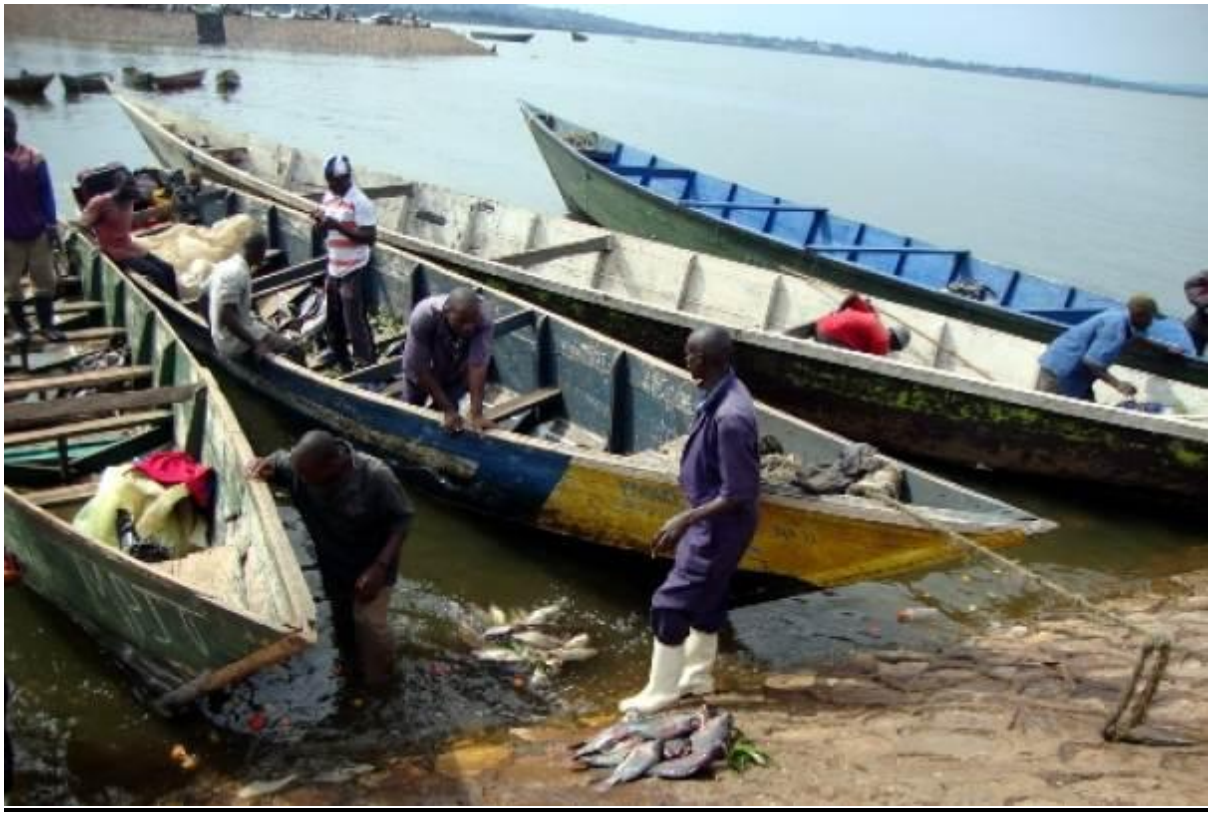
WISER Western Project

Proposal for a daily weather forecast for Kenyan fishermen on Lake Victoria

(Final version)



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Executive summary

There are about 40,000 fishermen in the Kenyan sector of Lake Victoria. Most of them fish from open wooden canoes powered by paddles and sail. Only 20% of the fishing boats have an outboard motor. The canoes capsize frequently as a result of adverse weather conditions. Drownings are common.

Most fishing expeditions last less than 24 hours and few Kenyan fishermen venture more than 50 km offshore.

Fishermen in the Kenyan section of Lake Victoria do not benefit from any weather forecast service at present.

It is therefore proposed that Kenya Meteorological Department (KMD) create a daily weather forecast for fishermen active in the Kenyan sector of the lake.

This would be issued every morning at 09.00 and would cover a period of two days. Each bulletin would forecast the weather on the lake for the day of issue and the following day.

The forecast for fishermen would consistently provide information on wind speed and direction, rainfall volume and spatial distribution and visibility.

It would also provide early warning of potential hazards, such as strong winds, high waves, water spouts and thunderstorms.

The bulletin would forecast the weather separately for the Gulf of Winam and for an area of the open lake to the west up to 60 km from the Kenyan coastline.

The forecast would be posted on the KMD website. It would also be sent direct to subscribers by email and social media applications such as WhatsApp.

However, the forecast would mainly reach fishermen through Luo language radio stations broadcasting to audiences in Western Kenya and via SMS messages to committee members of the 281 Beach Management Units (BMUs) along the Kenyan shore of Lake Victoria.

KMD would prepare the forecasts in SMS format, but they would be disseminated to individual BMUs by the national secretariat of the Kenyan Association of Beach Management Units, using a FrontlineCloud/Frontline Sync SMS portal.

The forecasts would use the same language and terminology that fishermen use to describe weather conditions on Lake Victoria in preference to scientific terminology.

The terms and expressions used would be harmonized as much as possible with those already used by the Uganda National Meteorological Agency (UNMA) in its existing mobile weather alerts for fishermen in the Ugandan section of the lake.

It is proposed to launch the Kenyan daily forecast in August 2016.

The forecast would be produced initially by Paul Oloo, the KMD County Meteorological Director in Homa Bay, and Vincent Sakwa, the County Meteorological Director in Kakamega. Paul is an experienced maritime forecaster. Vincent is an experienced severe weather forecaster.

The National Meteorological Centre in Nairobi should provide 24/7 support to these two forecasters to ensure that the bulletin s produced and disseminated regularly and on time whenever one or both of them are unavailable.

Once the forecast has become firmly established, responsibility for producing it on a daily basis should be transferred to the National Meteorological Centre (NMC) in Nairobi, along with the responsibility for producing ad hoc hazard warnings for fishermen on Lake Victoria. Ideally this transfer should take place in late September 2016.Paul Oloo should train NMC in the production and dissemination of the forecast as part of the handover process.

Introduction

There are about 40,000 fishermen in the Kenyan sector of Lake Victoria, according to the UN Food and Agriculture Organisation (FAO). Most of these fishermen are also subsistence farmers.

They are organised into 281 Beach Management Units (BMUs). These are village associations of fishermen, fish traders and fishing industry service providers, such as net repairers and ice makers. The BMUs regulate fishing and fish trading in each port and have official links to the government's Department of Fisheries.

Nearly all the fishermen operate from wooden canoes that are about eight metres in length. They have a low freeboard (clearance above the waterline) that and are vulnerable to capsizing in high waves and stormy weather.

Each canoe carries a crew of between three and 12 men. The number depends on the type of fish being caught and whether the fishermen are using nets or lines.

About 80% of the fishing canoes are powered by sail and paddles, according to Tom Guda, Chairman of the National Association of Beach Management Units.

Where these canoes can go and how fast they can move is largely determined by the speed and direction of the wind and the height of waves on the lake.

Only 20% of Kenyan fishing canoes have an outboard motor that allows them to travel fast in any direction, independently of wind speed and direction.

The safety of fishermen and their ability to navigate on the lake is therefore highly dependent on the weather.

Incidents of capsizing are common, but it is relatively uncommon for boats to sink. The upturned canoe usually floats on the surface of the water and the fishermen hang onto it until they are rescued.

About 5,000 people are officially reported to drown every year in Lake Victoria. Most of these are fishermen from Kenya, Uganda and Tanzania, whose boats capsize or sink in adverse weather conditions. Tom Guda thinks this official figure underestimates the real toll, since many deaths go unreported.

Few fishermen wear life jackets. Most say they cannot afford them.

Regular and reliable weather forecasts could help fishermen to avoid navigating on the lake in severe weather conditions and could therefore save lives.

In addition, the forecasts could enhance their ability to catch fish since the weather on the lake has a strong influence on fishing conditions..

Light or moderate rain brings fish to the surface of the lake and makes them easier to catch, but thunderstorms scare fish away.

Strong winds may endanger the boat’s safety, but they are also associated with good fishing conditions, particularly when the wind direction runs counter to the water current in the lake.

Water temperature also influences the amount of fish that can be caught. If the water is too hot, the fish die. If it is too cold, they go elsewhere. Temperate water that is neither too hot nor too cold provides ideal fishing conditions.

During the rainy season, the rivers that flow into Lake Victoria swell in volume and pour cold water into the lake. Fishing around river outlets tends to be poor at such times.

Fisheries officers report that the number of fishing boats in the Kenyan sector of Lake Victoria is increasing steadily as a result of population growth in lakeside communities.

Yet the volume and value of catches has been decreasing since the mid 1990s as a result of pollution and over-fishing.

With more fishermen than ever working on the lake and fewer fish to catch, the meagre incomes of individual fishermen are constantly being squeezed..

A new and regular source of information that helps boats to increase the size of their daily catch and navigate more safely on the lake would be eagerly welcomed by the fishing community.

Most Kenyan boats go out on fishing expeditions that last 24 hours or less.

Typically they set out during the daytime to set nets or long lines. The latter float on the surface and have multiple baited hooks attached to sinkers. The nets and lines are frequently left in the water to catch fish overnight. The fishermen then return the following day to harvest the night's catch and reset their nets and lines. However, some fishermen remain out on the lake during the hours of darkness.

Fishermen sometimes move temporarily away from their home port to base themselves in other villages where the fishing is better. But few boats venture more than 50 km away from the coast in their fishing expeditions.

Winds on Lake Victoria generally blow offshore in the morning, assisting sail-powered boats to reach fishing grounds away from the shore. But the wind normally changes direction later to blow onshore in the afternoon. This helps the boats to return to their home port under sail at the end of the day.

Fishermen who go out in the morning and return in the evening need a weather forecast for the rest of the day. But those who go out in the afternoon and remain on the water overnight, need a forecast for the following day as well.

A daily forecast, issued each morning and covering the 48 hours ahead, would serve the information needs of all Kenyan fishermen well.

Field research

The following research was undertaken to develop this proposal:

- Focus group discussions with fishermen at Kamin Oningo Beach in Siaya County and Arengo Beach in Kisumu County
- Conversations with fishermen at Port Victoria in Busia County
- A meeting with Tom Guda, the National Chairman of Beach Management Units in Kenya.

- Discussions with several Kenyan fisheries experts, including the directors of fisheries of Kisumu and Siaya counties. Ann Mokoro, the fisheries expert on the Agricultural Sector Development Support Programme (ASDSP) in Kisumu County, and Frederick Oguya, a water quality scientist with the Kenyan Maritime and Fisheries Research Institute (KEMFRI) in Kisumu.
- Discussions with meteorologists of Kenya Meteorological Department, including Ayub Shaka, Calistus Wachana and Paul Oloo.
- A two-day workshop in Kisumu with fishermen's leaders from Migori, Homa Bay, Kisumu, Siaya and Busia counties and a representative of the Uganda National Meteorological Authority in July 2016.
- Desk research on the SMS-based severe weather warning system for fishermen on Lake Victoria developed by the Uganda National Meteorological Agency.

Indigenous weather forecasting techniques

Kenyan fishermen have until now relied on observation of the clouds and stars and the behaviour of wild birds to alert them to weather-related hazards and to judge the quality of fishing conditions.

They also monitor surface currents in the lake, measuring them with floaters, to determine where fishing conditions are likely to be best.

Commonly used traditional indicators of weather conditions include the following:

- A big white cloud with black edges indicates that strong gusts of wind may come suddenly from any direction. This phenomenon is known in Luo as "Kus." It brings good fishing conditions, but is notorious for causing sailing boats to capsize.
- When fish eagles perch on a bush and cry out continuously a Kus is coming.
- When fish eagles fly up suddenly into the air in the middle of the lake, it is also means that a Kus is coming
- When the wind blows from the land there will be no fish
- When the wind blows from the lake fish will be plentiful.
- If it rains the catch will be even better
- No fish will be caught when there is thunder and lightning

- A moderate current means good fishing, Fish swim against the current.
- But fast currents destroy nets and bring poor fishing conditions
- When clouds form, the speed of currents in the lake increases and you catch no fish
- You catch more fish when the current is moving from the Gulf of Winam towards the open lake.

However, these indicators only provide an incomplete guide to weather conditions on the lake. They do not always allow fishermen to anticipate the arrival of sudden storms or strong winds which hinder their return to port and pose a threat to their safety.

Kenyan fishermen have not so far used weather forecasts from KMD to inform their fishing activity.

However, those who operate near the Ugandan border occasionally request by SMS the daily mobile weather alerts issued by the Uganda National Meteorological Agency (UNMA).

An example of the UNMA daily alerts for fishermen is given below:

MOBILE WEATHER ALERT FOR FISHERMEN IN KALANGALA UGANDA NATIONAL METEOROLOGICAL AUTHORITY

Alert YELLOW

Issued by UNMA

Area KALANGALA

Date 18TH MAY, 2016

Validity 6PM – 6AM

Advice BE AWARE

Wind MODERATE

Weather PARTLY CLOUDY

Visibility MODERATE

Issued at 01:10pm Wednesday 18th May, 2016.

The weather information needs of Kenyan fishermen

Some Kenyan fishermen will risk going out every day in almost any weather conditions to collect fish from their nets and lines which have been left out overnight. Neglecting to do so would result in an immediate financial loss.

But many do stay on shore if the weather conditions look really ugly and dangerous.

The types of information that fishermen say they would most like to receive in weather forecasts are:

1. **Wind speed and direction**

   This determines which direction sail-powered boats can move in and how fast they can travel. In the Gulf of Winam, strong westerlies often cause accumulations of water hyacinths which impede the progress of sail-powered canoes. High winds also whip up higher waves on the lake. High waves force all boats – even those with outboard motors – to travel more slowly. They may also swamp heavily laden canoes with a low freeboard, causing them to fill with water. Wind speed and direction may influence the quality of fishing as well as the safety of the boat.

   The fishermen have special names for different types of wind. These include the following:

   "Tarai" is a strong wind from the east.

   "Ombalo" is a strong wind from the south.

   "Ogingo" is a strong wind from the southwest which brings the danger of water spouts, a phenomenon much feared by the fishermen, called **"Nyakoi."**

   "Nyakoi" are particularly common in the shallow Gulf of Winam when the water surface temperature rises about 26.5 C. If a water spout hits a boat, it is likely to capsize or sink it and injure the crew in the process. If fishermen see a water spout coming towards them, some will cut their arm to make it bleed as a sacrifice to try and appease the impending threat and divert it.

   "Kus" is a strong wind usually encountered in deep water which produces gusts that come suddenly and unexpectedly from different directions. Kus provides good conditions for fishing, but is dangerous for sailing boats, which may suddenly capsize as the wind changes direction. During a Kus, the current usually moves in a different direction to the wind causing fish to come to the surface to feed.

2. **Rainfall**

   Light and moderate rain is generally associated with good fishing conditions. However, heavy rain can fill a canoe with water, pushing it lower in the water and endangering the safety of the boat and its crew.

3. **Thunderstorms**

   Heavy thunderstorms, accompanied by high winds and intense rainfall can endanger a boat's safety. Fishing is also poor when there is thunder and lightning.

4. **Wave height**

   Wave height is important to fishermen for several reasons. High waves slow down the movement of boats through the water. Very high waves can also swamp the canoes, causing them to take on water faster than it can be bailed out. The canoes have a very low freeboard and an open interior. They lie particularly low in the water on the return journey from fishing trips when they carry additional weight in the form of wet nets and the day's fish catch. High waves can also destabilize fishing canoes, causing them to capsize.

5. **Water temperature**

   Water temperature influences the quality of fishing. Fishermen are not just interested in the surface temperature of the lake. They also want to know about the temperature gradient beneath the surface. A warm current below the surface of the lake sometimes causes fish to rot in the nets before they can be harvested. Nile perch fishermen hang their drift nets as deep as 10 metres in the open lake, when they use two nets in a double layer.

6. **Speed and direction of water currents**

   The speed and direction of current in the lake can affect the quality of fishing. Conditions tend to be especially good when the direction of the surface

current runs counter to that of the wind. But currents that are too strong can destroy nets. Many boats are attracted to the combination of turbulent winds and strong currents that is often found to the north of Rusinga Island in the narrow strait between the open lake and the Gulf of Winam. The turbulent conditions in this area stir up nutrients from the lake bed and produce particularly good fishing. Normally a current flows into the Gulf of Winam on one side of the narrows between Uyoma and Mbita, while a counter-current flows out of the Gulf on the other.

7. Advice

All fishermen who were consulted about the content of the proposed forecast for Lake Victoria said they would like it to include advice from the Department of Fisheries. Most did not spell out what kind of advice they would like to receive, but some specifically requested advice about whether it was safe or not to go out on the water.

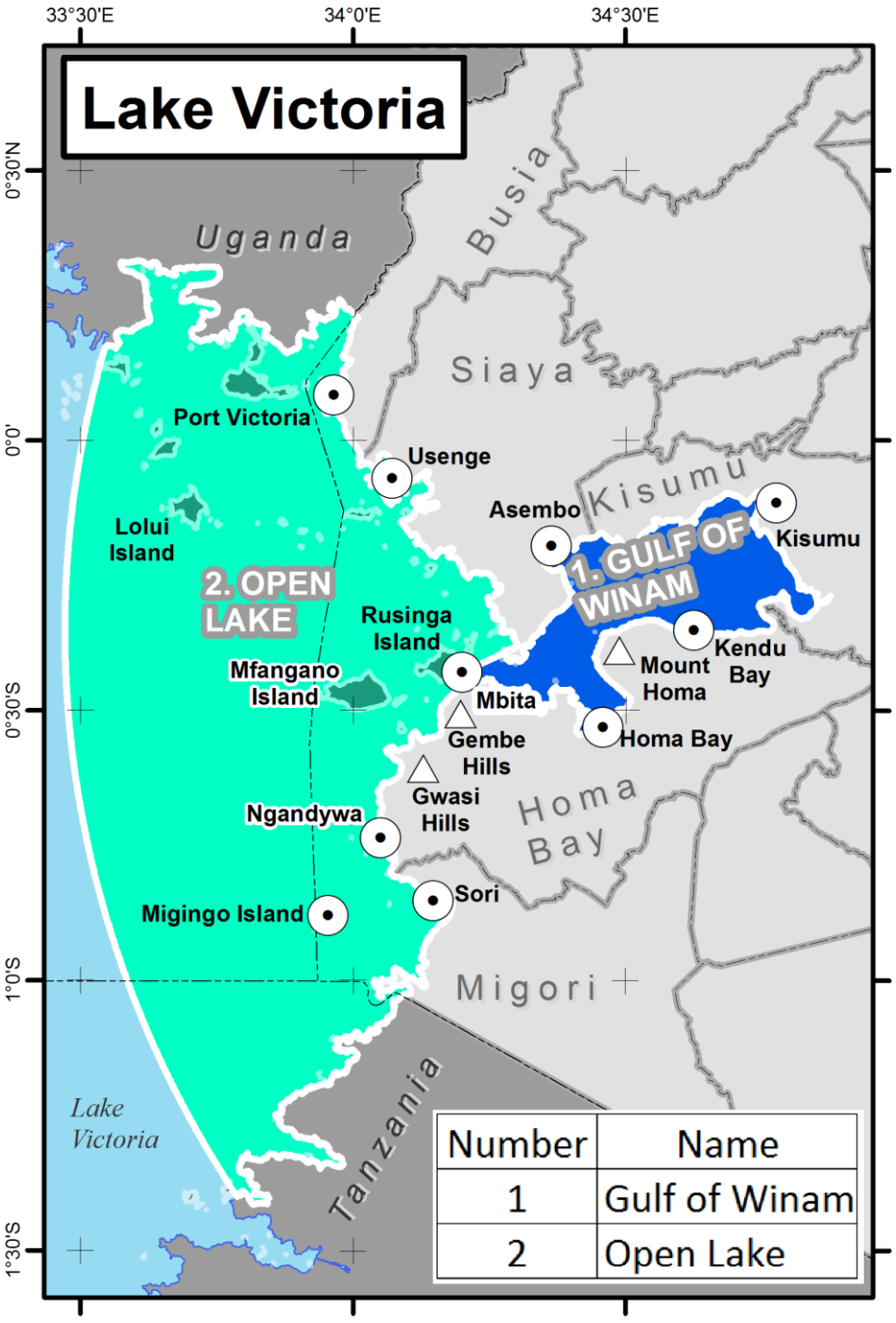
Weather conditions are usually different in the Gulf of Winam to those in the open lake. The gulf is relatively shallow, with a maximum depth of 25 metres. It is also enclosed by land on almost all sides. In the open lake, the water is deeper – up to 84 metres - and the weather can sweep in from the south and west over vast expanses of open water without encountering land obstacles in its path.

Separate forecasts should therefore be given for each body of water.

Kenya-based fishermen seldom venture further than 50 km into the open lake. It is therefore recommended that the KMD daily forecast for fishermen should focus on weather conditions in the following two areas of Lake Victoria:

- The Gulf of Winam
- The northeastern section of the open lake within 60 km of the Kenyan coast

These are illustrated on the map below.



The forecast information that KMD is technically able to provide

In August 2016, when this document was finalised, KMD did not have any functioning equipment that monitored weather conditions on Lake Victoria and

reported this information in real time. Neither did KMD have any equipment placed in the lake to monitor currents or water temperatures

Two buoys carrying floating automatic weather stations were stationed in the Kenyan sector of Lake Victoria in 2013. One was anchored to the lake bed off Homa Hills in the Gulf of Winam. The other was anchored off Rusinga Island in the open lake. These floating weather stations were operated by the Kenya Marine and Fisheries Research Institute (KEMFRI) in association with KMD.

However, KEMFRI officials in Kisumu said the buoys were no longer fully operational and were no longer sending back real time data. They also said that KEMFRI did not collect real time data on currents and water temperatures in the lake by any other means.

For the foreseeable future, KMD forecasts of weather on Lake Victoria will have to be based entirely on meteorological information from shore-based observation sites and satellite data.

The Lake Victoria weather model, made available online by the UK Met Office, is also a useful tool for forecasting weather on the lake. It forecasts the weather over the lake in 4km x 4 km squares.

KMD weather forecasters say these sources should be sufficient to enable KMD to provide accurate and reliable forecasts about **wind speed and direction** and probable **rainfall** conditions on the lake.

It remains to be seen how reliably wind direction can be predicted in the Gulf of Winam, where the land mass and areas of high ground surrounding the body of water may cause a great deal of local variation.

Knowing the wind speed and direction should also enable weather forecasters to predict the occurrence of dangerously high waves. However, KMD does not have sufficient information at present to forecast **wave height** accurately on a routine basis.

KMD is confident that it can also provide regular and accurate forecasts of **visibility** and **cloud cover.**

Visibility affects the ability of fishermen to navigate by sight, especially when they are a long way from the nearest land. Triangulation with landmarks on shore is also important for helping fishermen to locate their lines and nets. These are not usually marked by highly visible buoys for fear that other fishing boats will take advantage of these markers to locate and steal their catch.

Cloud cover may affect the air and water temperature and fishing conditions.

In addition, it should be possible for KMD to provide early warning alerts about the main weather-related hazards that affect fishermen; **thunderstorms, strong winds, exceptionally high and dangerous waves, intense downpours of rain** and **water spouts**.

It may be possible for KMD to use satellite data that is currently available to provide information about **water surface temperatures** in different parts of the lake. This remains subject to confirmation. However, it is less certain that KMD would be able to convey the limited water surface temperature information at its disposal in a way that would be useful for fishermen.

For the time being, KMD lacks the capability to provide real-time information on water currents in the lake.

It is difficult to see what useful weather-related advice KMD or the Department of Fisheries might be able to give fishermen other than general guidance about navigation hazards for small craft on the lake.

The Ugandan National Meteorological Authority (UNMA) provides this kind of guidance to Ugandan fishermen through its daily mobile weather alerts. These categorise the weather conditions at any given time by colour.

UNMA uses a four-colour hazard warning system based on that used by the UK Met Office.

This is calibrated as follows, based largely on the criteria of windspeed, visibility and the probability of thunderstorms occurring:

Green – **No alert.** No hazardous weather expected

Yellow – **Be aware.** There may be changes in the weather. Look out for signs of an approaching storm, such as clouds, wind gusts and higher waves

Orange- .**Be prepared**. The weather is likely to deteriorate. Consider moving to a safer area and be prepared to take any necessary action

Red - **Take action**. The weather will change soon to become life threatening. . Take all necessary action to get to a safe area.

It could be argued that for the sake of consistency Kenya should adopt exactly the same system of colour-coded alerts for its own forecast.

However, in my view, a three-colour hazard classification system would be easier for Kenyan fishermen to interpret. It would also have the advantage of being familiar to many who of them who know how traffic lights work for road traffic.

I therefore propose that KMD adopt the following three-colour traffic light system for all its forecasts and hazard warnings related to weather conditions on Lake Victoria:.

Green – No hazard warnings in force. It is safe for small craft to navigate on the lake.

Amber – **Be prepared** Potentially dangerous weather and water conditions are expected. Small craft should take special care if they decide to go out.

Red - **Take action**. Severe and dangerous weather and water conditions are expected. All vessels on the lake should take immediate and appropriate action to ensure their safety..

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This three-colour hazard-warning system would avoid the confusion that often arises between the yellow “be aware” and amber “be prepared” levels of hazard warning in other countries..

However, the green, amber and red hazard warning levels used in Kenya would have exactly the same meaning as in Uganda.The colour-coded hazard warnings issued b KMD and UNMA would therefore be consistent in meaning and easily understood by all fishermen on the lake.

It is proposed to launch the Kenyan daily forecast in August 2016. It would be produced initially by Paul Oloo, the KMD County Meteorological Director in Homa Bay, and Vincent Sakwa, the County Meteorological Director in Kakamega.

Paul is an experienced maritime forecaster. Vincent meanwhile, is an experienced severe weather forecaster.

The National Meteorological Centre (NMC) in Nairobi should provide 24/7 support to these two forecasters to ensure that the forecast is produced and disseminated regularly and on time whenever one or both of them are unavailable.

Once the forecast has become firmly established, responsibility for producing it on a daily basis should be transferred to the NMC, along with the responsibility for producing ad hoc hazard warnings.. Ideally this transfer should take place in late September 2016.Paul Oloo should train NMC in the production and dissemination of the forecast as part of the handover process.

Uganda's system of weather forecasts and hazard warnings for fishermen on Lake Victoria

The Uganda National Meteorological Agency UNMA) set up a pilot system of daily weather forecasts for fishermen on Lake Victoria in 2011. It is called Mobile Weather Alert.

The project targeted fishermen working in and around the Ssese islands, south of Entebbe and Jinja and associated fish landing sites and beaches on the mainland. This zone is known as Kalangala

UNMA issues a daily SMS weather forecast for fishermen in this area at between 03.00 and 04.00. The forecast is sometimes followed by an ad hoc hazard warning later in the day if conditions on the lake appear likely to deteriorate seriously.

The forecast and hazard warnings are delivered free of charge by SMS to:

- Nearly 10,000 individual fishermen who have signed up to receive the service
- Radio Ssese, a local radio station on the Ssese Islands which is widely listened to by fishermen in the area
- The National Lake Rescue Institute (NLRI)

The Mobile Weather Alerts have been extended to cover all of Uganda's shore line and fishing grounds in Lake Victoria. UNMA now issues daily forecasts for the following three zones of the lake:

- Northern shores of the lake (the eastern sector between Jinja and the Kenyan border)
- Kalangala and Buvuma districts (the area of offshore islands between Masaka and Jinja in south central Uganda)
- Western shores of the lake (between Masaka and the Tanzanian border)

However, in practice, nearly all the active users ot the Mobile Weather Alerts are in the central Kalangala and Buvuma zone.

Since the inception of the service, the Mobile Weather Alerts have been transmitted to fishermen free of charge to fishermen by the mobile operator MTN as part of its Corporate Social Responsibility initiatives. MTN has consistently sought to find a way of introducing some kind of charge for the service, but has so far failed to persuade fishermen to pay for it. At present it only delivers the alerts to individuals who have an MTN phone. It does not deliver the alerts to fishermen who subscribe to other networks.

UNMA aims to get all its forecasts and storm alerts to the end user within three hours.

It originally disseminated the information in English. However, in response to strong feedback from users, UNMA rapidly switched to using Luganda instead

UNMA uses the following information sources and climate analysis models to craft its weather forecasts and storm alerts.

- Date from UNMA shore-based weather stations
- Satellite data
- UK Met Office Africa Limited Area Model (LAM) forecast
- UK Lake Victoria Forecast
- European Centre for Medium-Range Weather Forecasts (ECMWF) products
- US National Oceanic and Atmospheric Administrtion (NOAA) Climate Prediction Centre forecasts for Africa
- The Regional Specialized Meteorological Centre for East Africa, based in Nairobi
- Feedback from forecast users. UNMA meets regularly with a group of 20 trained community leaders from fishing communities to get feedback on its forecasts.

In addition to communicating forecasts and hazard warnings by radio and SMS, UNMA also operates a weather information hotline for fishermen. It has publicised two telephone numbers which they can call for weather information and advice.

UNMA weather forecasts and hazard warnings for Lake Victoria use a four-colour code warning system. This is calibrated as follows:

Green – **No alert.** No hazardous weather expected

Yellow – **Be aware.** There may be changes in the weather. Look out for signs of an approaching storm, such as clouds, wind gusts and higher waves

Orange - **Be prepared**. The weather is likely to deteriorate. Consider moving to a safer area and be prepared to take any necessary action

Red - **Take action**. The weather will change soon to become life threatening. . Take all necessary action to get to a safe area.

UNMA uses the following weather conditions to define its four stages of weather alert for fishermen;

Colour codes: Meaning and implications

Colour coding	Very Low	Low	Moderate	High
Hazard thresholds				
Mean Wind	**0 – 5 KT**	**6 – 10 KT**	**11 – 20 KT**	**Over 20 KT**
Wind gusts	**5 – 10 KT**	**11 – 20 KT**	**21 – 30 KT**	**Over 30 KT**
Thunderstorms	**Light**	**Moderate**	**Strong**	**Severe**
Visibility	**> 1Km**	**500 – 1000m**	**100 – 500m**	**< 50m**
Response Level	Appropriate individual response under BAU.	Some multi-agency response but mostly BAU.	Multi-agency response needed.	Multi-agency Strategic response needed, mutual aid necessary perhaps national co-ordination.
Implications for users of Lake Victoria	Business as Usual (BAU)	Forecast weather may lead to hazardous conditions. Be aware	Weather conditions are likely to lead to hazardous conditions. Be prepared should the situation worsen	Weather conditions will lead to life threatening conditions on the Lake. Take action.
Public Advice	**Nil**	**Be Aware**	**Be Prepared**	**Take Action**

Channels of communication for delivering weather forecasts to fishermen in Kenya

Nearly all Kenyan fishermen on Lake Victoria listen to the radio when they are on shore. The peak listening times are during the evening and in the early morning.

However, only a minority of fishing canoes take an FM radio out onto the water during fishing expeditions.

The fishermen mostly listen to Luo language FM radio stations broadcasting from Nairobi and Kisumu and to local radio stations broadcasting from other towns on or near the lake shore.

Those based in Busia County mainly listen to the Samia language broadcasts of the KMD owned RANET community station Bulala FM in Budalangi.

Most Kenyan fishermen would only be able to listen to weather forecasts before setting out on a fishing trip. Not all would be able to receive weather updates by radio while they were on the water.

However, every fishing boat carries at least one mobile phone to stay in contact with other boats from the same village while out on the lake and to call for help in emergencies. Voice calls and SMS messages are used regularly to pass information between boats.

The boat phone is also used for emergency communication with the BMU of the home port. Many BMUs have access to at least one canoe with an outboard motor. This is often used as a rescue boat. It may also be used as a tug to tow sail-powered canoes out into the lake on days when there is no wind.

It would be easy for the BMUs to relay severe weather warnings to fishermen who are already out on the lake by mobile phone.

KMD should therefore use the following two channels to disseminate a daily weather forecast directly to fishermen on Lake Victoria:

- Luo-language radio stations serving Western Kenya and Bulala FM in Busia County
- SMS messages to at least two committee members of each BMU on the Kenyan coast of Lake Victoria.

Two of the most popular Luo language radio stations based in Kisumu, **Radio Nam Lolwe** and **Lake Victoria FM,** have already indicated their willingness to broadcast weather forecasts for fishermen on Lake Victoria free of charge.

The forecasts should also be disseminated through the following radio stations which are popular among fishermen:

- **Radio Ramogi –** the Luo language radio station of Royal Media Group. Ipsos quarterly media audience surveys consistently show Nairobi-based Ramogi to be the most widely listened to Luo language radio station in Kenya
- **Radio Mayienga** – the Luo language radio station of state broadcaster KBC
- **Gulf FM** – a local radio station based in Kosele, a lake shore town in Homa Bay County
- **Sunset FM** – a local radio station based in Homa Bay town

- **Pacho FM** - a local radio station based in Siaya town. Pacho was planning to increase its broadcast coverage area in 2016 to include the whole of Siaya County, including communities along the lake shore.
- **Bulala FM –** a KMD RANET station in the flood-prone Budalangi district of Busia County. It broadcasts mostly in Samia and Kiswhahili and is popular among fishermen based at nearby Port Victoria and other nearby fishing villages.
- **Ekialo Kiona Community Radio –** A community radio station on Mfangano Island that broadcasts mainly in the Suba language to the island's 26,000 population.
- **Milambo FM** – a community radio station based in Migori town in Migori County..

Tom Guda, the National Chairman of Beach of Management Units in Kenya, said the leadership of his organisation would disseminate daily SMS forecasts to all the Kenyan BMUs if KMD could supply the forecasts in SMS format and help the BMU association to establish its own FrontlineSMS messaging platform.

Sending the SMS forecast to at least two committee members of each BMU should ensure that the information always reaches at least one person who is physically present in the fishing port. This person can then relay the forecast by word of mouth to the fishing crews. The crews often meet at the BMU office before each fishing expedition.

The recipients of the SMS forecasts could also post the daily forecast on a noticeboard at the BMU office and relay any severe weather warnings by SMS to boats that are already on the water.

If the daily forecast for fishermen proves popular, KMD could eventually consider allowing individual fishermen to subscribe to SMS forecasts on annual basis for a fee that would cover the cost of transmission.

This fee would probably have to be set at around 1,000 Ksh per year.

KMD should also consider allowing fishermen to obtain SMS forecasts on demand by texting a short code number which would automatically send the latest SMS forecast in reply. This would be a premium rate service. It could probably break even by charging 10 to 15 Ksh per forecast requested.

SMS forecasts on demand are likely to work better for fishermen than for small-scale farmers because fishermen earn their cash income on a daily rather than a seasonal basis.

The modest cost of an SMS forecast can be offset against immediate cash income of anything from1,000 Ksh to more than 10,000 Ksh per boat per day.

Information gleaned from the forecast would often inform decisions that either increase the size and value of the day's catch or reduce the boat's losses. Fishermen would therefore find it easy to put an immediate financial value on the information.

One fisherman interviewed at Port Victoria said he sometimes paid 30 Ksh a time to access the Ugandan mobile weather alerts by SMS.

Delivering weather information in terms that fishermen can understand easily

The fishermen on Lake Victoria do not measure wind speed in kilometres or nautical miles per hour. They do not quantify rainfall in millimetres. And they do not think of wave height in terms of metres or temperature in terms of degrees Centigrade.

These units of measurements, on which meteorologists depend to interpret the weather, mean very little to the men in the fishing canoes.

To ensure that the fishermen understand the weather forecasts and feel confident to use the information to help shape their decisions, it will be necessary for KMD to express the forecasts in the kind of terminology that fishermen themselves use to describe the weather and its impact on their activities.

If the forecasts only use scientific units of measurement to describe weather on the lake, the fishermen's comprehension of the forecasts will be low and they are unlikely to use the forecasts much to inform their decision making.

Suggested terms to describe wind strength, rainfall volume, visibility and lake surface temperature are given below.

However further research will be required to finalize this list and provide standard definitions for each term that both meteorologists and fishermen understand easily.

Wind speed (KMD should ascribe a range of windspeeds to each category)

Calm – No wind

Light wind – 0 to 20 km per hour. Enough wind to enable a canoe to move slowly under sail

Moderate wind – 21-38 km per hour. Strong enough to enable a canoe to move at normal speed under sail

High wind – 39-60 km per hour. Strong enough make a canoe move fast under sail and cause tricky conditions for navigation. A high wind is also likely to cause higher waves than normal. Water may wash overboard into boats with a low freeboard.

Very high wind – Over 61 km per hour. A wind that is strong enough wind to make navigation dangerous. There is a strong risk of fishing boats capsizing. Very high waves are likely that may destabilize the boat and wash water into it.

Nyakoi. – water spouts. Whirling columns of wind and water that traverse the lake. If they hit a boat, they are almost certain to capsize or sink it and cause serious injury or death to the crew..

Rainfall (KMD should use the same definitions of rainfall quantity in mm for the following terms that it uses in forecasts for farmers. However, the description of each kind of rainfall for fishermen should relate to its impact on fishing and navigation on open water)

Light rain – 0-5 mm of rainfall in a period of 24 hours Very good fishing conditions. No impact on navigation

Moderate rain - 5-20 mm of rainfall in a period of 24 hours Good fishing conditions. Very little impact on navigation.

Heavy rain - 20-50 mm of rainfall in a period of 24 hours Interferes with fishing activities. Navigation becomes difficult.

Very heavy rain - More than 50 mm of rainfall in a period of 24 hours. Fishing activities are forced to stop. Navigation becomes very difficult and potentially dangerous.

Thunderstorm – Thunder and lightning, frequently accompanied by bursts of intense rainfall and sudden gusts of strong wind.

Wave height

Given the lack of available data to forecast wave height accurately at present, it is proposed that KMD should only forecast high waves in circumstances where unusually high and potentially dangerous waves are likely to occur as a result of high wind speeds.

High waves - Speed of canoes through water severely reduced. Waves may wash into the boat. Boats may become unstable.Strong risk of capsizing.

Visibility

Good – Objects may be seen and recognized in daylight at more than 10 km.. Distant landmarks on shore are clearly visible.

Fair – Objects may be seen and recognized in daylight at a distance of 5 km to 10 km. Distant landmarks on shore may not be clearly visible. They may be obscured by haze

Moderate – Objects may be seen and recognized in daylight at a distance of 1km to 5 km. Distant landmarks on shore cannot be seen. You may not be able to see the shore at all

Poor - Objects may be seen and recognized in daylight at a distance of 100 metres to 1 km. It is difficult or impossible to see the shore at all, even if it is nearby.

Very poor – You cannot see objects in daylight that are more than 100 metres away. You may not be able to see other fishing boats that are close by. There is a high danger of collision with other boats.

Lake water surface temperature

Warm – Warmer than usual for the location and time of year

Cold – Colder than usual for the location and time of year

Proposed content and format of the Lake Victoria daily weather forecast

KMD should produce a daily weather forecast for fishermen at 09.00 every morning covering a period of 48 hours.

It should forecast the weather in terms of two main climatic zones on the lake:

- The Gulf of Winam
- The open waters of Lake Victoria up to 60 km from the Kenyan shore

The daily forecast should forecast the weather for three distinct periods of the day in each zone:

- The morning – from sunrise till noon (when winds normally blow offshore)
- The afternoon – from noon till sunset (when winds normally blow onshore)
- Night-time – the hours of darkness between dusk and dawn

In addition, KMD should issue ad hoc severe weather warnings for all shipping on Lake Victoria whenever the need arises.

Each forecast and severe weather warning should be should be created in two different formats: one for the internet and radio, the other for SMS:

- **Internet and radio** - This would be the standard version of the forecast. It would contain the most complete and detailed information. The forecast would run to two A4 pages. The first page would contain a weather map, a written commentary and any hazard warnings that might be in force. The second page would consist of two weather forecast tables; one for the Gulf of Winam, the other for the open lake. These tables would provide an at-glance summary of the weather conditions expected. The forecast would be distributed to interested parties by email and social media. It would also be posted on the KMD website. The text part of the forecast would be written in the form of a ready-to-read script of up to 200 words suitable for radio stations. This script should conform to a regular and predictable structure and would be designed to be read aloud within two minutes. Radio stations would be encouraged to read the script verbatim in English or translate it into Luo for broadcast.

  The internet/radio version of the forecast would routinely contain information on:

  - Wind speed and direction
  - Rainfall volume and spatial distribution
  - Visibility
  - Hazard warnings

- **SMS –** A short message using standard abbreviations that would normally fit into the SMS space limit of 160 characters (Occasionally it might be slightly longer and be transmitted as two linked SMS messages).The SMS forecast would focus on forecasting the same four types of weather information:

  - Wind speed and direction
  - Rainfall volume and spatial distribution
  - Visibility
  - Hazard warnings

Each daily forecast would normally be packaged into two separate SMS messages, The first SMS would forecast the weather for the day of issue. The second message would contain the forecast for the following day.

Hazard warnings would be issued, when appropriate, as separate SMS messages.

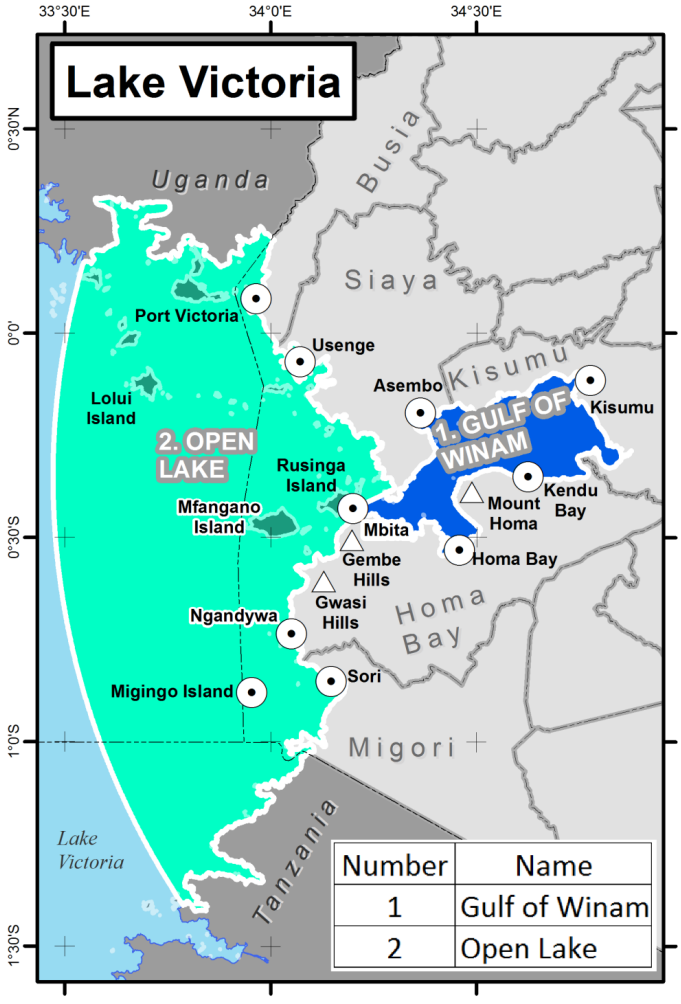
Proposed templates for all three types of report are attached to this document in the following annexes:

- Annex 1 – Template for daily internet and radio forecast and sample bulletin
- Annex 2 - Template for hazard warning bulletin and sample bulletin
- Annex 3 -– Quick reference guide for recipients of SMS forecasts, containing examples of the daily forecast and early warning messages

Annex 1 - Template for daily internet/radio forecast and sample bulletin

Kenya Meteorological Department

Daily weather forecast for fishermen on Lake Victoria
Date of issue: 15th June 2016



Advisory to fishing craft

Green/Amber or Red Text description of conditions for today

Green/Amber or Red Text description of conditions

Summary

Here is the weather forecast for fishermen on Lake Victoria issued by the Kenya Meteorological Department at 09.00 on *day….date…month ….year.*

Mention any severe weather warnings that will be in force during all or part of the forecast period.

Forecast for the Gulf of Winam today

Forecast for the Open Lake today

Forecast for the Gulf of Winam tomorrow.

Forecast for the Open Lake tomorrow

For further information contact: *(Name and job description)*
Mobile: *(+254……..)*
Email: *(……...)*

Zone 1: Gulf of Winam

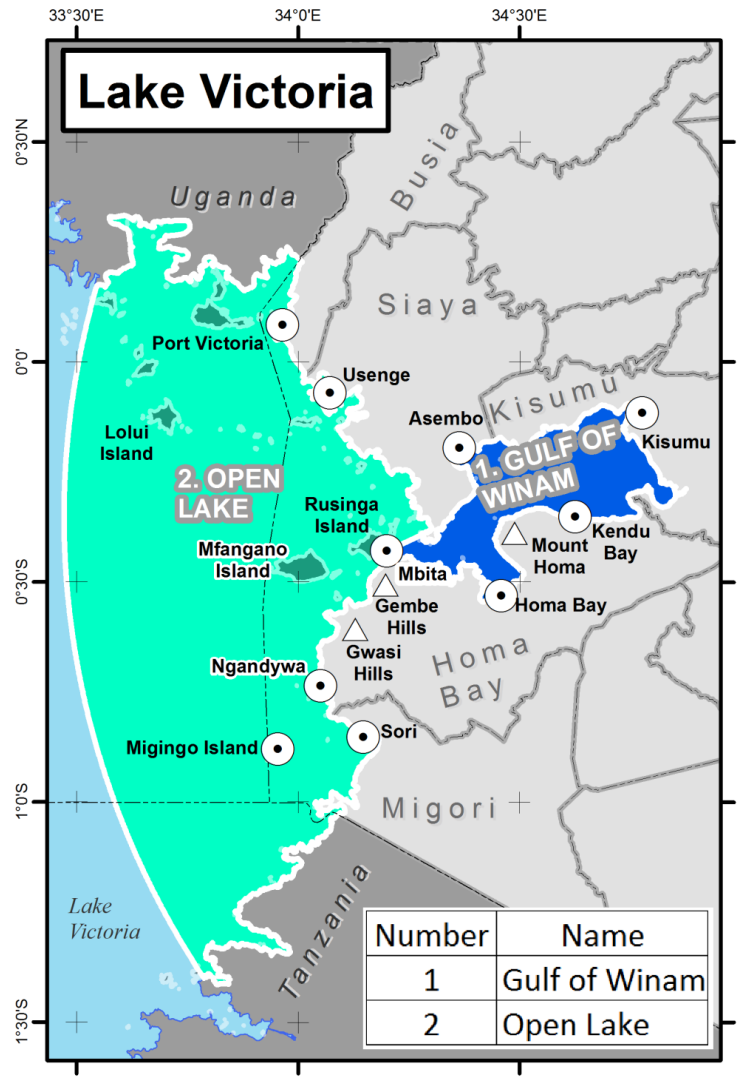
Tuesday	Wind speed and direction	Rainfall/ Cloud cover	Rainfall distribution	Visibility	Hazards/ Warning level
Morning	**Wind dir** strength	**ICON** Text description		Text description	**ICON** Text description
Afternoon					
Night					
Wednesday					
Morning					
Afternoon					
Night					

Zone 2. Open Lake

Tuesday	Wind speed and direction	Rainfall/ Cloud cover	Rainfall distribution	Visibility	Hazards/Warning level
Morning	**Wind dir** strength	**ICON** Text description	**ICON** Text description	Text description	**ICON** Text description
Afternoon					
Night					
Wednesday					
Morning					
Afternoon					
Night					

Kenya Meteorological Department

Daily weather forecast for fishermen on Lake Victoria
Date of issue: 15th June 2016



Advisory to fishing craft

Green Tuesday -.No weather warnings in force

Amber Wednesday - High winds everywhere and possibility of water spouts (Nyakoi) in the Gulf of Winam

Period covered by forecast:

09.00 Tuesday June 15th to
06.00 Thursday June 17th

Summary

Tuesday
Light easterly winds in the Gulf of Winam will give way to a moderate southwesterly breeze in the afternoon. There is a low probability of light rain in the afternoon. Visibility will be good. Overnight winds in the Gulf will be light and variable.

In the open lake, moderate northwesterly winds in the morning will become southwesterly in the afternoon. Visibility will be good. There may be light rain near the Ugandan coast overnight

Wednesday
A high wind from the southwest) will blow in the Gulf of Winam all day, raising the danger of water spouts (nyakoi). The wind will turn westerly after dark and become moderate in strength. Visibility will remain good.

The strong Southwesterly wind will also dominate the open lake during the day time, causing high waves. Visibility will be good. At night the wind will become southerly and weaken in strength to moderate.

For further information contact:
Paul Oloo – Principal marine forecaster Lake Victoria
Mobile: +254 711 222 333
Email: paul.oloo@meteo.go.ke

Zone 1: Gulf of Winam

Tuesday July 18	Wind speed and direction	Rainfall/ Cloud cover	Rainfall distribution	Visibility	Hazards/ Warning level
Morning	**E** Light	 Sunny intervals		 Good	No warnings in force
Afternoon	**SW** Moderate	 Light rain	 Few places	 Good	No warnings in force
Night	**VARIABLE** Light	 Cloud cover			No warnings in force
Wednesday July 19					
Morning	**SW** High	 Sunny		 Good	Amber warning **High wind/ Water spouts**
Afternoon	**SW** High	 Sunny intervals		 Good	Amber warning **High wind/ Water spouts**
Night	**W** Moderate	 Partial cloud cover			No warnings in force

Zone 2. Open Lake

Tuesday July 18	Wind speed/ direction	Rainfall/ Cloud cover	Rainfall distribution	Visibility	Hazards/ Warning level
Morning	**NW** Moderate	 Sunny intervals		 Good	No warnings in force
Afternoon	**SW** Moderate	 Sunny intervals		 Good	No warnings in force
Night	**VARIABLE** Light	 Light rain	 Few places		No warnings in force
Wednesday July 19					
Morning	**SW** High	 Sunny		 Good	Amber warning **High wind/ Water spouts**
Afternoon	**SW** High	 Sunny intervals		 Good	Amber warning **High wind/ Water spouts**

Night	**S** **Moderate**	 Partial cloud cover			No warnings in force

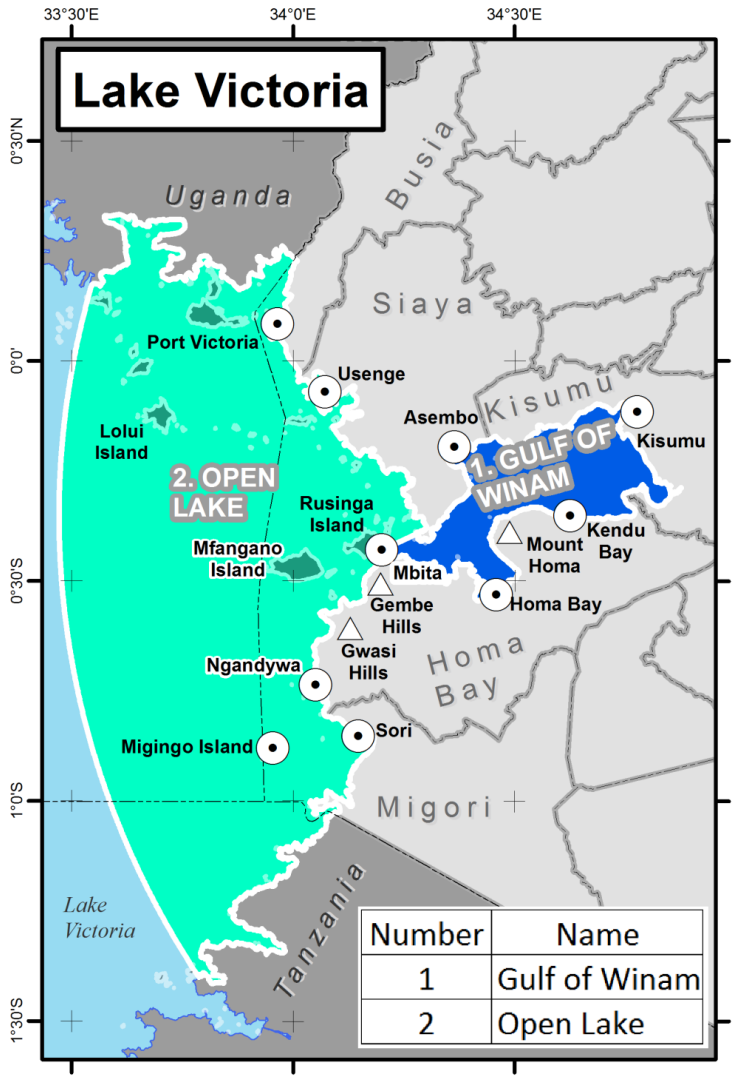
Annex 2- Template severe weather warning and sample bulletin

Kenya Meteorological Department

Severe weather warning for fishermen on Lake Victoria

Date of issue: *(day)(date)(month)(year)*

Time of issue xx.xx



For further information, please contact:
(Name and job title of KMD forecaster)
Mobile: *+254 XXXXXXXXX*
Email*: XXXXXXXXXXX*

Fill this bar with colour of warning

(Red/Yellow) **level severe weather warning**

Kenya Meteorological Department issued the following *(red/yellow)* level severe weather warning to all fishing craft and all other shipping on Lake Victoria at xx.xx on *day….date…month ….year.*

The warning is in force in *(sector of lake)* from xx.xx on (day)(date)(month)

(*Text describing severe weather hazard and the sector of the lake to which the hazard warning applies)*

(Advice to fishing craft and other vessels on Lake Victoria)

Key to colour code of hazard warnings

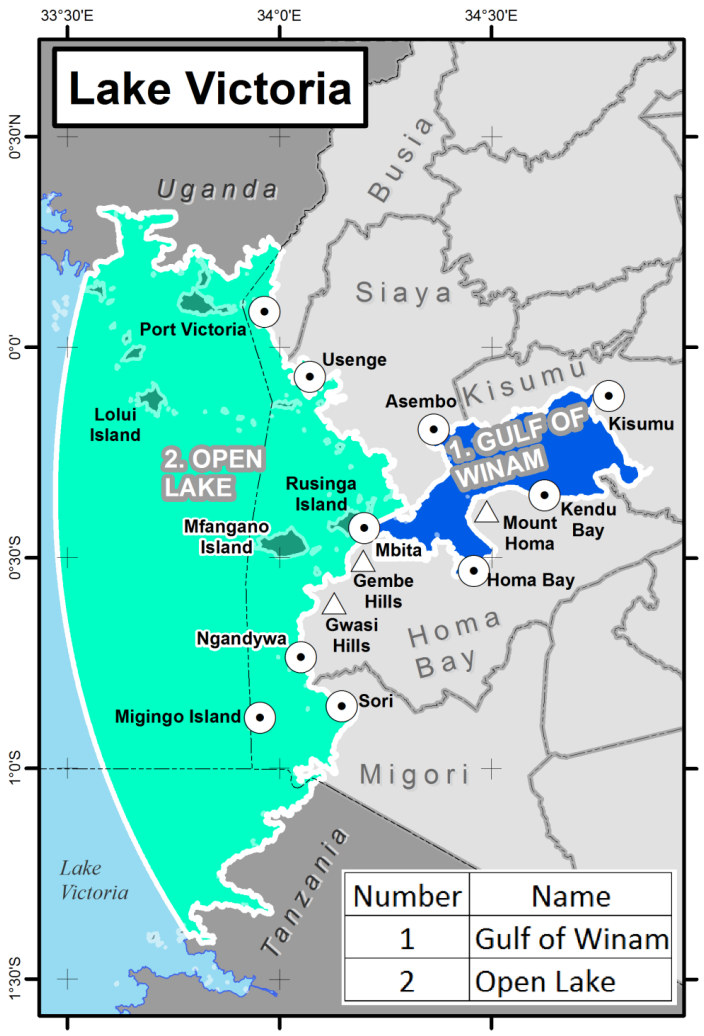
Green – No hazard warnings in force. It is safe for all boats to navigate on the lake.
Amber – Be prepared. Potentially dangerous weather and water conditions are expected.
Red – Take action. Dangerous and potentially life threatening weather and water conditions are expected. Take immediate and appropriate action to ensure your safety.

Kenya Meteorological Department

Severe weather warning for fishermen on Lake Victoria

Date of issue: Tuesday 5th July 2016

Time of issue 15.45 East Africa Time (EAT)



For further information, please contact:
Paul Oloo – Principal Marine Forecaster Lake Victoria
Mobile: +254 711 222 333
Email: paul.oloo@meteo.go.ke

Kenya Meteorological Department (KMD) issued the following red "take action" warning to all shipping in the Open Lake zone of Lake Victoria. It applies from 17.00 EAT on Tuesday July 5th until 06.00 EAT on Wednesday July 6th

A very high wind from the south will blow throughout the night. Sustained wind speeds of more than 80 kph and gusts of up to 100 kph are likely. There will be high waves and heavy showers of rain in many places.

KMD also issued an amber "Be aware" warning for all shipping in the Gulf of Winam. It applies from 18.00 EAT on Tuesday July 5th until 05.00 EAT on Wednesday July 6th.

High southerly winds of up to 55 kph and moderate waves are expected. Moderate rain will occur in a few places.

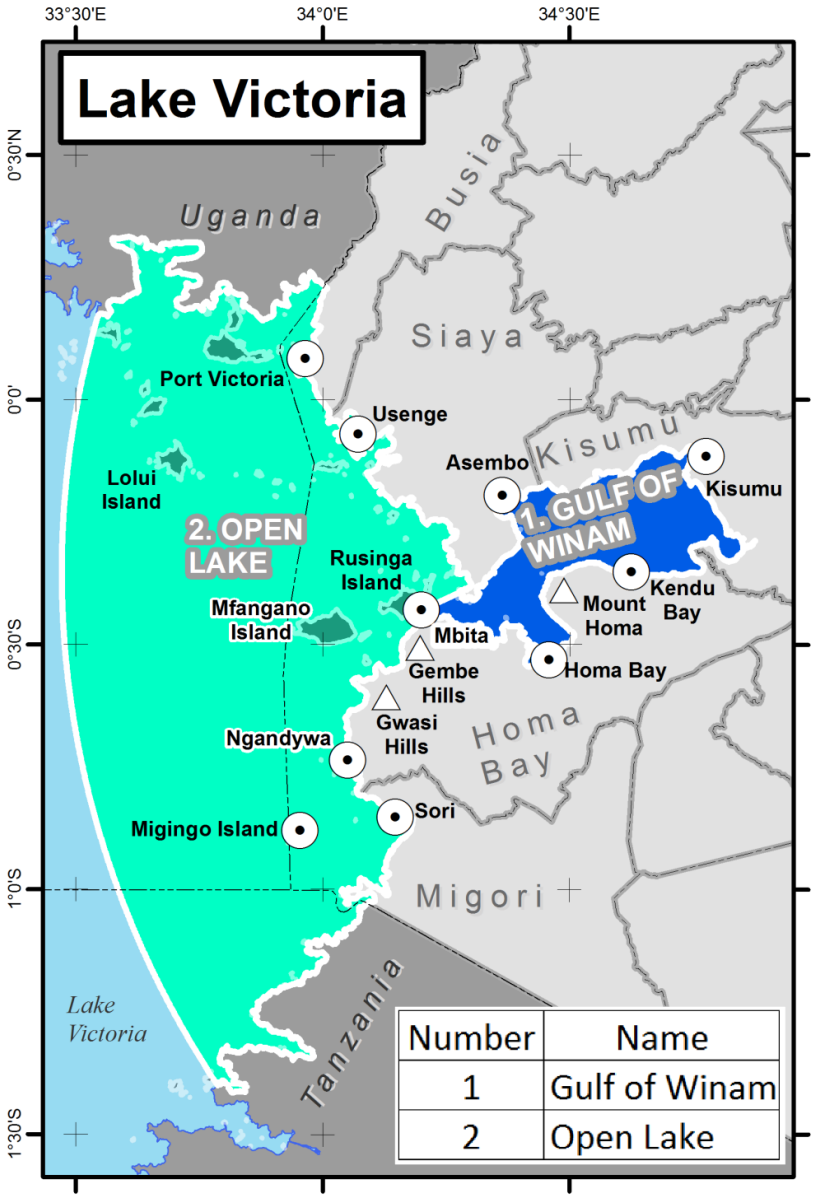
Key to colour code of hazard warnings

Green – No hazard warnings in force. It is safe for all boats to navigate on the lake.
Amber – Be prepared. Potentially dangerous weather and water conditions are expected.
Red – Take action. Dangerous and potentially life threatening weather and water conditions are expected. Take immediate and appropriate action to ensure your safety.

Annex 3 – Reference guide for recipients of SMS forecasts

Kenya Meteorological Department

Reference guide for interpreting SMS weather forecasts for fishermen on Lake Victoria



The daily weather forecast covers the day of issue and the next day, It includes separate forecasts for the Gulf of Winam, referred to as Zone 1, and the Northeast area of Lake Victoria's open waters, referred to as Zone 2.

Standard abbreviations used in SMS messages

Abbreviation	Meaning	Explanation
AM	Morning	From dawn until 12.00 pm or noon.
Amber	Amber flag	Potentially dangerous conditions for navigation are expected on the lake. Be prepared and take appropriate precautions.
Apr	April	
Aug	August	

C	Centigrade	Degrees Centigrade measure temperature. Water freezes at 0 degrees Centigrade and boils at 100 degrees.
Calm	No wind	Fishing boats cannot move through the water under sail.
Clear	Clear sky	There are no clouds. At night, the moon and stars are visible.
Cloud	Cloudy sky	The sky is completely covered by cloud, but it is not raining.
Dec	December	
E	East	Wind coming from the east.
Fair	Fair visibility	Between 5 and 10 km in daylight. You cannot see distant landmarks very clearly, often because of haze.
Feb	February	
few	few places	Rain will probably fall in less than 33% of places, less than one in three places in the zone
Fri	Friday	
Good	Good visibility	More than 10 km in daylight. You can see distant landmarks very clearly.
Green	Green flag	No severe weather warnings in force.
hail	Hail storm	Rain drops freeze to form pellets of ice that fall from the sky.
he rain	heavy rain	Between 20 and 50 mm of rain falls in 24 hours. The rain interferes with fishing and navigation becomes difficult.
hi wave	high waves	Unusually high waves that pose a danger to small boats.
hi wind	High wind	39 to 60 km per hour. Strong enough make a canoe move fast under sail. High waves may wash water into the boat.
Jun	June	
Jul	July	
KMD	Kenya Meteorological Department	The government department which produces weather and climate information, including forecasts, alerts and warnings.
li rain	Light rain	Less than 5 mm of rain in 24 hours. Very good fishing conditions. Rain has no impact on navigation.
li wind	Light wind	Less than 20 km per hour. Enough wind to enable a canoe to move slowly under sail.
LV	Lake Victoria	
many	Many places	Rain will probably fall in 33% to 67% of places, about half of all places in the zone.
Mar	March	
May	May	
max	Maximum	Mostly used to describe the hottest temperature expected or recorded over a specific period of time – usually 24 hours
min	Minimum	Mostly used to describe the lowest temperature expected or recorded over a specific period of time – usually 24 hours
mm	Millimetres	Used to measure the depth of rain that falls on a small patch of ground. There are 1,000 mm in a metre, Most parts of Western Kenya receive 900 to 1,500 mm of rainfall each year
mo rain	Moderate rain	Between 5 and 20 mm of rain in 24 hours. Good fishing conditions. The rain has very little impact on navigation.
mo wind	Moderate wind	21 to 38 km per hour. Strong enough to enable a canoe to move at normal speed under sail
mo vis	Moderate visibility	Between 1 and 5 km in daylight. Distant landmarks cannot be seen. You may not be able to see the shore at all.

Mon `	Monday	
most	Most places	Rain will probably fall in more than 67% of places, more than two thirds of places in the zone.
N	North	Wind coming from the north.
NE	Northeast	Wind coming from the northeast.
NIGHT	Night time	The hours of darkness from sunset to sunrise the next day.
NW	Northwest	Wind coming from the northwest.
Nyakoi	water spout	A powerful twisting column of wind mixed with water droplets which occurs over water. It comes down from the cloud to the lake and sucks water upwards. Water spouts often occur on Lake Victoria during thundery conditions. They will capsize or sink small boats if they hit them.
Nov	November	
PM	Afternoon	From 12 pm or noon until sunset.
P/Cloud	Partly cloudy	The sky is partly covered by cloud. At night, the moon and some stars may be visible
poor	Poor visibility	You can see nearby objects at a distance of 100 metres to 1 km in daylight. It is difficult or impossible to see the shore, even if it is nearby.
Red	Red flag	Dangerous weather conditions are expected on the lake. Take appropriate action immediately to ensure your safety.
S	South	Wind coming from the south.
Sat	Saturday	
Sep	September	
Sun	Sunday	
SE	Southeast	Wind coming from the southeast.
SW	Southwest	Wind coming from the southwest.
temp	Temperature	How hot or cold an object is. Usually expressed in degrees Centigrade. Weather forecasts indicate the air temperature in the shade, not the air temperature in direct sunlight.
Thu	Thursday	
tstorm	Thunder storm	Clouds emit flashes of lightning and rumbles of thunder. Thunderstorms often bring sharp downpours of rain and gusty high winds
Tue	Tuesday	
v he rain	Very heavy rain	More than 50 mm of rain in 24 hours. Very intense rain that is usually accompanied by high wind, Fishing activities have to stop. Navigation becomes very difficult.
v hi wind	Very high wind	Wind speed of more than 60 km per hour. Conditions on the lake become dangerous and life-threatening. High waves may wash water into the boat. Fishing boats may capsize.
v poor	Very poor visibility	0 to 100 metres. You cannot see the shore, It is very difficult to see other boats that are nearby.
var	Variable wind direction	The wind may blow from several different directions.
Wed	Wednesday	
W	West	Wind coming from the west.
1,	Zone 1	Gulf of Winam.
2,	Zone 2	Open lake up to 60 km from the Kenyan coast.

Structure of the daily SMS forecast

1. *Lake Victoria (LV)*
2. *Day of the week to which forecast applies*
3. *Date and month to which forecast applies*
4. *Gulf of Winam (1)*
5. *Morning (AM)*
6. *Wind speed and direction*
7. *Rainfall volume and distribution (if any)*
8. *visibility*
9. *Afternoon (PM)*
10. *Wind speed and direction*
11. *Rainfall volume and distribution (if any)*
12. *visibility*
13. *Night time (NIGHT)*
14. *Wind speed and direction*
15. *Rainfall volume and distribution (if any)*
16. *Cloud cover*
17. *Open lake (2)*
18. *Morning (AM)*
19. *Wind speed and direction*
20. *Rainfall volume and distribution (if any)*
21. *visibility*
22. *Afternoon (PM)*
23. *Wind speed and direction*
24. *Rainfall volume and distribution (if any)*
25. *visibility*
26. *Night time (NIGHT)*
27. *Wind speed and direction*
28. *Rainfall volume and distribution (if any)*
29. *Cloud cover*
30. *KMD*

Example of daily forecast for next 48 hours split into two SMS messages

LV Mon Jul 28.1:AM, li wind SE,good. PM,mo wind,W, li rain few,good, NIGHT li wind var.2, AM mo wind S, li rain many, mo vis, PM mo wind SW, good, NIGHT li wind SE, clear - KMD

LV Tue Jul 29:1.AM ,li wind E,good,.PM,mo wind NW, mo rain many, poor,NIGHT, li wind var,2, AM li wind SE, li rain few, mo vis.PM mo wind W, good,NIGHT li wind E,p/cloud - KMD

Example of hazard warning message

LV YELLOW WARNING. Tue Mar 12. 1, PM tstorm, v hi wind SW, he rain most, nyakoi, 2, PM, tstorm, v hi wind W, v he rain most - KMD

Explanation of other common terms used in weather forecasts

Evaporation	The processes of liquid water becoming absorbed into the air as water vapour. Evaporation speeds up when temperatures are high and humidity is low and there is a wind
Fog	Ground level cloud that reduces visibility to less than 1 km.
Humidity	The level of moisture in the air. It is usually expressed as the percentage of air saturation with water, Warm air can hold more moisture than cold air.
Probability	The likelihood that an expected event will actually occur. Weather forecasters are never completely certain that the weather will turn out as they expect. They can indicate the degree of probability that a forecast event will happen.
Rain Gauge	An instrumental used to measure the amount of rain that has fallen during a period of 24 hours. The standard rain gauge is a round cylinder, usually made of metal, with a funnel at the top to catch rain water.
Thermometer	An instrument to measure temperature. Weather forecasts express temperature in degrees centigrade. 0^0 Centigrade is the temperature at which water freezes to become ice, 100^0 Centigrade is the boiling point of water
Warning	An urgent message advising that severe weather is likely to occur soon which may endanger life or damage property
Waterspout	A powerful twisting column of wind mixed with water droplets which occurs over water. It comes down from the cloud to the lake and sucks water upwards. Water spouts often occur on Lake Victoria during thundery conditions. They will capsize or sink small boats if they hit them.

Key to colour-coded hazards warnings

Green – No hazard warnings in force. It is safe for all boats to navigate on the lake.

Amber - Be prepared. Potentially dangerous weather and water conditions are expected. Small boats should take special care if they decide to sail on the lake.

Red – Take action. Dangerous and potentially life threatening weather and water conditions are expected are expected. All boats on the lake should take immediate and appropriate action to ensure their safety.