



KENYA MARINE AND FISHERIES RESEARCH INSTITUTE

FRESH WATER SYSTEMS

**Assessing the fluoride levels in Lake Baringo and her catchment, its
ecological and human effects for informed decision**

TECHNICAL REPORT: KMF/RS/2021/C8221(1)


JUNE, 2021

DOCUMENT CERTIFICATION

Certification by Director Freshwater Systems

I hereby certify that this report has been done under my supervision and submitted to the Director.

Name: Dr. Christopher Mulanda Aura (PhD)

Signature: 

Date: 16th June, 2021

Certification by Director General, KMFRI

I hereby acknowledge receipt of this Report

Name: Prof. James M. Njiru, PhD

Signature: 

Date: 18th June, 2021

Citation:

Nyakeya, K., Odoli, C.O., Mugo, J., Nyamweya, C., Aura C.M. and Njiru J.M. (2020). Assessing the fluoride levels in Lake Baringo and her catchment, its ecological and human effects for informed decision. 29pp. KMF/RS/2021/C8221(1)

ACKNOWLEDGEMENTS

We are very grateful to the Board of Management of The Kenya Marine and Fisheries Research Institute for allocating funds for use to undertake this activity. We also wish thank KMFRI technical staff namely: Conland Barongo, Peter Ombati and Benjamin Arwaita who assisted in sample collection and analyses.

Abstract

It is the goal of every government to provide safe and clean water and for its entire people, to ensure a healthy and productive population. Most of the members of the Lake Baringo riparian communities as well as her catchment are suffering from the adverse effects of dental and skeletal fluorosis. The World Health Organization (WHO) recommends a maximum limit of 1.5ppm fluoride content in cooking or drinking water. The recommended limit is even lower in an area with hot climate such as Baringo since people drink more water. Kenya has adopted the WHO guideline of 1.5ppm fluoride limit. About 30 to 50% of the Kenyan population is affected by fluorosis, but with regional differences in prevalence and severity. The study aimed at assessing the fluoride levels in Lake Baringo and her catchment, its ecological and human effects for informed decision. Results showed that fluoride levels recorded along the river continuum of Rivers Molo and Perkerra were within the recommended limits by the WHO. However, in the lake (river mouths) the levels were >1 mg/L. socio-economic data showed that the riparian community uses the lake water for domestic purposes hence compromising their health. Although enough data was not collected to cover both wet season and dry spell, we recommend for further study for informed decision making. For the meantime, however, we recommend for an alternative source of water for drinking by the riparian community.

Keywords: Flouride; WHO guidelines; Lake Baringo

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1.0 Introduction

It's the goal of every government to provide safe and clean water and for its entire people, to ensure a healthy and productive population. This however is not always possible. Fluoride is essential to living organisms at concentrations between 1-3mg/day (Katsonu *et.al.*, 2013), when this limit is exceeded it poses a threat to human health due to its high affinity for Ca²⁺ ions contained in bones and teeth. The most common disease associated with fluoride is fluorosis. The initial most common symptoms are seen as brown specs on teeth, while later stages result in severe skeletal damage (Redda *et al.*, 2006).

The World Health Organization (WHO) recommends a maximum limit of 1.5ppm fluoride content in cooking or drinking water. The recommended limit is even lower in an area with hot climate such as Baringo since people drink more water. Kenya has adopted the WHO guideline of 1.5ppm fluoride limit (Karuiki *et al.*, 1984). Lake Baringo water has been reported to contain 5.4 mg F/l (5.3-5.6) and had a pH of 10.4 (10.1-10.7) (Gikunju *et al.*, 1992). The reported level is way above the recommended limit and hence could be affecting the lake's biodiversity as well as riparian communities dependable of the lake water. More so, fluoride (F) in fish and marine products has been reported in several countries, to be a major source of dietary F (Opinya *et al.*, 1991) and hence a potential contributor in the development of fluorosis.

Lake Baringo is inhabited by several species of fish which are consumed by the local population and to a large extent shipped as far to the capital city of Nairobi. The lake is located in East Africa's Great Rift Valley where F occur in abundance (Kariuki *et al.*, 1984). The aim of the present investigation was to assess the fluoride levels in Lake Baringo and her catchment, its ecological and human effects to guide in decision making.

2.0 Methodology

2.1 Study Area

This study was conducted from November 2020 and April, 2021 (dry and rainy season accordingly) along rivers Molo and Perkerra (longitudinally from the source to the mouth) as well various identified lake wide representative sampling point in Lake Baringo (Nyakeya *et al.*, 2020). This was based on the geochemical principle that the more the samples and well distributed they are, the more representative they are of the study area.

2.2. Sampling

Stringent measures were also taken when cleaning the sample bottles before sampling to prevent contamination. The bottles were cleaned with metal free nitric acid (HNO₃) then rinsed several times with distilled water and deionised water. While in the field each container was again rinsed at least twice with the water about to be sampled. The geographic co-ordinates were also taken at the point of collection using a Geographic Positioning System (GPS).

2.3. Fluoride analyses

AWWA/APHA-4500_F - Ion Selective Electrode Method was used for analyses of fluoride. The method describes the operational procedure for the DR359Tx Ion Concentration Meter. It provides guidance for determining Fluoride ion (F⁻) in potable, surface and saline water samples. The Ion Concentration Meter was calibrated prior to using the meter for testing. When used carefully the Ion Concentration Meter with a good electrode has an accuracy of $\pm 0.5\%$ (0.005 units) with applicable range of 0.001 to 9990 units.

2.4 Socio-economic data

Descriptive research design was used. Both qualitative and quantitative methods were also used. Descriptive research design tries to minimize the disadvantages of qualitative and quantitative methods when used alone (Masue, 2010) hence the advantages of each was applied. For example, while the opinions of the respondents are contained by the use of qualitative methods and those related to quantitative data demands some statistics. Purposive research design was used to collect data from the already affected people by fluoride. The target population involved all people residing at Kampi ya Samaki Centre but since we did not have the exact number, we opted to use a sample size similar to other similar studies conducted in the same area of interest as recommended by (Ozoemelem 2009). We therefore, used 40 respondents.

This study used primary data only as techniques of data collection where questionnaires (i.e. both closed and open-ended questions) and observation schedules were used. both qualitative

and quantitative analysis. Before analysis stage, the researcher arranged raw field data in an orderly manner so as to facilitate systematic retrieval later. Data was then entered into Excel sheets. Codes were then developed and transformed into categorical labels and themes. The coded data was then transferred to SPSS Programme for further analysis. The collected data was thereafter analysed by different analysis techniques. Analysis was done in SPSS and it was presented in form of descriptive analysis using tables where frequency and percentages were calculated.

During data collection confidentiality was kept in mind in order to adhere to ethical principles regarding cultural values, traditions, and taboos of community living around Kampi ya Samaki. The participation of respondents was voluntary. Also the rules of confidentiality and anonymity was observed. The data obtained was kept confidential and was used for the purpose of this study only.

3.0 Results and discussion

3.1 Demographic data of the respondents

Majority of the respondents were female (83%) (Figure 1). This is because female group of adults are generally left at home to take up the in-house chores as men are involved in taking care of the livestock and other chores to sustain their families.

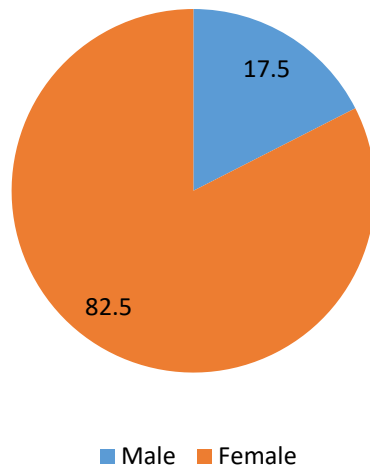


Figure 1: The percentage proportion of respondents by gender (n= 40)

We also wanted to know the level of the respondents and their responses were as indicated in Figure 2 below. About 38% of the respondents had secondary level of education whereas just 10% had no formal education at all. Only 5% of the respondents had university education. Generally, the low level of education is attributed to high poverty level associated with the climatic condition of the area. The area is mainly semi-arid and therefore there is no any gainful economic activity such as agriculture hence people in this region depend on livestock which to a certain extent is a reserve to a few. Fisheries also support their livelihood but to a lesser extent because the fishery of Lake Baringo is declining at an alarming rate due to overexploitation and environmental degradation.

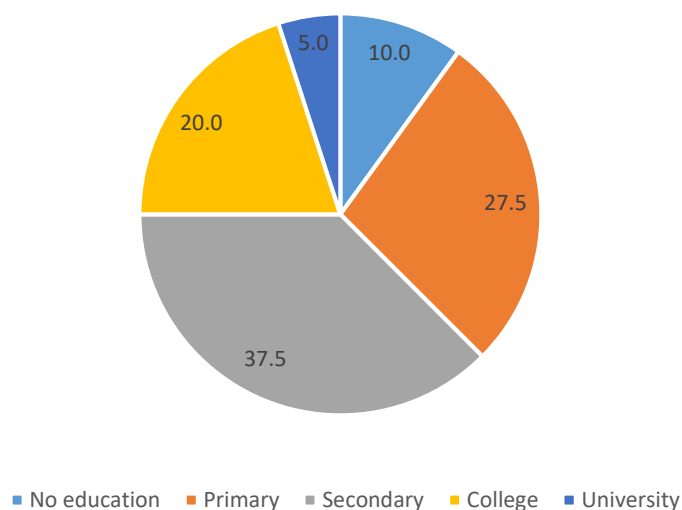


Figure 2: The percentage proportion of respondents level of education (n= 40)

3.2 Socio-ecological effects of fluoride

The respondents were asked to state the effects fluoride has had on their bodies (Figure 3). It is evident that fluoride has serious effects on the health of the people because 24% of the respondents rated its negative effects as very high whereas only 7% of the respondents confirmed that it has low effects.

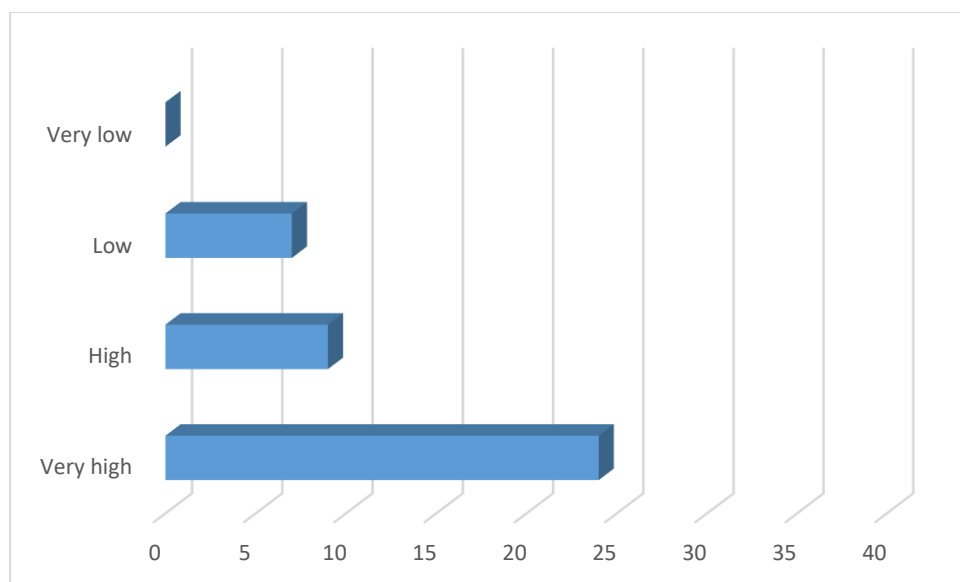


Figure 3: Respondents fluoride effects rating (n= 40)

They were also asked to state some of the parts of the body worst affected and they said that the teeth, bones and the general human vertebra is among the most affected. During our survey, we affirmed their assumptions when we came across men and women with bent backs, bowed legs as a result of brittle bones.

To ascertain how they get the fluoride contamination, we wanted to know how they use the water from Lake Baringo and their responses were as illustrated in Figure 4. It was noted that water from the lake is used for domestic and bathing/washing, irrigation, bathing and washing. This was confirmed by 28% of the respondents. The same water is used for drinking thus compromising the health of the riparian community. Fluoride has a biomagnification property whereby it accumulates and sediments in the human joints thus causing serious deleterious effect in the bones, a condition known as fluorosis.

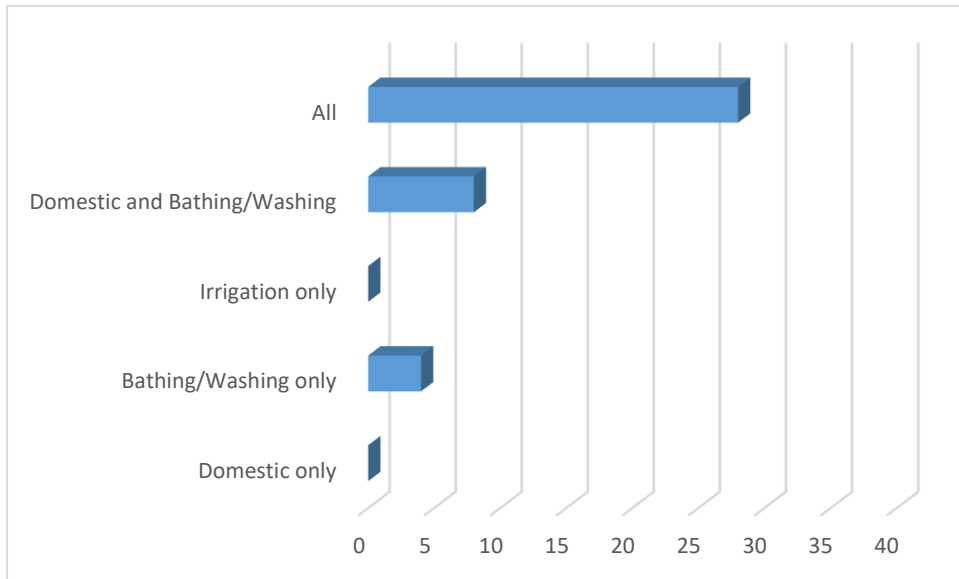


Figure 4: Lake Baringo basin water uses as scored by respondents (n= 40)

3.2 Fluoride concentrations

River mouth stations, S1 and S3 for rivers Perkerra and Molo recorded 1.1 mg/L and 0.73 mg/L (Figure 5 and 6) respectively of fluoride concentrations which is the highest levels recorded among all the sampled stations. In general terms stations upstream in both the rivers had low levels of fluoride as compared to the concentrations depicted in the lake. The lowest fluoride level (0.038 mg/L) was recorded in R. Perkerra at Chemasusu overflow sampling station.

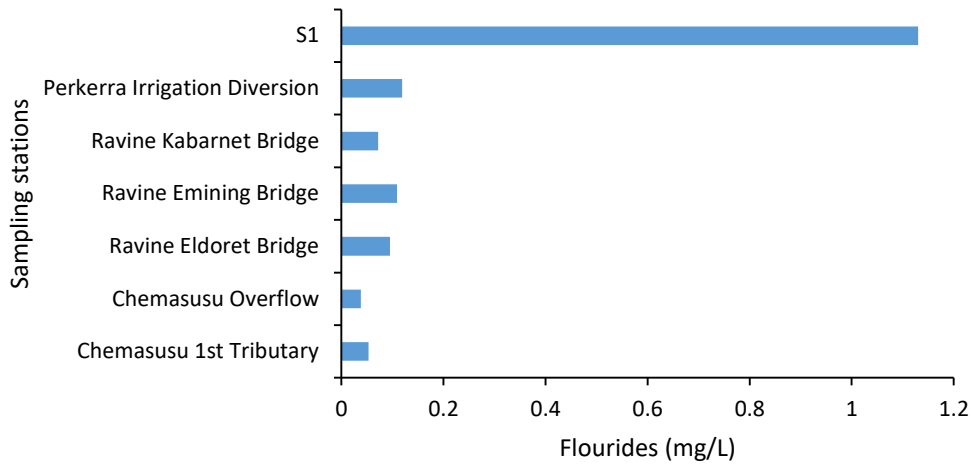


Figure 5. Fluoride levels as recorded in the sampling stations of R. Perkerra and its river mouth (S1) in Lake Baringo

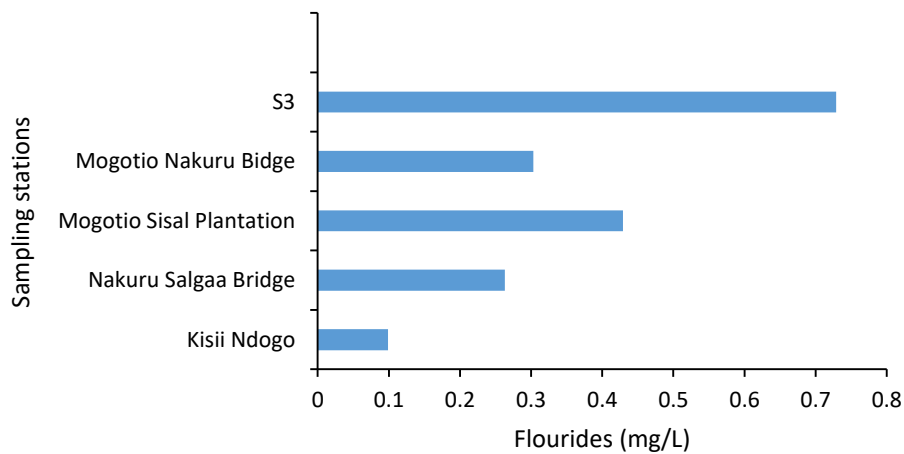


Figure 6. Fluoride levels as recorded in the sampling stations of R. Molo and its river mouth (S3) in Lake Baringo

High levels of fluoride in Lake Baringo is associated with emissions from volcanic activities in the East African Rift System. The lake contains 55 mg/L of fluoride, more than 35 times the amount recommended by WHO (GDC, 2014). The high concentrations recorded in the lake compared to the river stations could be attributed to high temperatures increasing solubility and mobility of the ions which could be attributed to the elevated temperatures as a result of hydrothermal alteration, the area is known to geothermally active as evidenced by the presence of fumaroles and hot springs.

4.0 Conclusion and recommendations

The aim of this study was to assess the fluoride levels in Lake Baringo and her catchment, and determine its ecological and human effects to guide in decision making. The chemical analysis done on samples obtained along the rivers Molo and Perkerra right from upstream showed low levels that were within the WHO standards. However, samples form the river mouths within Lake Baringo demonstrated that fluoride is in high levels of >1 mg/L. Socio-economic data on the use of the lake water by the riparian community showed that fluoride had adverse effects on their health. A larger population who use the water mainly for domestic and irrigation do develop a condition known as fluorosis resulting into unnecessary bone breakage and bending hence is a common disease around this area. Although enough data was not collected to carry out meaningful statistical analysis, we still conclude that fluoride in the Lake Baringo basin has serious ecological effects especially on the riparian community. However, we were unable to carry out an analysis on fish tissues to determine its effects on the fish and fish ecology in general due to insufficient funds. We therefore, recommend that further comprehensive study be done in the entire lake ecosystem to clearly discern the effects of fluoride. However, in the meantime, we recommend for an alternative source of water for drinking by the riparian community because fluoride has a biomagnification effect. Therefore, whether taken in low levels, eventually it will bioaccummulate in the bones causing adverse effects on human health.

References

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- Karuiki, D.N., H.M. Thairu and L.W. Njenga (1984). Dietary sources of fluoride in Kenya, from: S. Likimani (ed) *Fluorosis Research Strategies*. African Medical Research Foundation, Nairobi, Kenya, 32-36.
- Katsanou,K.,Siavalas,G., and Lambrakis 2013: Geochemical controls on fluoriferous groundwaters of the Pliocene and the more recent aquifers: The case of Aigion region, Greece
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- Redda, H.K., Zenebe. M., Helmut.K., Demes .R., Wondowossen.F., Legesse.Z., and Kjell.B., 2006: The Geographic distribution of fluoride in surface and ground water in Ethiopia with Emphasis on The Rift Valley. *Jour Science of Total Environment* Vol 367 pp182-190

APPENDICES

Appendix 1: Submission letter of the technical report to the Director General KMFRI

KENYA MARINE AND FISHERIES RESEARCH INSTITUTE

TELEPHONE: KISUMU 254770567443
E - mail: kmfkisumucentre@yahoo.com
When replying please quote
Ref. No. KMF/RS/2021/ C21.ii
If calling or telephoning ask
For: *Dr. Aura*
Please address your reply to
Ag. DIRECTOR



KISUMU CENTRE
P.O. BOX 1881
KISUMU
KENYA
DATE: 16/06/2021

The Director General
Kenya Marine and Fisheries Research Institute
Headquarter and Mombasa Centre
P.O. Box 81651 080100
MOMBASA



RE: SUBMISSION OF TECHNICAL REPORT FOR PC PERIOD 2020-21

The above refers,

KMFRI Freshwater systems (FWS) have successfully implemented the 2020-2021 PC on "the assessment of fluoride levels in Lake Baringo and her catchment, its ecological and human effects for informed decision".

Herein attached is the technical report and fact sheet, which highlights activities involved.

We therefore submit this report and fact sheet for your perusal and dissemination to the relevant stakeholders. Your support is highly appreciated.

Thank you.

Dr. Christopher M. Aura (PhD)
Ag. Director - FWS

Director FWS
Dissemination
18th June 2021

Appendix 2: Submission letter of the technical report to Director FWS

KENYA MARINE AND FISHERIES RESEARCH INSTITUTE

Mobile: +254 722395764
Email: cogombe@yahoo.com
If calling, ask for Dr. Odoli
Please address your reply to;
Station Coordinator.



Baringo Research Centre,
P. O. Box 231- 30403,
Margit,
Kenya.

Ref: KMF/BR/AD

Date: 14/06/2021

To Ag. Director FWS,
KMFRI,
P.O BOX 1881,
Kisumu.

Dear Sir,

RE: SUBMITON OF REPORT ON ASSESSING THE FLUORIDE LEVELS IN LAKE BARINGO AND HER CATCHMENT, ITS ECOLOGICAL AND HUMAN EFFECTS FOR INFORMED DECISION-KMF/RS/2021/C21.ii

Please herein find the above report for your personal perusal and submission to the Director.


Key issues observed from study were as follows:

1. The chemical analysis done on samples obtained along the rivers Molo and Perkerra right from upstream showed low levels that were within the WHO standards.
2. However, samples form the river mouths within Lake Baringo demonstrated that fluoride is in high levels of >1 mg/L. More so, socio-economic data on the use of the lake water by the riparian community showed that fluoride had adverse effects on their health.
3. Although enough data was not collected to carry out meaningful statistical analysis, we still conclude that fluoride in the Lake Baringo basin has serious ecological effects especially on the riparian community.

A handwritten signature in black ink, appearing to read 'C. Odoli', is written over a horizontal line.

Dr. Cyprian O. Odoli (PhD)
Station Coordinator

Appendix 3: Approved requisitions to assess the fluoride levels in Lake Baringo and its catchments

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**KMFRI BARINGO STATION
INTERNAL MEMO**

TO: STATION COORDINATOR
FROM: RESEARCH
DATE: 12th APRIL 2021
SUBJECT: FACILITATION FOR SAMPLING TOWARDS MEETING THIS YEAR (2020-2021) PC TARGETS

We are scheduled to sample during this dry season for the following targets:

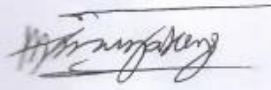
1. Map and monitor major point sources of pollution and assess their effect on fish ecology in lake Baringo at Molo and Perkerra river mouths.
2. Assessment of fluoride levels in Lake Baringo and its catchments and its effects on fish ecology and human life.
3. Assess the effectiveness of installed chokor oven in reducing fish post-harvest losses and enhancing income of processors at Kampi ya Samaki along Lake Baringo.

The above named PCs have been combined because of meagre resources and I hope with dedication our team will be able to deliver. Meanwhile, all the laid down MOH guidelines on COVID 19 shall be exercised during the execution of this important activity.

The purpose of this memo therefore is to request for a 3-day night out for the following officers who are scheduled to carry out the sampling as from 13/04/2021.

S/No.	Name	Job Group	Days	Rate	Amount
1	Dr. Cyprian Odoli	D3	3	10500	31500
2	Kobingi Nyakeya	C3	3	8400	25200
3	James Mugo	D2	1	8400	8400
4	Julius Kiplagat	B3	1	4900	4900
5	Ben Rotich	B3	2	4900	9800
6	Caroline Kibet	Intern	1	4900	4900
	Total				84700

Yours sincerely,



Kobingi Nyakeya

2

Acc
Approved - process
immediately as the
activity begins 13/04/21
12/04/21

T.N.A
12/4/2021

A. Don

KMFRI-BARINGO STATION
INTERNAL MEMO



4/3/2021

FROM: LABORATORY

TO: STATION CO-ORDINATOR

SUBJECT: MONITORING FISHERY AND LIMNOLOGICAL CHANGES OF LAKE BARINGO

The scientific team will undertake the above-mentioned activity. The activity will take place for four days w.e. 9/03/2021, hence I request for your facilitation for the effectiveness of the same.

NO.	NAME	RATE	NO. OF DAYS	TOTAL AMOUNT	SIGN
1	Dr Cyprian Odoli	1500.00	4	6000.00	
2	James Mugo	1000.00	4	4000.00	
3	Kobingi Nyakeya	1000.00	4	4000.00	
4	Benjamin Arwaita	750.00	4	3000.00	
5	Ben Rotich	750.00	4	3000.00	
6	Conland Barongo	750.00	4	3000.00	
7	Julius Kiplagat	750.00	3	2250.00	
8	Peter Ombati	500.00	4	2000.00	
9	Winnie Chelagat	750.00	4	3000.00	
10	Zablon Magoka	750.00	3	2250.00	
11	Okirigiti Odieki	750.00	2	1500.00	
12	Sally Chemarich	750.00	3	2250.00	
13	Benard Oyaro	750.00	4	3000.00	
14	Kilima Lekarip	500.00	4	2000.00	
15	Caroline Kibet	500.00	3	1500.00	
16	Boniface Mwenda	500.00	3	1500.00	
17	Winnie Cheptarus	750.00	4	3000.00	
18	Jane/ Gitenya	750.00	3	2250.00	
19	Joseph Waweru	750.00	3	2250.00	
20	Riziki Walumona	750.00	3	2250.00	
21	Communication			16500.00	
22	Fuel + 2T(3 litres)			70600.00	
				TOTAL KSH	
				71,350	

Payment of field staff process check

Thank you

Yours faithful

[Signature]
Conland Barongo

②

ice approved for processing as conducted reviewed
8/03/21

Arefon Jalen

③

CASTER
TWINA
8/8/2021

Noted



KMFRI BARINGO STATION
INTERNAL MEMO

TO: STATION COORDINATOR
FROM: RESEARCH
DATE: 4th NOVEMBER 2020
SUBJECT: FACILITATION FOR THE ASSESSMENT OF FLUORIDE LEVELS IN LAKE BARINGO AND ITS CATCHMENTS

This is to bring to your attention that we are planning to undertake fieldwork on fluoride levels in Lake Baringo and its catchments in order to assess its ecological and human effects. This forms on of the PC targets for this financial year. Since the study covers the catchments of Lake Baringo, we are scheduled to sample rivers Molo and Perkerra and their tributaries. This therefore means that the scientific team will be operating from Nakuru County since these rivers originate from the Mau Complex.

The purpose of this memo therefore is to request for a 3-day night out for the following officers who are scheduled to carry out the sampling as from 11th November 2020.

Name	Designation	Days	Rate	Amount (Sh)
Kobingi Nyakeya	Research Scientist II	3	8400	25200
James Mugo	Research Scientist I	3	8400	25200
Dr. Cyprian Odoli	Senior Research Scientist	3	10500	31500
Ben Rotich	Driver	3	4900	14700
Conland Barongo	Technician II	1	4900	4900
Julius Kiplagat	Aux. Staff	2	4900	9800
Caroline Kibet	Intern	1	4900	4900
Modicayo Orwa	Acc. I	1	8400	8400
Winnie Kiplagat	Intern	1	4900	4900
Sample analysis	N/A	15 samples	350	5250
Fuel	N/A	3	3500	10500
Community	N/A	3	3500	10500
Fare to/fro Nakuru	N/A	-	500	1000
Total				156,750.00

Yours sincerely,

Kobingi Nyakeya

ACC
Approved for processing

04/11/2020

Action taken

04/11/2020

Appendix 4: Work ticket

G.P. 26

MINISTRY OF Kenya Marine & Fisheries Research Institute

TRANSPORT-DAILY WORK TICKET DEPT.* Kenya Marine TICKET NO. **P 139738**

PREVIOUS W.T. No.* 8890 G.K. No.* KCA 182F MAKE* NISSAN NAVARA UNIT* BANWA STATION* MALIGAI

Driver's Name and Number			Number, Name and Designation of Authorizing Officer				Specimen Signature of Authorizing Officer	
1	<u>BEN KATICA (1928)</u>	4	1	<u>DR. CYPRIAN O. ODOL - S/C</u>			<u>[Signature]</u>	
2		5	2	<u>KOBIOLA O. AKSIA - RS</u>			<u>[Signature]</u>	
3		6	3	<u>MAGETO N. GUSIA - TRA (1202)</u>			<u>[Signature]</u>	

4. 19990 - Kenya Marine Research Institute

Date	Driver's No.	Details of journey and route in full	No. and Signature of person authorizing Journey		Oil drawn (litres)	Fuel drawn (litres)	P.O.L. (S 15) Voucher No. or L.P.O. or Cash Voucher No.	Time		Speedo Reading at end of Journey	Kilometres of Journey
			No. (4)	Signature (5)				Out (9)	In (10)		
11/4/21	1	Mochowet - Nymbet & Baeu	4	<u>[Signature]</u>	20	855	855	6:00 am	2:30 pm	145855	81
14/4/21	1	Mochowet - Nymbet & Baeu	4	<u>[Signature]</u>	20	859	859	6:10 am	4:20 pm	145853	76 km
15/4/21	1	Mochowet - Nymbet & Baeu	4	<u>[Signature]</u>	20	861	861	6:00 am	4:30 pm	145788	76 km
16/4/21	1	Mochowet - Nymbet & Baeu	4	<u>[Signature]</u>	20	868	868	6:00 am	4:20 pm	145814	76 km
17/4/21	1	Mochowet - Nymbet & Baeu	4	<u>[Signature]</u>	20	834	834	6:00 am	3:34 pm	145899	85 km
18/4/21	1	Mochowet - MALIGAI	4	<u>[Signature]</u>	20	866	866	8:00 pm	11:00 am	146203	124 km
19/4/21	1	Mangot - Eldama bank	1	<u>[Signature]</u>		1162	10795	11:30 am	1:38 pm	146052	29 km
15/4/21	1	Narvon - Eld. Ruwen - MALIGAI	1	<u>[Signature]</u>		6272		8:30 am	4:50 pm	146140	139 km
16/4/21	1	MALIGAI - KYS MALIGAI	1	<u>[Signature]</u>				9:25 am	12:30 pm	146219	25 km
17/4/21	1	MALIGAI offices - Molo - back	1	<u>[Signature]</u>				6:00 am	7:40 pm	146786	708 km
17/4/21	1	MALIGAI offices - KYS - NAKURU	1	<u>[Signature]</u>		40.82		6:00 am	9:45 pm	146488	62 km
17/4/21	1	NAKURU - KYS - MALIGAI offices	2	<u>[Signature]</u>				10:00 am	1:41 pm	146640	152 km
18/4/21	1	MALIGAI offices - KYS MALIGAI - back	3	<u>[Signature]</u>				1:45 pm	5:52 pm	146790	150 km
19/4/21	1	Mangot - KYS - Mangot office	3	<u>[Signature]</u>				8:00 am	2:00 pm	146857	47 km
20/4/21	1	Mangot - Nyalani - Mangot office	3	<u>[Signature]</u>				8:30 am	2:57 pm	146909	72 km
21/4/21	1	Mangot - Kaharot - Mangot office	1	<u>[Signature]</u>		51.52		10:00 am	4:30 pm	147128	219 km
22/4/21	1	Mangot - Kaharot - Mangot office	1	<u>[Signature]</u>				12:00 pm	1:30 pm	147221	98 km

These headings to be completed by issuing Officer

KENYA MARINE & FISHERIES RESEARCH INSTITUTE

8884

TRANSPORT - DAILY WORK TICKET

DEPT. *K.M.F.R.I.*

TICKET NO. KM

PREVIOUS W.T. NO. *8883*

REG. NO. *KCA 182 F*

MAKE *Nissan*

UNIT *1800cc*

LABORATORY *BARINGO*

Driver's Name and Number				Number, Name and Designation of Authorizing Officer				Specimen Signature of Authorizing Officer			
1 <i>Schuyt Chemut (128)</i> 4				1 <i>BE OBOI Cyprian</i>							
2 <i>Ben Roinet (128)</i> 5				2 <i>1333 - Samuel Othman (128)</i>							
3				3 <i>1353 - Paul Ouma (10)</i>							
7				4 <i>1469 - James Mulo</i>							
Date	Driver's No.	Details of Journey and Route in full	No. and Signature of person authorizing Journey	Oil drawn (Litres)	Fuel drawn (Litres)	Voucher No. or L.P.O. No.	Time		Speed Reading end of Journey	Kilometres of Journey	
(1)	(2)	(3)	No. (4) Signature (5)	(6)	(7)	(8)	(9) Out	(10) In	(11)	(12)	
1/09/20	1	Mangal - Kambi - Mangal	2 <i>James Mulo</i>		21.6	024608977	7:10am	5:30pm	131884	47km	
2/09/20	1	Mangal - Nakuru - Mangal	2 <i>James Mulo</i>				7:10am	5:40pm	131890	20km	
3/09/20	1	Mangal - Kambi - Mangal	3 <i>James Mulo</i>				8:00am	5:30pm	131645	57km	
4/09/20	1	Mangal - Kambi - Mangal	3 <i>James Mulo</i>		14.77	12506	8:00am	4:00pm	127094	0km	
7/09/20	1	Mangal - Kambi - Mangal	3 <i>James Mulo</i>				11:00am	5:00pm	131736	47km	
9/09/20	1	Office - Mangal - Office	3 <i>James Mulo</i>				9:00am	5:00pm	131762	6km	
9/09/20	1	Office - Meru - Office	3 <i>James Mulo</i>		7.32	02174	10am	1:30pm	131762	60km	
9/09/20	1	Office - Meru - Office	3 <i>James Mulo</i>				1:30pm	2:00pm	131805	64km	
9/09/20	1	Office - Kariakara - Office	3 <i>James Mulo</i>				2:00pm	5:30pm	131926	89km	
9/09/20	1	Office - KBT - Office	3 <i>James Mulo</i>				8:30am	5:00pm	132006	100km	
10/09/20	1	Office - KBT - Office	3 <i>James Mulo</i>				7:00am	5:00pm	132137	97km	
11/09/20	1	Mangal - Kambi - Mangal	3 <i>James Mulo</i>		8.4	1240	7:00am	9:30am	132185	52km	
12/09/20	1	Mangal - KBT - Mangal	3 <i>James Mulo</i>		6.53	026014778	2:30pm	5:00pm	132271	86km	
16/09/20	1	Mangal - KYS - Mangal	4 <i>James Mulo</i>				9:00am	5:00pm	132334	63km	
17/09/20	1	Mangal - KYS - Mangal	4 <i>James Mulo</i>		30.5	3320578	8:50am	3:00pm	132323	270km	
18/09/20	1	Mangal - Nakuru - Mangal	4 <i>James Mulo</i>				11:30am	5:00pm	133171	146km	
21/09/20	1	Mangal - Kambi - Mangal	1 <i>James Mulo</i>				5:20pm	7:30pm	133301	70km	
21/09/20	1	Mangal - Eldoret	1 <i>James Mulo</i>								
22/09/20	1	Eldoret - Mangal	1 <i>James Mulo</i>								

Date	Driver's No.	Details of Journey and Route in full	No. and Signature of person authorizing Journey	Oil drawn (Litres)	Fuel drawn (Litres)	Voucher No. or L.P.O. No. or Cash Voucher No.	Time		Speed Reading end of Journey	Kilometres of Journey
(1)	(2)	(3)	No. (4) Signature (5)	(6)	(7)	(8)	(9) Out	(10) In	(11)	(12)
23/9/20	1	Office - Mangal - Office	1 <i>James Mulo</i>				3:00pm	4:00pm	133318	5km
24/9/20	1	Mangal - KYS - Mangal	4 <i>James Mulo</i>				8:40am	4:00pm	133504	20km
25/9/20	1	Mangal - Office - Mangal - Office	4 <i>James Mulo</i>				9:40am	5:00pm	133574	13km
28/9/20	1	Mangal - KYS - Mangal	3 <i>James Mulo</i>				5:30am	Cancelled		
26/09/20	1	Mangal - Kambi - Mangal	3 <i>James Mulo</i>				8:00am	5:00pm	133604	87km
28/09/20	1	Mangal - KYS - Mangal	3 <i>James Mulo</i>				7:00am	5:00pm	133669	54km
29/09/20	1	Mangal - KYS - Mangal	3 <i>James Mulo</i>				6:00am	5:00pm	133748	35km
30/09/20	1	Mangal - KYS - Mangal	1 <i>James Mulo</i>							
1/10/20	1	Mangal - KYS - Mangal	3 <i>James Mulo</i>							

SUMMARY OF WORK TICKETS

DRIVER'S REPORT OF DEFECTS	Action taken by Officer	Totals - Fuel and Oil drawn		Certified all entries checked, Details entered in Vehicle Log Book.
		Ltr. (Fuel)	Ltr. (Oil)	

Appendix 4: Fact sheet for dissemination to the key stakeholders



KENYA MARINE AND FISHERIES RESEARCH INSTITUTE
FRESH WATER SYSTEMS

FACT SHEET

**Assessing the fluoride levels in Lake Baringo and her catchment, its
ecological and human effects for informed decision**

JUNE 2021

AUTHORS

Nyakeya, K., Odoli, Mugo, J., C., Riziki, W. J. Nyamweya, C., Aura, C, M.

KMFRI Headquarters

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KMFRI Baringo Station

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Background information

It is the goal of every government to provide safe and clean water and for its entire people, to ensure a healthy and productive population. Most of the members of the Lake Baringo riparian communities as well as her catchment are suffering from the adverse effects of dental and skeletal fluorosis. The World Health Organization (WHO) recommends a maximum limit of 1.5ppm fluoride content in cooking or drinking water. The recommended limit is even lower in an area with hot climate such as Baringo since people drink more water. Kenya has adopted the WHO guideline of 1.5ppm fluoride limit. About 30 to 50% of the Kenyan population is affected by fluorosis, but with regional differences in prevalence and severity. Lake Baringo is inhabited by several species of fish which are consumed by the local population and to a large extent shipped as far to the capital city of Nairobi. The lake is located in East Africa's Great Rift Valley where F occur in abundance (Kariuki *et al.*, 1984). The study aimed at assessing the fluoride levels in Lake Baringo and her catchment, its ecological and human effects for informed decision.

Findings

Socio-ecological effects of fluoride

- ✓ Fluoride has serious effects on the health of the people whereby 24% of the respondents rated its negative effects as very high whereas only 7% of the respondents confirmed that it has low effects (Figure 1).

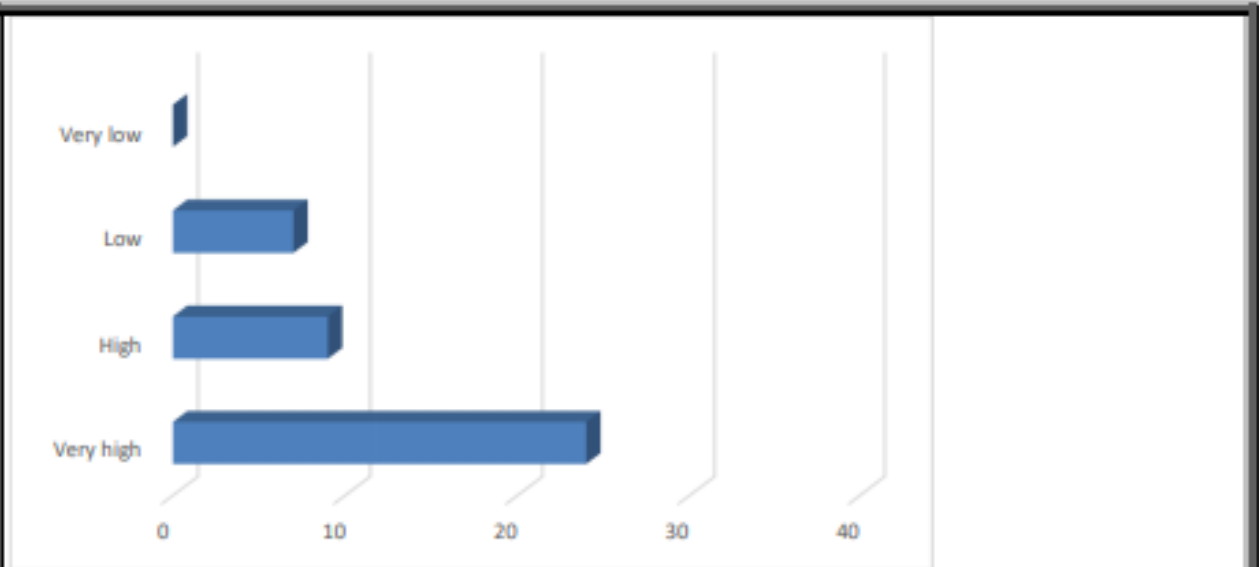


Figure 1: Respondents fluoride effects rating (n= 40)

- ✓ The people of Kampi ya Samaki relies on the water from Lake Baringo mainly for their domestic use and irrigation thus compromising their health (Figure 2)

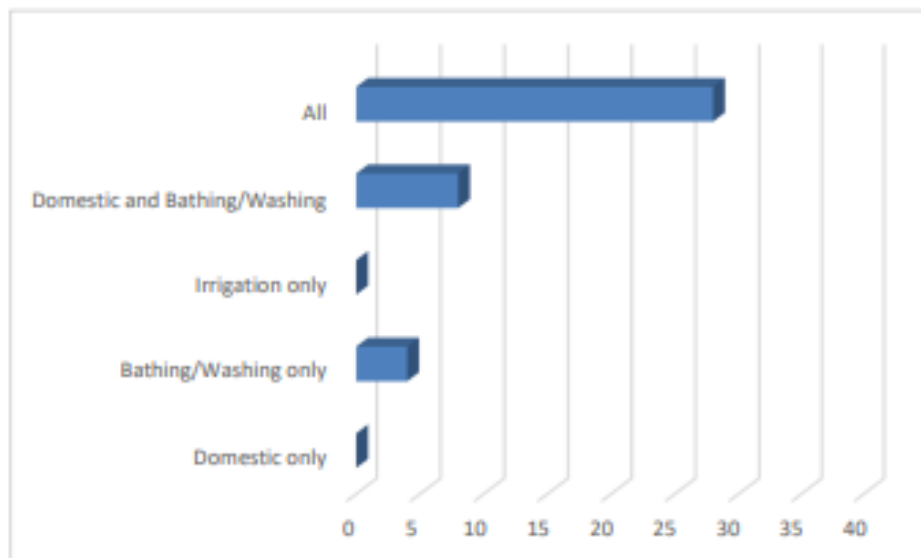


Figure 2: Lake Baringo basin water uses as scored by respondents (n= 40)

Fluoride concentrations

- ✓ Rivers molo and Perkerra recorded fluoride levels that are within the recommended standards by the WHO, but the levels in their respective river mouths were >1 mg/L (Figure 3 and 4).
- ✓ Due to its biomagnification nature, fluoride even if taken in small quantity will eventually result into adverse effects on human health.

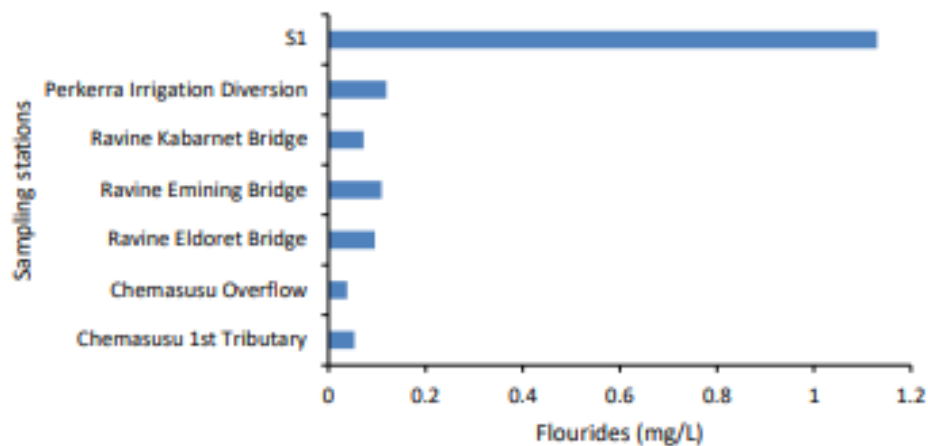


Figure 3. Fluoride levels as recorded in the sampling stations of R. Perkerra and its river mouth (S1) in Lake Baringo

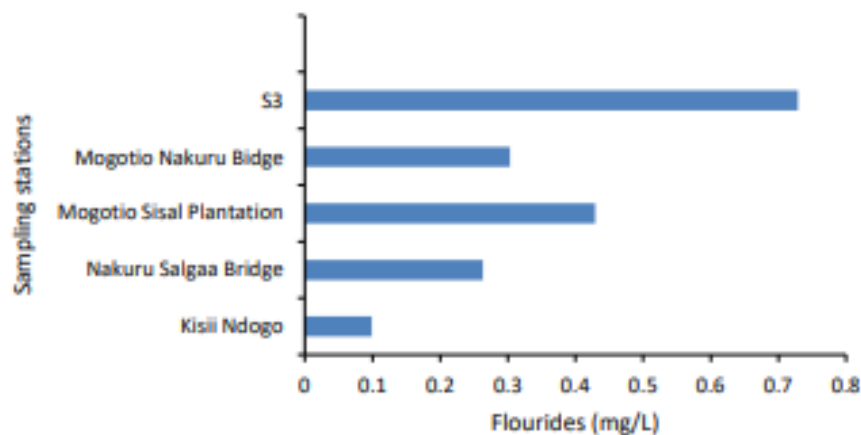


Figure 6. Fluoride levels as recorded in the sampling stations of R. Molo and its river mouth (S3) in Lake Baringo

Conclusion

- ✓ A larger population who use the water mainly for domestic and irrigation in Lake Baringo basin do develop a condition known as fluorosis resulting into unnecessary bone breakage and bending hence is a common disease around this area.
- ✓ The chemical analysis done on samples obtained along the rivers Molo and Perkerra right from upstream showed low levels that were within the WHO standards. However, samples from the river mouths within Lake Baringo demonstrated that fluoride is in high levels of >1 mg/L.

Recommendations

These results recommends for an alternative source of water for drinking by the riparian community because fluoride has a biomagnification effect.

Acknowledgment

We wish to thank Kenya government through KMFRI seed fund for funding this study. County government of Baringo fisheries officials, Local administration and communities are acknowledged for their valuable information.

Appendix 8: Dissemination to Beach Management Unit

KENYA MARINE AND FISHERIES RESEARCH INSTITUTE

Telephone 020-8021560/1
020-2353904
Mobile: 0712003853
Fax: 020-2353226
Email: director@kmfri.co.ke
When replying please quote
Reference no:
and date:
When calling or telephoning ask
for:
Please address your reply to:
The DIRECTOR GENERAL



HEADQUARTERS
P.O. Box 81651
MOMBASA
KENYA

KMF/RS/2021/C21.ii

Date: 21st June 2021

To: Beach Management Unit (BMU) Chairman
Kambi ya Samaki

Dear Sir/Madam,

RE: SHARING 2020-21 FY FACT SHEET/BRIEF

Kenya Marine and Fisheries Research Institute (KMFRI) is a state corporate body, established in 1979 under the Science and Technology Act (Cap 250), which has since been repealed by the Science, Technology and Innovation Act No. 28 of 2013. KMFRI is under the Ministry of Agriculture Livestock and Fisheries. The institute is empowered to carry out research in marine and freshwater fisheries, aquatic biology, aquaculture, environmental chemistry, ecological, geological and hydrological studies, socio-economical as well as chemical and physical oceanography.

In this regard, KMFRI conducted a number of research expeditions in 2020-2021 financial year on "Assessing the fluoride levels in Lake Baringo and her catchment, its ecological and human effects for informed decision" and came up with technical report and Fact sheet/brief.

The purpose of this letter is to share the findings in a summarised fact sheet/brief as information for possible management and conservation measures of the aforementioned systems. Attached herewith please find the technical reports and Fact sheet/brief for your perusal and further action.

Yours Sincerely,

Dr. Christopher M. Aura (PhD)

For: Director General/KMFRI

**COUNTY DIRECTOR
FISHERIES BARINGO**

For Christopher M. Aura
20th June 2021

Appendix 9: Dissemination to County Director of Fisheries

KENYA MARINE AND FISHERIES RESEARCH INSTITUTE

Telephone 020-8021560/1
020-2353904
Mobile: 0712003853
Fax: 020-2353226
Email: director@kmfri.co.ke
When replying please quote
Reference no:
and date:
calling or telephoning ask
Please address your reply to:
The DIRECTOR GENERAL



HEADQUARTERS
P.O. Box 81651
MOMBASA
KENYA

Date: 21st June 2021

KMF/RS/2021/C21.ii

To: County Director of Fisheries
Baringo

Dear Sir/Madam,

RE: SHARING 2020-21 FY FACT SHEET/BRIEF

Kenya Marine and Fisheries Research Institute (KMFRI) is a state corporate body, established in 1979 under the Science and Technology Act (Cap 250), which has since been repealed by the Science, Technology and Innovation Act No. 28 of 2013. KMFRI is under the Ministry of Agriculture Livestock and Fisheries. The institute is empowered to carry out research in marine and freshwater fisheries, aquatic biology, aquaculture, environmental chemistry, ecological, geological and hydrological studies, socio-economical as well as chemical and physical oceanography.

In this regard, KMFRI conducted a number of research expeditions in 2020-2021 financial year on **"Assessing the fluoride levels in Lake Baringo and her catchment, its ecological and human effects for informed decision"** and came up with technical report and Fact sheet/brief.

The purpose of this letter is to share the findings in a summarised fact sheet/brief as information for possible management and conservation measures of the aforementioned systems. Attached herewith please find the technical reports and Fact sheet/brief for your perusal and further action.

Yours Sincerely,

Dr. Christopher M. Aura (PhD)

For: Director General/KMFRI

COUNTY DIRECTOR
FISHERIES BARINGO

24th June 2021