance conflict resolution mechanisms among the communities and promote equitable distribution of resources.

In the Lake Victoria Basin and the Highlands West of the Rift Valley lightning strikes are highly probable, especially in Kisii, Nyamira, Kericho, Bomet, Kisumu, Nandi, Bungoma (Mt. Elgon areas), and Kakamega Counties. Residents in these areas are advised not to shelter under trees or near metallic structures when it is raining.

There is a possibility of isolated storms that may cause floods in low-lying areas and along rivers. The public is advised not to walk through flooded waters or cross flooded rivers to avoid loss of lives. County Governments are also advised to clear drainages in good time to avert artificial flooding of the urban areas.

Water passages, alleys, channels and dried up rivers should also be cleared of debris, to avoid flooding in the event of sudden storms during the season.

2.6.3 Transport and Public Safety Sectors

Isolated storms may occur over a few areas leading to flash floods. This may result in structural damage to roads and bridges which may in turn lead to transport challenges. Slippery roads and poor visibility during rainstorms may also pose a danger to motorists and pedestrians. The public should therefore take utmost care during the rainy period to minimize accidents that could result from such weather conditions.

2.6.4 Water and Energy Sector

The depressed rainfall may lead to below-normal stream flows, low recharge of aquifers as well as reduced water levels in rivers and reservoirs. This will in turn result in the disruption of water supplies both for domestic and livestock use. Efficient water management and tracking should therefore be enhanced to ensure that the water needs of animal and human populations in the affected areas are met. Relevant authorities and the public are also encouraged to practice rainwater harvesting and storage in order to supplement their water needs.

The low water levels in the hydropower-generating dams over the Seven Forks dams are expected to persist and this may reduce hydropower production. Careful reservoir management and continuous monitoring of water levels should be enhanced in order to stabilize power production.

Long dry spells may lead to dusty conditions which may deposit dust on solar panels and reduce their performance. Continuous monitoring and cleaning of solar panels should be enhanced.

2.6.5 Health Sector

Malnutrition-related diseases are expected to rise in the ASAL areas, especially among the elderly, pregnant and lactating mothers, and children. Thus, rapid vulnerability assessment should be enhanced to identify the most vulnerable population and provide them with food relief and food supplements.

Water scarcity is likely to lead to an upsurge in diseases such as diarrhea, dysentery, typhoid, and amoebiasis. Relevant authorities are urged to provide safe drinking water and treatment chemicals to populations that draw water from open sources as well as promote public education on Water and Sanitation Hygiene (WASH).

Normal transmission of vector-borne diseases such as malaria is expected in areas that are prone to outbreaks, including the Lake Victoria Basin, Northeast, Northwest, and Coastal areas aggravated by high temperatures which are conducive for mosquito breeding. Cases of dengue and chikungunya fevers may also increase over the Coastal region. Health authorities are advised to preposition and redistribute medical supplies and insect-treated nets in the affected areas.

2.6.6 Environment and Forestry Sector

The destruction of forest biodiversity is expected to increase due to forest and wildfires, logging, increased charcoal burning, and encroachment of forest areas for pasture. To mitigate these threats, relevant authorities and communities are encouraged to increase surveillance for

fires and illegal activities in forested areas. Conservation measures should also be promoted to allow for improved vegetation regeneration and restoration of forest habitats. By implementing these measures, the negative impacts of these destructive activities can be reduced, and the biodiversity of forest ecosystems can be preserved.

During periods of flash floods, soil erosion is likely to occur as the ground is bare following prolonged dry spells, especially in arid and semi-arid regions. To mitigate this, plans should be put in place to enhance soil conservation measures, such as the use of cover crops, terracing, and erosion control structures. These measures can help to prevent the loss of fertile topsoil, which is essential for agriculture and ecosystem services.

The limited resources such as water and forage in and around parks are expected to lead to an increase in human-wildlife conflicts. These conflicts can result in damage to property, crops and even human fatalities. To mitigate such incidences, relevant authorities should take proactive measures such as providing forage and watering points to wildlife. These measures can help reduce the competition for resources between humans and wildlife, thus minimizing conflicts and promoting peaceful coexistence.

3 OCTOBER-NOVEMBER-DECEMBER 2022 CLIMATE REVIEW

3.1 Review October-November-December 2022 "Short Rains" Season

The "Short Rains", October to December (OND) season constitutes an important rainfall season in Kenya and more so in the Highlands East of the Rift Valley and Southeastern lowlands.

The start of the seasonal rains (onset) was delayed over most parts of the country except the western sector where the rainfall season continued from September. The onset criteria were not met in certain regions, including Machakos, Msabaha, and all stations over the northeast and northwest. The rainfall distribution both in time and space was poor throughout the country, especially in the months of October and December.

In November, the distribution was good over several parts of the country except over the northern sector and parts of the southeastern lowlands (Machakos) where distribution was poor. The poor rainfall performance over several parts of the country was mainly as a result of the prevailing La Nina conditions and negative Indian Ocean Dipole.

The seasonal rainfall analysis from 1st October to 31st December shows that depressed rainfall was received over North-western, North-eastern, Coast, most stations over the Southeastern lowlands, several stations over the Highlands East of the Rift Valley including Nairobi County, and a few stations over the Highlands West of the Rift Valley and Central Rift Valley. The following stations recorded near-average rainfall Kakamega (124.7%), Kericho (123%), Kisii (98.9%), Narok (95.7%), Moi Air Base (95.3%), Thika (88.7%,), Makindu (81.9%), Nyahururu (81.2%), Kisumu (79.1%), Embu (78.2%) and Kitale (77.4%). All the other stations recorded less than 75% of their OND LTMs with Lodwar recording the lowest percentage at 15.2%.

The highest seasonal total rainfall amount of 588.2mm was recorded at Kericho Meteorological station. Other stations that recorded significant amounts of rainfall are Kakamega (532.6mm), Kisii (514.2mm), Meru (404.9mm), Embu (383.1mm), and Thika (319.0mm). On the other hand, stations that recorded less than 100mm are Machakos (60.6mm), Marsabit (53.5mm), Mandera (52.5mm), Msabaha (47.1mm), Wajir (30.2mm), and Lodwar (8.5mm). ***Figure 3a*** shows the OND 2022 rainfall performance (%) while ***Figure 3b*** shows the total rainfall amount recorded in OND 2022 (Blue bars) in comparison with the OND LTMs (Red bars).

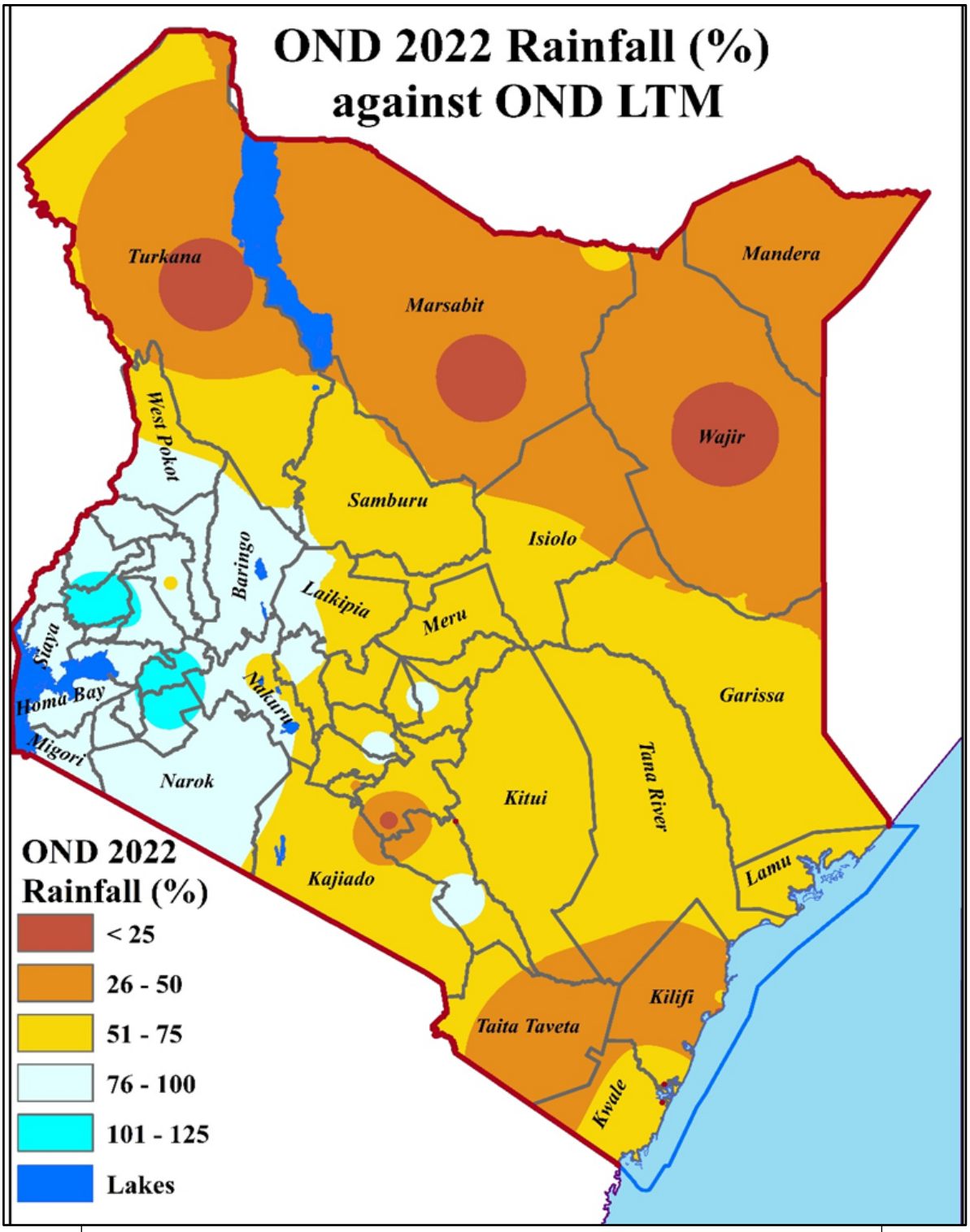

Fig. 3a: OND 2022 Rainfall Totals as a percentage of the OND LTM

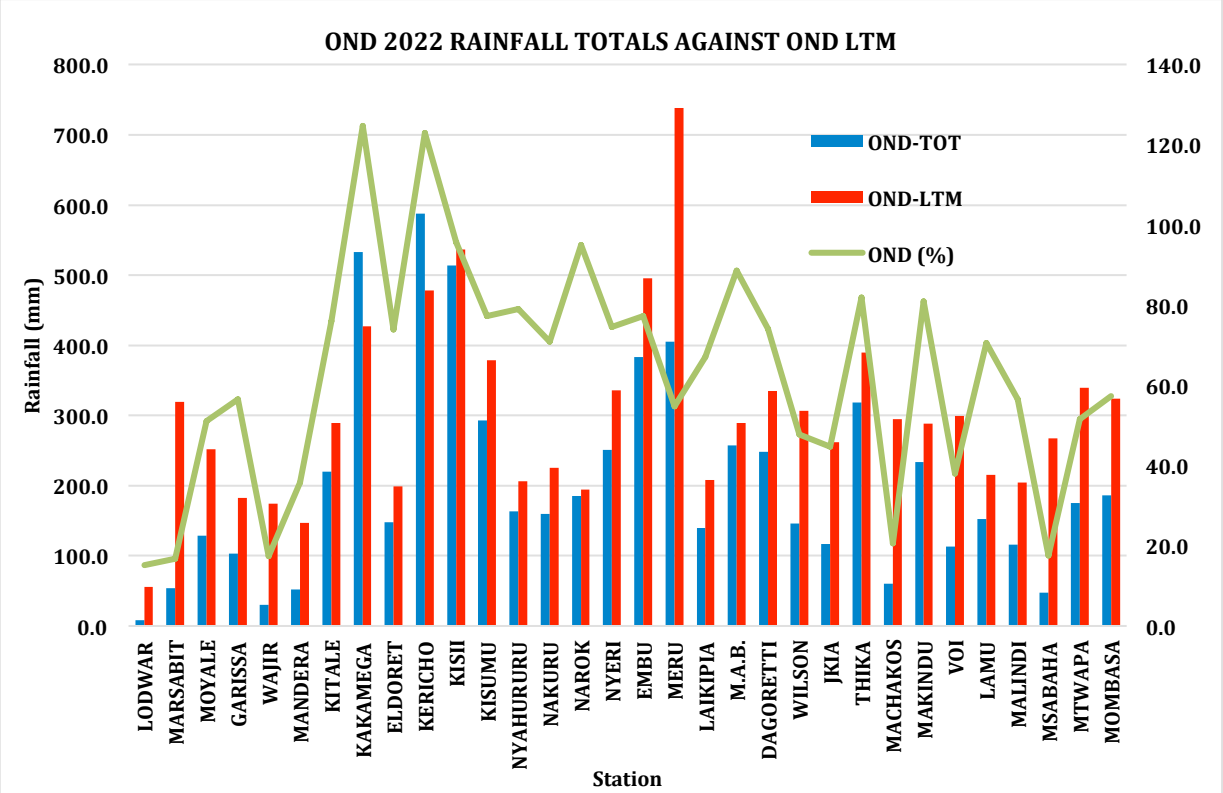

Figure 3b: OND 2022 Rainfall Amount Against OND LTM

3.2 Experienced Impacts during the October-November-December 2022 Season

The impacts experienced were compiled in collaboration with various sectors as indicated.

3.2.1 Agriculture and Food Security

During the OND 2022 season, dry conditions over most parts of the country led to a decline in crop and livestock production. There was also an infestation of fall armyworms in several parts of the country that destroyed crops. This led to below-average harvests and high market prices of staple foods, especially in the ASAL areas which in turn worsened food insecurity, hence increasing the number of vulnerable households requiring food relief and other subsidies.

Livestock deaths were reported in the ASAL areas of the northern and parts of the southeastern lowlands and Coastal regions as a result of a lack of water, pasture, and browse. The body conditions of the remaining livestock in these areas were poor resulting in low prices. Most pastoralists lost entire herds, thus affecting their livelihoods. There was a high occurrence of animal diseases such as anthrax and rabies as a result of the massive migration of animals in search of food, water, and pasture.

The below-average rainfall was however conducive for harvesting and reduced post-harvesting losses, especially over the western sector of the country. It also provided an opportunity to desilt earth water reservoirs and structures, repair irrigation and water harvesting infrastructure across irrigated areas as well as construct and maintain feeder roads thus enhancing access to food commodities from the farms.

3.2.2 Disaster Management

Cases of localized storms were reported in some Counties such as Narok, Kitui, and Garissa that led to fatalities, displacement of people, and destruction of infrastructure.
Resource-based conflicts increased over the northern, Southeastern lowlands, Central Rift Valley, and some parts of Eastern Kenya (Meru and Tharaka Nithi) where fatalities were reported and livestock was stolen. Human-wildlife conflicts were also reported in several counties resulting in the loss of human lives.

3.2.3 Water Resources Management and Energy

The depressed rainfall received over the ASAL areas during most of the OND 2022 season led to reduced water resources, especially in the months of October and December when communities and livestock were faced with acute water shortages. There was increased pressure on boreholes due to pumping; some boreholes over the northern sector dried up. Residents had to walk for long distances in search of water both for human and livestock consumption. However, the water situation improved slightly in November over isolated areas in the southeastern lowlands (Taveta and Kitui), Central Rift Valley (Laikipia) northeastern (Isiolo, Central and Southern Garissa), Southern Rift Valley (Narok), parts of West and North Pokot (Riwo and Suam) and the Coastal region (Kwale and Tana North) as a result of the rainfall received during the month. Water shortage persisted over the northwestern and most of the northeastern regions. Most water pans, sand dams, and rock catchments dried up completely in Marsabit, Turkana South and East, and Central Mandera. There was poor recharge of shallow wells in the northern parts of the country, particularly along rivers Kerio, Malmalte, and Turkwel. Reduced water levels led to a reduction in areas under irrigation over the Northern (Turkana, Marsabit, and Isiolo) and parts of the Central Rift Valley (Baringo and Laikipia).

The depressed rains led to reduced water in rivers impacting hydropower production, especially the large hydropower plants, and mini-grids. The performance of solar power plants was reduced slightly as a result of dust settling on the solar panels due to the dry weather conditions. Some biogas plants were shut down due to a shortage of water in some homesteads.

3.2.4 Environment

Wildlife deaths were reported in the ASAL areas of northern and southeastern lowlands as a result of a lack of forage and water in and around the conservancies and game parks.
There was an increase in wild and forest fires in Aberdares, Mt Kenya, and Mau forests.
Illegal charcoal burning for commercial purposes to supplement income from farmlands due to the prolonged drought led to environmental degradation.

3.2.5 Transport and Public Safety

Traffic was temporarily disrupted along Kismayu road in Garissa following heavy rains that caused flooding on 19th November. Transport along Nguni – Nuu road along river Enziu in Kitui county was also temporarily disrupted following heavy rains that were experienced over the area on 15th and 16th November 2022.

NB: This outlook should be used together with the 24-hour, 5-day, 7-day, and monthly forecasts, regular updates, and advisories issued by this Department. Weekly County forecasts are available from County Meteorological Offices.

KEY OF SCIENTIFIC WORDS USED

Rainfall performance is generally categorized as follows:

- Below 75% of the LTM – Below Normal (Depressed) rainfall
- Between 75% and 125% of the LTM - Near normal rainfall
- Above 125% of the LTM – Above Normal (Enhanced) rainfall

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