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01: KMFRI research scientists complete a 17-day research cruise of the North Kenyan Bank

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Research in Brief

What lies in the North Kenyan Bank fishery zone?

A Bank off the northern Kenya coast is acquiring significance - the North Kenyan Bank (NKB). The fishing zone has been identified as an important emerging fishery that is expected to spur economic growth for the local fishing communities. This is so because artisanal fishers have depleted fish catches in narrow waters, and are now advancing towards the North Kenyan Bank, which is largely unexploited, in search of fish. The fishery zone is unique along the coastline of tropical East Africa. It is of considerable interest as it holds huge potential likely to boost local fishery resources.

Why embark on the research cruise?

Little is known about the fishery zone. And this is what spurred the Kenya Marine and Fisheries Research Institute (KMFRI) team, headed by Chief Scientist onboard Dr Immanuel Mbaru, into action. The cruise leader led an 18-member team comprised of youthful KMFRI researchers and technologists for the 17-day research expedition at NKB from 9th to 26th March, 2020. Eight women participated in the cruise. RV Mtafiti is manned by the Kenya Coast Guard Services Navy officers who had accompanied the group under the leadership of Major Mwangandi, the RV Mtafiti ship Commanding Officer.

The role of Chief Scientist is to guide the scientific team onboard on research activities of the survey. They include sampling, managing scientific equipment, and ensuring everything is done in adherence to set standards and procedures. This is aimed at meeting research objectives of the cruise to achieve credible results. The expedition was funded by the Government of Kenya, through KMFRI, and SAPPHIRE project.



Top, KMFRI researchers and Kenya Coast Guard Services team. Below, cruise leader Dr Mbaru (2nd left) with researchers and technologists prepare CTD rosette for deployment

“The main reason of the survey is to understand factors that influence productivity in the NKB. The area has high fish abundance. The question is: What really is happening? Is it the current dynamics, bathymetry or benthic habitats?” Dr Mbaru elaborated. “Catches from our local fishers at NKB are significantly higher compared to other areas along the Kenyan Coast,” he added.

Productivity can be anything from the presence of small to big organisms. Bathymetry usually involves mapping of the sea floor.

“We might have an idea of how much fish are in the area through EK60. The echo sounder quantifies the amount of biomass beneath the water column, and with the echograms and acoustic signatures that can be seen on the screen, we can process the data and have an idea of how much fish are present in the area,” Dr Mbaru said. “The EK60 Echo Sounder has transducers mounted

under the vessel, and sends pulses of water that reflect any encounter in the water from small creatures to ocean floors, giving a nice track of how organisms are distributed along the water column where the vessel goes,” said Ms Mary Ontomwa, a fisheries research scientist with a keen interest in hydro acoustics.



Tracking echo sounder data on the screen

“Red snappers are mainly caught in the North Kenyan Bank,” echoed fisheries research scientist Ms Fatuma Mzingirwa. “Our data will therefore be extremely useful in understanding where the fish are and the present conditions where there is an indication of high abundance,” she added.

Water samples were taken to measure oxygen levels, dissolved oxygen levels, nutrients, carbon, conductivity, temperature and salinity. The information is tied to how organisms are doing and how they are distributed. “We sample along the water column to understand these oceanographic parameters that are extremely useful in understanding the system. The level of phytoplankton in the waters inform primary productivity of any ecosystem,” Dr Mbaru said.

“Conductivity is a measure of how much well a solution conducts electricity, and it is directly related to salinity. Using CTD devices, knowledge obtained can provide a more detailed understanding of the ocean water’s characteristics through the entire water column, which is crucial for understanding the physics involved. The physics in turn allow biologists understand why the biology is present or not present at different depths and why the chemical makeup of the water changes over depth,” explained Mr Salim Athman, a physical oceanographer and early career marine scientist. CTD stands for Conductivity, Temperature and Depth.



CTD deployment

“The NKB is influenced by four types of currents: The East African Coastal Current (EACC), which flows parallel to the coastline but is not rich in nutrients. The EACC branches and forms the South Equatorial Current, and during the North East Monsoon, we have the Somali Current originating from the north. When these currents meet, they cause mixing of waters and you end up with very high productivity characterised by lots of phytoplankton and zooplankton that are deposited in the system, which make fish move to the area for food,” expounded Dr Mbaru.

It has previously been reported that the Tana River discharges sediments into the Ocean. These sediments from Tana River pileup to form a 130m mountain. It is this mountain of Tana River sediments that are perturbed during the South East Monsoon as the EACC gains its northerly momentum.

Phytoplankton and bongo plankton nets were deployed to collect phytoplankton and zooplankton data respectively.



Bongo plankton nets being retrieved



Lab technician Ken Oduor collects zooplankton samples

In the food web, phytoplankton are primary producers and zooplankton are primary consumers; small fish are secondary consumers with top predators being tertiary consumers.



Josephine collects water samples for microbiology tests



Josephine, a microbiologist, during a working group session

Plankton are organisms drifting in oceans, seas, and bodies of fresh water. “They do not have swimming mechanisms and are food for other organisms,” said KMFRI’s Ms Josephine Marigu, a microbiologist and a team leader for one of the working groups onboard. “More planktons means more fish. Particular fish eat a particular type of plankton,” added the early career ocean professional, who also doubled up as a planktonologist.



Top, phytoplankton sampling. Below, Principal Scientist Dr Osore holds unsorted phytoplankton and zooplankton samples

The movement of waves and currents and the way the bottom behaves have a huge effect on the ocean dynamics such as upwelling. “The Acoustic Doppler Current Profiler (ADCP) helped us measure the speed of water current along the sea transect, while EK60 Echo Sounder collected bathymetry data and depths,” said early career marine ocean professional Mr Samuel Ndegwa, a marine geologist.



Research scientists and technologists prepare marine research tools

KMFRI’s early career ocean professional Ms Amina Makori, a marine geologist, and a leader of a working group coordinated bathymetry sedimentary sampling. “The aspects of fish ecosystem are interrelated with the sea floor. Benthic characterisation helps establish whether benthic structures are made of silt, sand, or gravel, and whether they have minerals that are good for fish productivity,” she said.



Marine geologist Amina and team during working group session.

“Due to human induced actions such as burning of fossil fuels, a lot of carbon dioxide is released into the air and dissolved in the ocean. “By analysing water samples therefore, we are likely to get a correlation between climate change, water quality and aspects of dissolved oxygen with past surveys,” she said. “If too much carbon dioxide is dissolved in the ocean, it depletes oxygen and marine organisms which include fish may not survive in that kind of an ecosystem.”

KMFRI’s technologist Mr Oliver Ocholla was in charge of water quality data and sample collection onboard. “Samples of dissolved oxygen are collected, incubated in the dark for five days where we analyse them again for BOD5 (biological oxygen demand), TSS (total suspended solids), POC (particulate organic carbon) and chlorophyll,” he said.



Fisheries researcher Mary and technologist Oliver conduct water quality tests

“Samples are collected and three litres of each filtered immediately. Filtrate is stored and will be analysed in KMFRI labs,” Mr Ocholla added. “Nutrients sample are also collected, frozen, waiting laboratory analysis for nitrates, ammonia, phosphate, nitrites and silicates.”

Research scientists will tie in oceanographic conditions, currents, and the water pathways to how they affect the water mass, which are linked to how organisms are distributed. The analysis is mainly part of chemical oceanography comprising of parameters such as temperature, PH (alkalinity or acidity), conductivity, turbidity (clarity of water) and alkalinity.

Women researchers take the bull by the horns

Ms Amina and Ms Josephine, who were onboard RV Mtafiti for the third time now, said being team leaders has been no walk in the park. "It's been both exciting and challenging. Sampling takes place 24 hours. There are timelines for each activity. This means sleepless days and nights. Waking people up is a challenge. However, it has been a good experience learning how to manage people, coordinate activities, and grow in different aspects out of science," said Josephine. "As women researchers, these cruises give us the exposure that we need. Taking a leading role in such cruises reaffirms that women can succeed in anything they put their mind to," concluded Amina.



Lab technologists Mr Ken Oduor and Mr Robinson Okumu analyse water samples onboard

Socioeconomic Impact of the Study

Dr Mbaru said the RV Mtafiti expedition will be key in assessing socioeconomic impacts on Kenya's fishing communities.

"Once we analyse data that has been derived from this survey, the findings will help research students, fellow researchers, NGOs, CBOs, policy makers and scientific community. But ultimately we intend to disseminate this information to fisher communities who are the end users of the information," he said.

The information will be packaged in technical reports, policy briefs and publications that will be published in peer-reviewed scientific journals, accessible to everyone across the globe.

He added: "We need to engage the communities more; scientists used to face resistance from communities in conservation agenda. Today they are more receptive to their projects. There is need to have an integrated approach and involve communities more in research initiatives and have more community conservation initiatives."

Dr Mbaru emphasises on the need to work closely with policy makers, saying they rely on information generated by the scientific community in drafting blue economy policies.

"Let's have an integrated approach. Communities must be involved, empowered financially, technically to enable them contribute effectively," he said.

Dr Mbaru's brief career profile

Dr Mbaru has a strong fisheries background with a Bachelors of Science degree in Fisheries and Aquatic Science from Moi University, a Masters degree in Fisheries Science from Rhodes University, South Africa, and a PhD in Environmental studies from Australia. Dr Mbaru has participated in three cruises: demersal and trawl survey along the West Coast of Madagascar, a demersal survey around the Island of Mauritius, and dropline survey onboard RV Roberto in Kenya where he was a cruise leader.

"I deviated slightly from science when I embarked on my PHD. My focus now is more on social science aspects of my research projects and integrating human dimensions in my research agenda. I'm interested in how research impacts on communities and environment. This aspect has been missing," said Dr Mbaru.

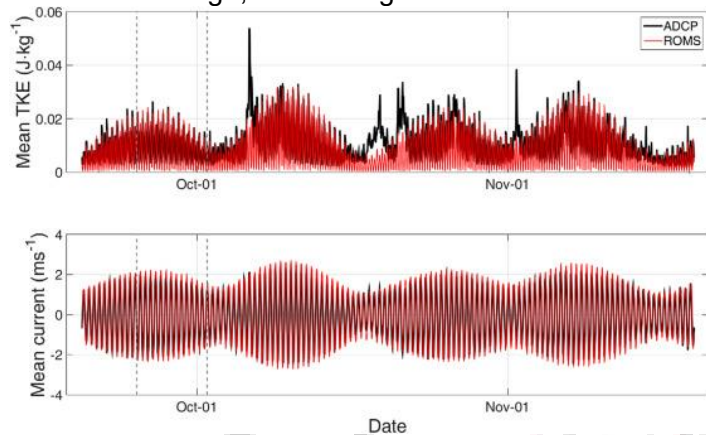
Marine Research Tools Deployed

During the expedition, KMFRI researchers deployed a number of sophisticated marine research equipment to collect data. They include Acoustic Doppler Current Profiler (ADCP), CTD rosette, zooplankton and phytoplankton nets.

Acoustic Doppler Current Profiler

ADCP is deployed in deep sea waters at a depth of 300 metres. The equipment is crucial in generating hydro-acoustic data and providing information on water current velocity over different depths. It is connected to a transducer which sends sound at a constant

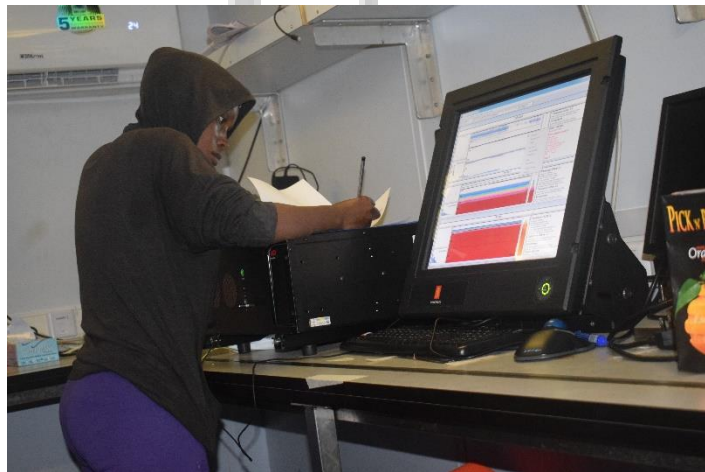
frequency range from 38KHz and above. The data was continuously stored as the ship moved over to planned transects. “ADCP and EK60 Echo Sounder do not work simultaneously as both use sound frequencies to collect data. If switched on simultaneously, it can cause noise due to interference of the sound frequencies which are in the same range,” said Ndegwa.



ADCP observations

EK60 Echo Sounder

This acoustic research tool was used to generate data on fish density and their location, and identification of plankton community and biodiversity. It has a transducer unit mounted under the vessel that sends echoes of what is in the water column. The echo sounder provides a nice track of organisms distributed where the research vessel goes.



Amina, a marine geologist, reads echo sounder data

Bongo plankton nets

They were deployed for zooplankton sampling. Bongo nets consist of two plankton nets mounted next to each other. These plankton nets are ring nets with a small mesh width and a long funnel shape. Both nets are enclosed by a cod-end that is used for collecting plankton. The bongo net is pulled horizontally through the water column by a research vessel. Using a bongo net, a scientist can work with two different mesh widths simultaneously. A bongo net is trawled horizontally through the water column by a research vessel.



Bongo plankton nets being deployed



Bongo plankton nets being trawled

CTD Rosette

CTD stands for Conductivity, Temperature and Depth. This device collects a wide range of data underwater to help scientists understand the characteristics of the ocean such as currents, its composition, and how it changes over time.

Water sampling bottles close remotely to collect water samples of different depths. The CTD unit gathers data using electronic sensors and sends data back to the ship. Investigators use its thrusters to maintain position above the CTD. As the CTD descends through the water column, electronics monitor many ocean properties like light levels, pressure and temperature. Electronics also measure turbidity (how cloudy the water is with tiny particles).



CTD rosette being lowered into the ocean

As the CTD returns to the surface sampling, bottles are closed remotely to capture water at specific depths. The water is then analysed to measure concentrations of nutrients like nitrate, phosphate and silicate. It is also analysed for concentrations of trace elements like iron, which is important for plankton growth.

Onboard the ship, water samples can be analysed for the number of and types of plankton. CTD data collected has allowed scientists map where cold and warm currents travel in the ocean, to determine the different temperature gradient within the Western Indian Ocean.

The CTD is also mounted on a ship deck. It is downcast (lowered) to a determined depth. A conducting wire cable communicates between the CTD and an onboard ship computer which commands (closes sample bottles per determined depth) and visualises data being collected during upcast (lifting of the rosette). This helps determine the different thermocline (different temperature layers within the water).

Water Quality Measuring Instruments

Water monitoring tools measure water quality parameters directly in natural water. The parameters taken included pH, dissolved oxygen (DO) concentration, redox potential, turbidity, salinity and temperature.



Water quality monitoring set



Lab technologist Ms Teresia Nyambura and research scientist Amina take measurements of water samples. The parameters included temperature, salinity, PH, oxygen and dissolved oxygen levels.