DAR ES SALAAM COASTAL WATER POLLUTION AS FROM FEBRUARY TO JULY 1984

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DECLARATION

This dissertation has not been submitted for a degree in any other University.

J.N.W. BIGAMBO, M.D.

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C O N T E N T S

Page

Declaration .....(i)

Acknowledgement.....(ii)

Contents.....(iii)

Abstract..... 1

Introduction and Review of Literature 2

Objectives of the Study..... 11

Specific Objectives 11

Materials and Methods..... 12

-Map of Sample Site 13

Results..... 17

Discussion 29

Conclusion and Recommendations..... 31

References..... 33

Bibliography..... 36

Appendix..... 40-41

ABSTRACT

Twelve water samples; two from each site were taken monthly as from February to July at around hightide, along the Dar es Salaam coast for quality examination. All the three indicators used, total coliform, faecal coliform, and faecal streptococci show that there is pollution at the three sites; the Harbour, Banda Beach and Selander bridge. The pollution level is much above European Economic Community guide standard. But it is comparable to about 22% of Tanzanian inland streams.

Lead and cadmium where found to be present in concentrations much above the recommended Tanzania standards; and hence pose health risks.

More studies are recommended inorder to have a better understanding of the problem of pollution in the area; that could lead to a better approach in reducing the health risks involved.

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INTRODUCTION AND REVIEW OF LITERATURE

Water Pollution - as a Global Problem

Alteration in composition of water to the effect that it becomes less suitable for one or all of its functions for which it would be suitable in a natural state is considered as water pollution.

Almost all countries of the world have a water pollution problem and where it is serious it first become so as a result of urbanisation and industrialisation (WHO 1966). The countries with the longest experience of it are therefore those that are now industrially well developed, and it is those too that, have had the most experience in ways of overcoming the problem. The fact that some of these countries are spending hundreds of millions of dollars each year on capital work to secure pollution abatement is itself evidence that they are conscious of the harm it does.

The problem is likely to be even more severe in the developing countries; where rates of population growth are higher; where industry must not only provide for an increasing pupulation but also raise the standard of living; and where financial resources are slender and subject to what must seem at sight to be of more urgent demand.

In as early as 1960's a WHO survey had indicated that the rate of pupulation growth in 75 developing countries was 40% greater than the average for the world as a whole; which probably

means that it is a t least double that in some of the older industrialised countries. It was then estimated that water pollution problems might double or more than double every ten years for some decades (WHO 1966)

It is apparent that water pollution by human wastes must be expected to increase very much faster in the developing than in the developed countries. If the cost of remedial measures increases proportionately, the problem will shortly be of overwhelming magnitude, and advice and assistance are urgently needed so that it may be tackled effectively and economically as soon as possible (WHO 1966)

Many countries have reported natural waters becoming repulsive and stinking while fishes are destroyed and beaches once attractive becoming repellent and unhuginic (WHO 1966). A recent case is the Tel Aviv beach in the Meditterranean sea reported by Worral (1983).

Coastal Pollution sources and types

Pollution of coastal waters may be accidental and sometimes have grave consequences. In most cases it arise from various sources such as uncontrolled discharge of sewage and industrial wastes in the sea, and the discharge of sewage and from ships, the handling of cargo and the exploration and exploitation of the sea bed and ocean floor; and conveyance by air and other routes of pollutants from land. If wastes contain persistent substances, discharges into rivers even at considerable distances upstream from the mouth can result in substantial quantities reaching the sea.

The major classes of pollutant reaching coastal waters are decomposable organic materials, heavy metals, and other toxic matter, disolved and suspended non toxic inorganic substances and pathogenic organisms (IMCO/FAO/UNESCO/WMO/WHO/IAEA/UN Joint Group of Expert on Scientific aspects of Marine Pollution 1971).

Many factors such as dilution, temperatu e, adsorption sedimentation and nutrient deficiences influence self purification of the sea. The marine environment is generally unfavourable to the survival of most pathogenic organisms. However, under special circumstances, particularly in warm coastal waters near large cities pathogenic agents may be found in marine waters in proximity of the coastall line and in estuaries (Brisou 1968; Mallan 1970; Goyal Nelson 1984).

Effects of coastal water pollution on human health

(i) Microbiological

Fish do not naturally carry a wide variety of pat ogens and those that may contaminate the market products are normally derived from the environment i.e. from pollution of the water in which they live and improper handling after they are removed from

the water (Borgstrom et al 1961-65; WHO 1968)

Sewage bacteria and viruses e.g. the virus of polio, or of hepatitis A may be concentrated by shell fish, such as Oysters and clams; (Chang 1968, WHO Expert Committee on Hepatitis 1964) and fish may carry Vibrio parahaemolytic us, Salmonella species, Clostidium botulinus and other organisms (Riemann 1969).

Various species of bacteria, particulary Proteus spp., if present in scromboid fish may under conditions favourable to their growth, break down histidine like substance into saurine, a histomine like substance which has caused disease in human beings on numerous occasions (Halstead 1967). With the rapid expansion of fisheries as a means of providing a source of protein especially in tro ical developing countries, there is an increasing concern over the presence of toxin in fish. The hazards of marine biotoxins are particularly insidous because species of fish that have been eaten for many years without danger often suddenly become poisonous and harmful effects including many deaths have resulted (WHO 1972). In many cases cooking procedures do not destroy the toxin (Bagnis et al. 1970).

Chemical - heavy metals

Due to transport by the common vehicles of pullution; (air, food, and water,) chemicals including heavy metals tend to occur where they are neither made nor used. The main route of Lead and Cadmium from the sea to man is through eating fish crustanes, mollusces and other of the like.

Lead:

The major sources of intake of lead in adults who are not occupationally exposed is in food. Oysters and shellfish that man uses as food accumulate lead (WHO 1972). Such fish from marine polluted with lead would lead to lead foxicity when eaten by man.

The total burden of lead found in man appear to vary within the comparatively narrow limit of 100 - 400mg (Smith 1966).

Although symptoms of clinical lead poisoning do not appear in adult individuals at levels in the whole blood below 80mg/100g (in children levels might be lower-Bradley et al 1956), the inhibition of certain enzymes involved in the synthesis of haem can be shown to occur at lower levels starting with d- aminolaevulinic acid dehydratase (Waldron 1966). Epidemiological evidence suggests that such inhibition is demonstrable at lead levels considered to be within "normal" limits i.e. 30 - 40 ug per 100 g (Hernberg and Nikkanen 1970).

Though there has been no confirmation of causal relationship between lead absorption and mental retardation (Gordon et al 1967); acute encephalopathy in youhg children is followed by permanent neurological consequences in at least 25% of cases (Byers 1959; Chisholm and Harrison 1956).

Cadmium:

Some marine animals are reported to be capable of concentrating cadmium more than 4500 fold from water (Noddack and Noddack

1940). In non pulluted areas, shellfish have been reported to contain 0.05 mg/kg (Schroeder and Balassa 1961) where as in polluted waters values up to 470 mg/kg in livers of shellfish and cattle fish (Ishizaki et all 1970) have been confirmed.

The total burden of the average man is about 30 mg. Chronic cadmium poisoning produces proteinuria, and affects the proximal tubules of kidney, causing the formation of kidney stones (Kazantzis et al 1963).

The toxic effect on the mammalian testis have been well established since it was first observed by Parizek and Zahor (1956). A specific disease " Itai Itai" (Ouch-ouch) has been observed in Tayama City in Japan. In this disease there are painful symptoms from multiple fractures arising from oestiomalacia (Murata et al 1970). Cadmium has also been implicated in human prostate carcinoma (Kipling and Waterhouse 1967). One toxic effect of cadmium is attributed to its action on the sulfhydryl groups of essential enzymes (Granata et al 1970).

Coastal Water Pollution in Dar es Salaam

According to Madati (1981) the grossly inadequate sewerage and drainage system as well as the mushrooming industries which are located and which operate without environmental control being imposed are the main contributory factors leading to shore line pollution in Dar es Salaam.

Humphrey & Parteners (1979) had earlier noted the inadequancy of information about the composition and volume of the effluent also to be contributory. This has been exacerbated by failure to monitor shore line water quality, in spite of the fact that Dar es Salaam discharges untreated human sewage and industrial wastes to the sea. Sites used for discharge south to north: the harbour, Ocean Road outfall, Selander bridge and Msasani bay, indicated on the map in the Materials and Methods section.

The Harbour:

The harbour receives domestic and industrial wastes from Kipawa, Ukonga, Yombo, Kiwarani, Temeke, Tandika, Mtoni, Chang'ombe Mgulani, Kurasini, Keko, Shimo la Udongo, City centre, and Kigamboni. The discharges are through the sewarage system, ephemeral streams, seepages and the dumping of wastes and oils into the harbour, Sewage from the Ocean Road sewer is flushed into the harbour by each incoming tide (Humphrey & Pateners 1979). Superficial observation reveals a turbid appearance, unpleasant odours, petroleum and tar residues, filthy beach deposits and floating faecal lumps. Some of the industrial wastes reaching the harbour may contain harmful chemicals, that include heavy metals.

Ocean Road Outfall

Ocean road area recives a fairly large amount of raw sewage from the city centre, Upanga, and Kariakoo. The sewage pipe discharges from a break in the pipe onto the mud flats exposed at low tides. The effluent is mainly untreated domestic sewage which spreads onto the mud flats during low tide forming a channel to the sea, and during high tide the sewage emerge from the pipe to the sea surface and is moved according to the tidal currents and prevailing wind. Feacal lumps and floatables have been observed in concentrations long distances from the outfall at Band beach fish market in the harbour and along ocean road beach, emanating from this outfall and also from other smaller outfalls and ships (Brycesson et al 1979).

Selander Bridge - Msimbazi Creek

Msimbazi creek is heavily polluted due to inflows of effluent from Vingunguti, Buguruni, Ilala, Kariakoo, Tabata, Kigogo, Magomeni, Mabibo, Mburahati, Manzese, Mwanyanyamala and Ubungo. Most of the sewage enters the ground by pit latrines, and septic tanks, but during rainy period there is flooding and overspillage into ditches and streams which enter Msimbazi. Most industrial effluents are untreated; and reach Msimbazi through channels and streams. Effluents include dyes and strong alkalis from textile factories, oils and tar from heavy vehicle depots and power stations, organic wastes from breweries,

and meat plants and various industrial wastes such as metals, acids, pesticides, paints and chemicals from factories.

Msasani Bay:

Msasani bay receives domestic effluents through ephemeral streams, and channels from Regent Estate, Kijitonyama, Mwenge, University, Mikocheni, Lugalo, Kawe and Mbezi. Industrial effluents include organic wastes from the meat factory at Kawe which pollute the stream leading to Mbezi. During the rains these are washed down to the sea.

OBJECTIVES OF STUDY

The extent of pollution and its variation with time is not fully known for Dar es Salaam coast water. It is therefore important to determine its extent and variation for a period of six months.

SPECIFIC OBJECTIVES

(i) To determine microbiological sea water quality at Dar es Salaam using total coliform, faecal coliform and faecal streptococci as parametres.

(ii) To determine chemical sea water quality at Dar es Salaam using lead, and cadmium as parametres.

MATERIALS AND METHODS

a) Samples Sites:

Six sites were selected following the criteria of areas with either highest man water contact through swimming, fishing, collection of cockles, crabs, and flat fish, cleaning of fish, or in any other way having influence on human health. These are the harbour, Banda beach, Selander bridge, Oysterbay, Msasani and Africana, numbered on the map I, II, III, IV, V and VI respectively.

The Harbour-Site I: has a lot of repairing of fish nets, and fishing boats. Its installed seats, makes it a relaxation, or a pastime place people washing hands at sea, before eating more snacks.

Pollution source of the area effluents from domestic and industria industrial wastes. Sewage from Ocean Road sewer flushed by incoming tide.

The Banda Beach - Site II: is heavily used for swimming, catching and selling of fish, collection of cockles, crabs, and flat fish. There is intensive man-water contact.

Pollution source - is sewage from Ocean Road sewer flushed by incoming tide.

Selander bridge - Site III: This site is used for fishing and occasionally for swimming.

Pollution source - industrial and domestic waster.

Oysterbay - Site IV: is mainly used for swimming

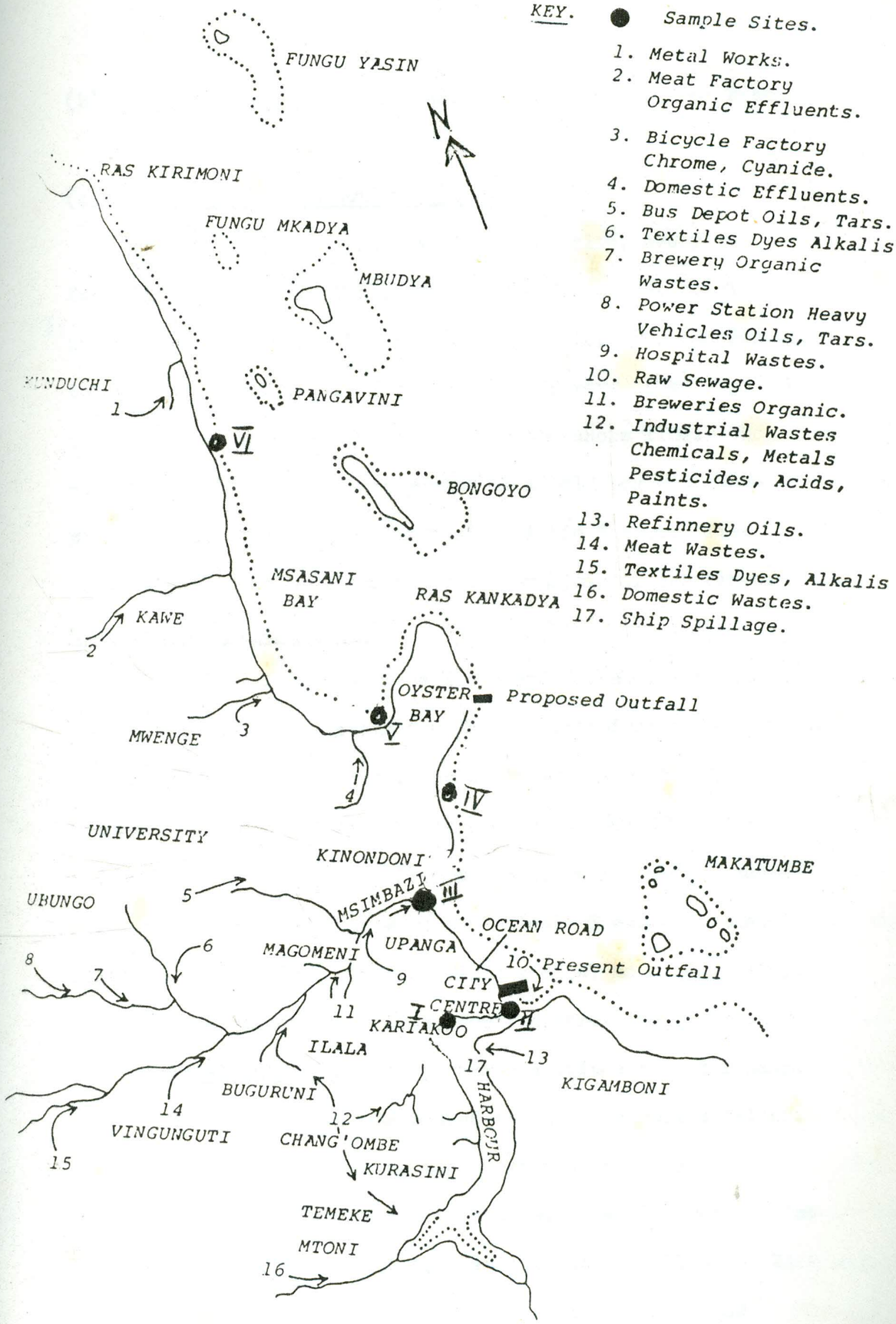
No obvious pollution source.

Msasani - Site V: mainly used for fishing

Near Pollution source - domestic effluents.

Africana - Site VI: has the least man water contact and hardly

SAMPLE SITES IN RELATION TO EFFLUENTS.



any fishing takes place there.

Pollution source - nil

(b) Period of Study: The study was carried out from February to July of 1984.

(c) Sample collection and analysis:

Two samples were collected from each site, every month from February to July 1984. One sample for microbiological analysis and the other for chemical analysis. The samples were taken during high tide. Samples of water were taken from the water surface at about 10 meters from the shore line. The collected samples were transported in a cold box with ice-packs to the laboratory and analysed within 6 hours after collection as far as microbiological analysis is concerned.

Microbiological analysis:

Faecal coliform, total coliform and faecal streptococei the recommended para-meters for faecal contamination were used.

After a pilot sampling, appropriate volumes to give colonies within the reliable range of 20 to 60; 20 to 80; and 20 to 100 for feacal coliform, total coliform and feacal streptococci respectively were estimated. These were then filtered on cellulose membrane filters of 47 mm diameter; 0.45 micrometer pores for each site, for the three indicators.

i Total coliform: An appropriate volume of water sample or its dilution was passed through a membrane filter. The filter retaining the microorganisms was placed on an absorbent pad saturated with M-Endo broth (Difco 0749) in a petri dish, then incubated at 35°C for 24 hours. Metallic sheen colonies were counted and reported per 100 mls of original sample.

ii Faecal coliform: The filter retaining the microorganisms was placed on absorbent pad saturated with M-FC broth (Difco-883) in a petri dish. The dish was incubated at 44.5°C for 24 hours. After incubation, the typical blue colonies were counted under low magnification and the number of faecal coliforms reported per 100 mls of original sample.

iii. Faecal streptococci: The filter retaining the micro-organisms was placed on KF streptococcus agar (Difco 0496) and incubated 35°C for 48 hours. Red and pink colonies were counted as streptococcus; and reported per 100 mls of original sample (EPA 1978).

2. Chemical analysis:

Lead and cadmium are metals that are found in some of the effluents discharging to the sea. At certain levels of concentration they are known to be toxic to man, and hence the need to know their present concentration.

Samples for chemical analysis were acidified with 3 mls of concentrated nitric acid to every 100 mls sample water; Then stored in refrigerator at about 4°C until time of chemical analysis.

Direct aspiration atomic absorption spectroscopy was used for lead and cadmium. The sample was aspirated and atomised in a flame. Light bean from a hollow cathode lamp whose cathode is made of one element to be determined was directed through the flame into monochromitor and on to a detector that measures the intensity of light passing through the sample. The wave length of the light beam characterised only by the metal being illuminated, the light energy absorbed

by the flame being a measure of the concentration of that metal in the sample. This reported in mg/L after conversion by a standard calibrated curve (EPA 1979). The curves are reproduced in ap endix IV for lead and Appendix V for cadmium.

Precision and Repeatability:

The lamp current was kept within the advised range of best results of 3-4 m A and at the principal wovelength and not attenative. The standard solutions of respective elements were prepared as outlined in Atomic Absorption data book by Pye Unican for SP 9 AAS.

For every set of tests of a particular day of using one instrument a new calibration curve was drawn.

All the calibrations were repeated after the test, and repeatability was high for mslame a standard solution of bad containing 2 and 6 ug/ml gave absorbance of 0.011 and 0.033 respectively. After the test they gave 0.010 and 0.029 respectively.

Results:

Results of tests for total coliforms, faecal streptococci and faecal coliforms are summarised in tables I, II, and III respectively. Figures No. I and No. 2 give a graphical presentation of faecal coliform.

Lead and cadmium results are in tables, IV and V respectively. Figures 3 and 4 present variation of lead in graphical form while figures 5 and 6 present that of cadmium.

Table I: Total Coliforms Variation with time and site

(count/100ml sea water)

Site / Date	I	II	III	1V	V	V1
06.02.84	108,000 (0.1)	61,000 (0.1)	900 (0.5)	20 (10)	1000(0.1)	< 100(1.0)
07.03.84	800,000 (0.1)	7,200(0.5)	3,100(1.0)	<100(100)	< 100 (5.0)	< 100(50)
09.04.84	+	+	+	+	+	+
08.05.84	10,000(0.01)	1,000(1.0)	10,000(1.0)	<100(50)	< 100 (1.0)	< 100(50)
07.06.84	6,500(1.0)	20,000(0.1)	24,000(0.1)	400(5.0)	400(5.0)	< 40(50)
04.07.84	3,000(1.0)	1,200(0.1)	100(0.1)	100(50)	< 10(20)	< 10(50)

( ) Vol. of sea water filtered in ml

EEC standards(Guide) is 500 colonies/100 mls.

(appendix II)

Variation by site significant $P < 0.05$

$X^2 = 29.3$

Variation with time not signficant $P > 0.05$

$X^2 = 1.3$

+ samples were all contaminated

Table II : Faecal Streptococci Variation with time and site

(count/100 ml sea water)

	I	II	III	IV	V	VI
06.02.84	200(0.5)	2400(2.0)	2100(1.0)	950(10.0)	1000(0.1)	23(50)
07.03.84	4100(1.0)	1100(2.0)	6000(1.0)	60(10.0)	100(5.0)	11(50)
09.04.84	11000(0.1)	320(5.0)	8000(1.0)	510(10.0)	3100(1.0)	12(100)
08.05.84	2000(0.5)	830(10.0)	7200(0.5)	10(50.0)	400(1.0)	120(10.0)
07.06.84	7500(1.0)	80(10.0)	1500(5.0)	100(10.0)	1000(5.0)	80(10.0)
04.07.84	2000(1.0)	1000(10.0)	1000(5.0)	200(10.0)	100(5.0)	60(10.0)

(-) Volume of sea water filtered

EEC Standards (guide) 100 colomes/100 mls

Variation by Site Significant P $<$ 0.05

$x^2 = 15.6$

Variation with time not Significant P $>$ 0.05

$x^2 = 1.3$

Table III: Faecal Coliform Variation with Time and Site

(count/100ml sea water)

Site / Date	I	II	III	1V	V	V1
06.02.84	1,200(0.5)	3,000(2.0)	1,200(1.0)	<10 (100)	100 (1.0)	4(50)
07.03.84	24,000(1.0)	7,800(0.5)	600(1.0)	8 (100)	7 (5.0)	0(100)
09.04.84	100,000(0.1)	1,000(1.0)	80000(0.1)	2 (100)	100 (1.0)	0(100)
08.05.84	24,000(0.1)	5,100(1.0)	36000(0.1)	57 (100)	100 (1.0)	0(50)
07.06.84	12,000(0.5)	1,080(5.0)	22000(0.1)	120 (100)	2000(5.0)	<20(100)
04.07.84	500(0.1)	400(5.6)	70(5.0)	40 (100)	20(10,0)	00(100)

( ) volume of sea water filtered ml

EEC standards(guide) 100 colonies/100ml

variation by site significant $p < 0.05$

$X^2 = 29.3$

variation with time not significant

$p > 0\text{-}02$

$X^2 = 1.3$

Fig. 1: FAECAL COLIFORM VARIATION WITH TIME

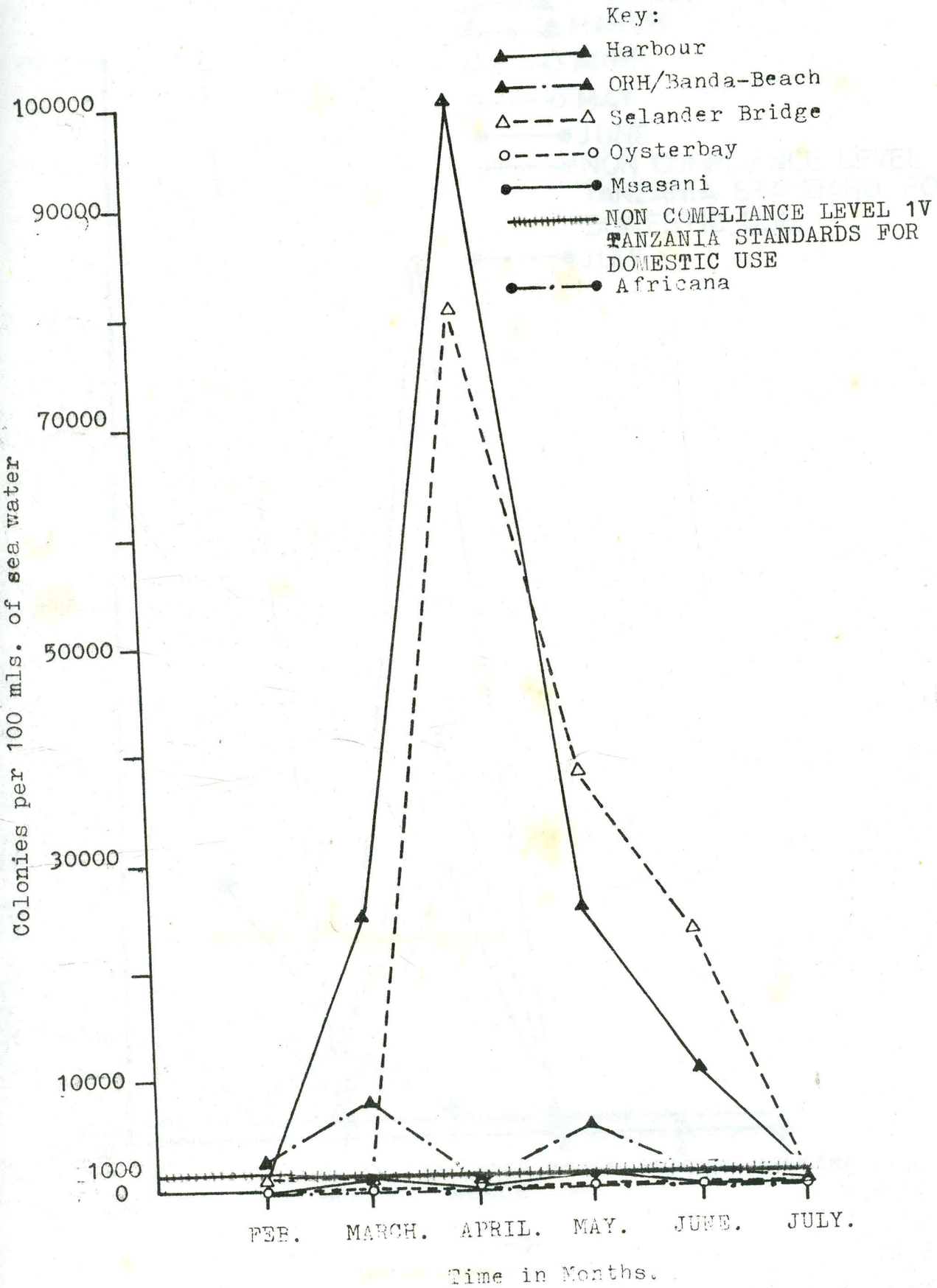


Fig: 2: FAECAL COLIFORM VARIATION BY THE SITE

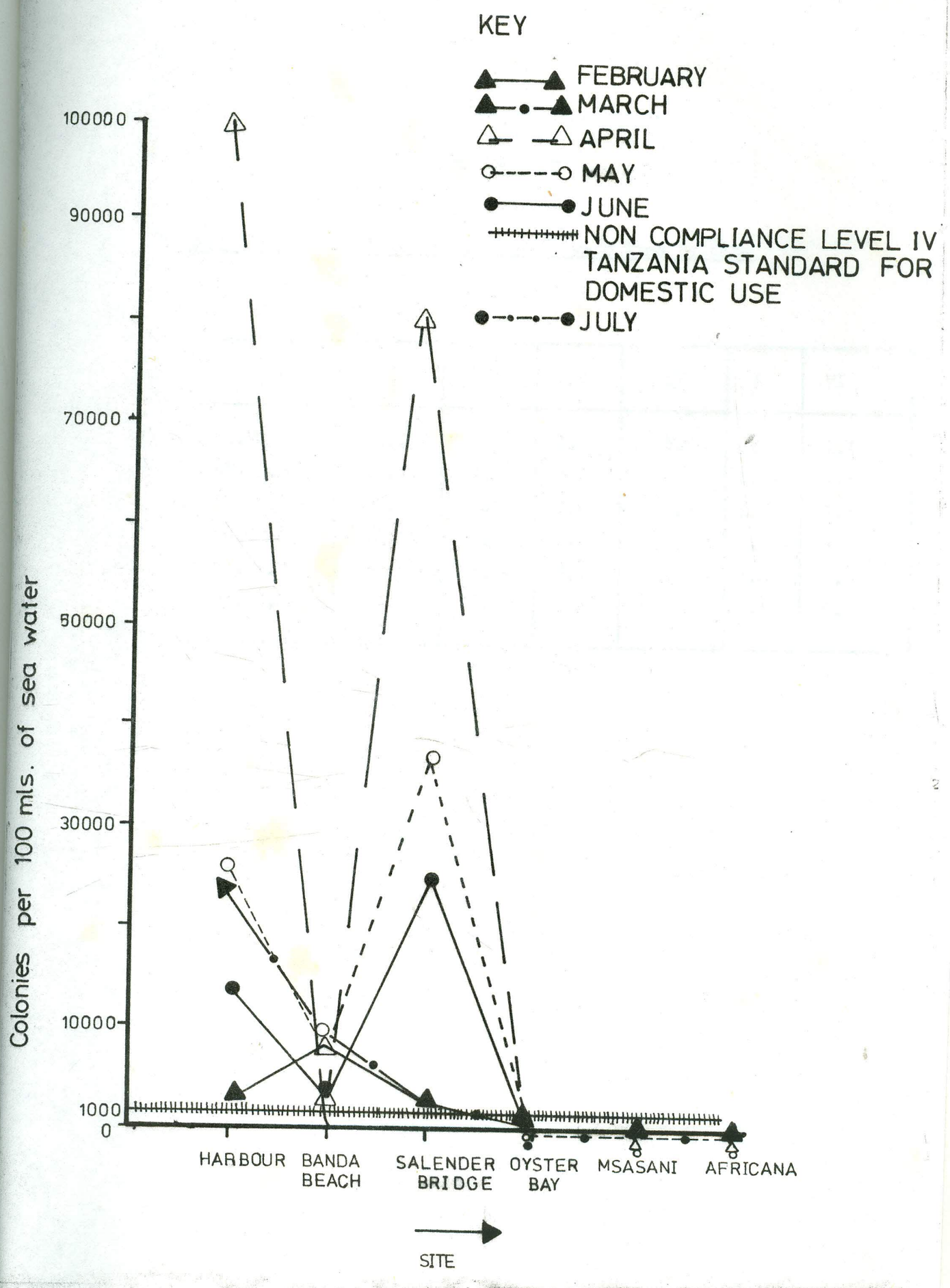


Table IV : Lead conc. in mg/l with Time by Site

	I	II	III	IV	V	VI
06.02.84	1.4	1.4	1.8	0.8	1.0	1.4
07.03.84	1.4	1.2	1.0	0.8	1.2	1.6
09.04.84	1.2	1.4	1.0	1.2	1.4	1.6
06.05.84	1.4	1.6	1.6	1.8	1.9	1.9
07.06.84	0.6	1.2	0.4	1.6	1.8	1.8
04,07,84	0.5	0.5	0.5	0.8	0.6	0.5

Fig.3: VARIATION OF LEAD CONC. IN mg/l WITH TIME (3 SITES SOUTH).

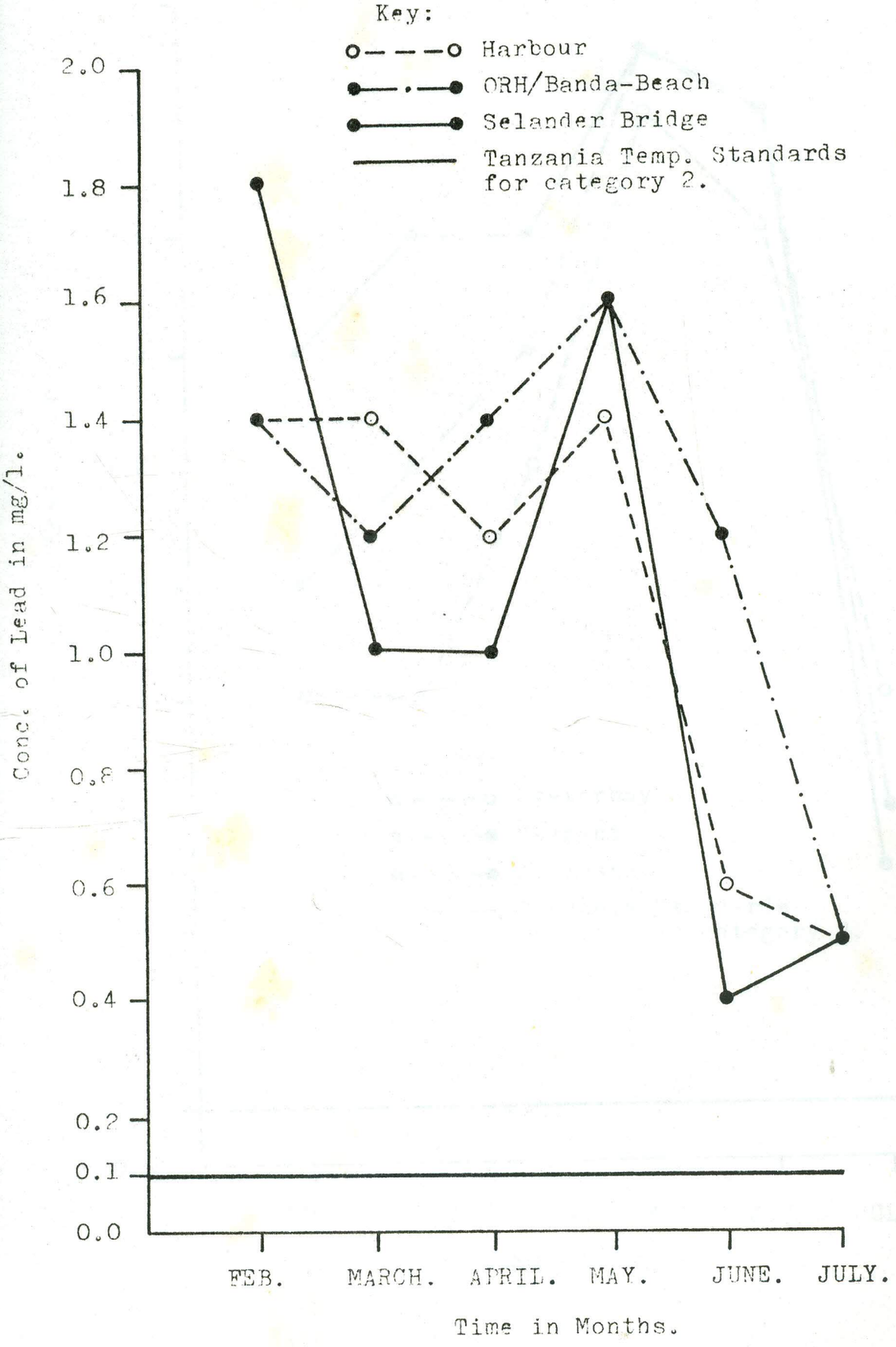


Fig. 4: VARIATION OF LEAD CONC. WITH TIME (MONTHS) IN mg/l (FOR 3 SITES NORTH)

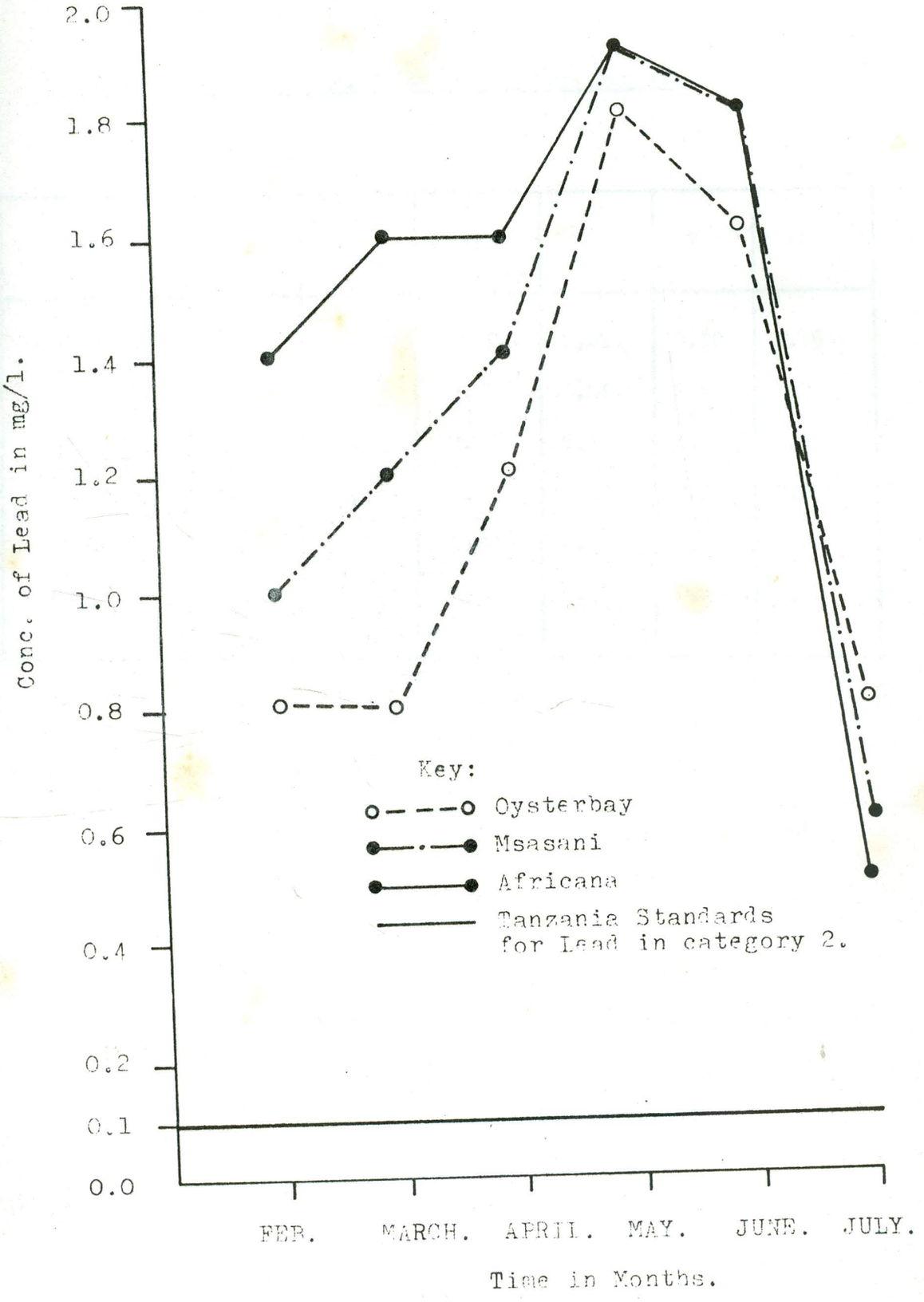


Table V: Cadmium conc. in mg/L with time per site

	I	II	III	IV	V	VI
06.02.84	0.21	0.19	0.20	0.21	0.20	0.19
07.03.84	0.19	0.18	0.20	0.21	0.26	0.25
09.04.84	0.31	0.30	0.24	0.33	0.29	0.33
06.05.84	0.22	0.15	0.24	0.28	0.29	0.29
07.06.84	0.11	0.16	0.09	0.29	0.26	0.26
04.07.84	0.18	0.19	0.16	0.19	0.18	0.21

Fig.5: VARIATION OF CADMIUM WITH TIME (MONTHS) IN mg/l FOR 3 SITE SOUTH.

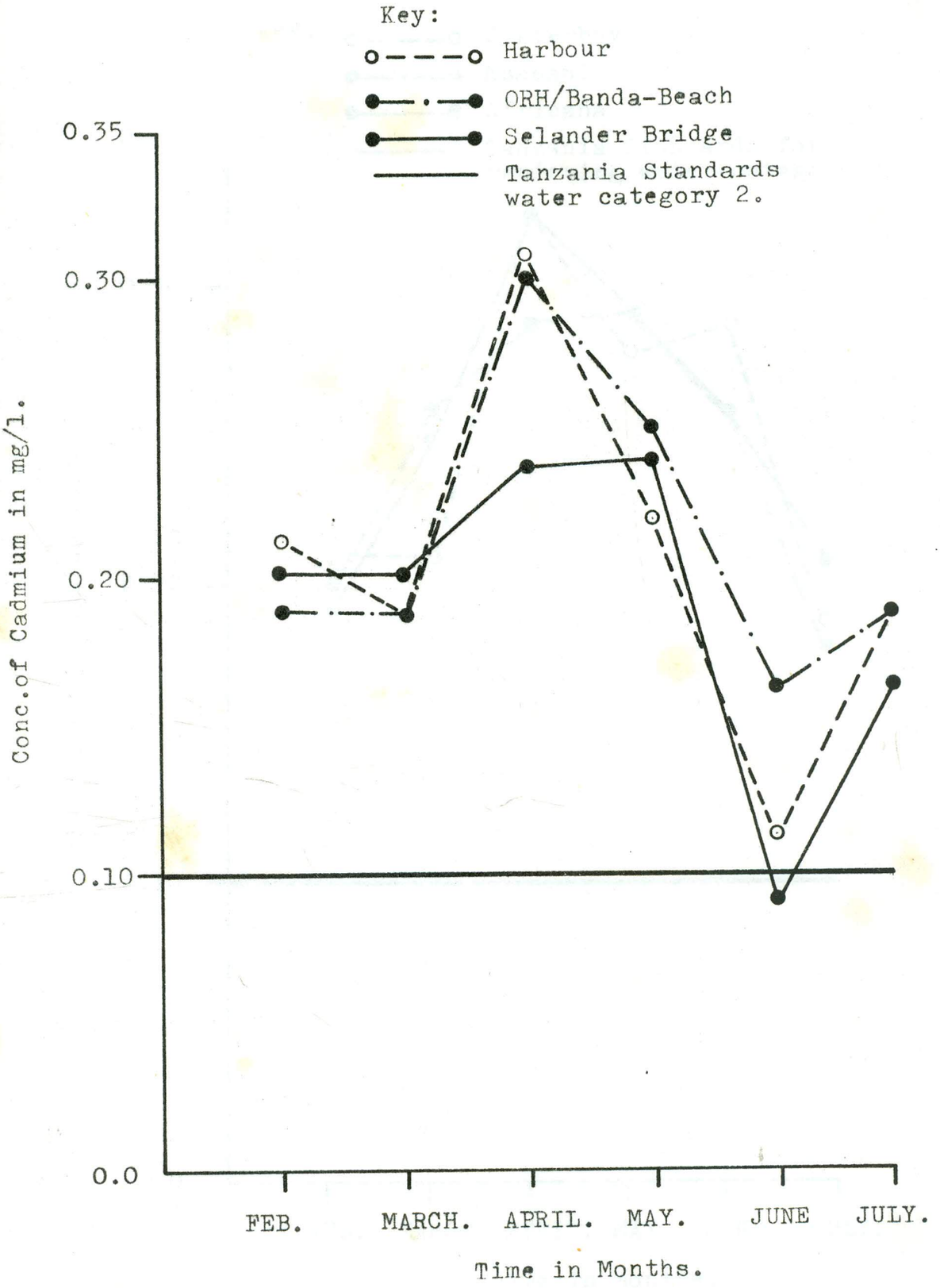
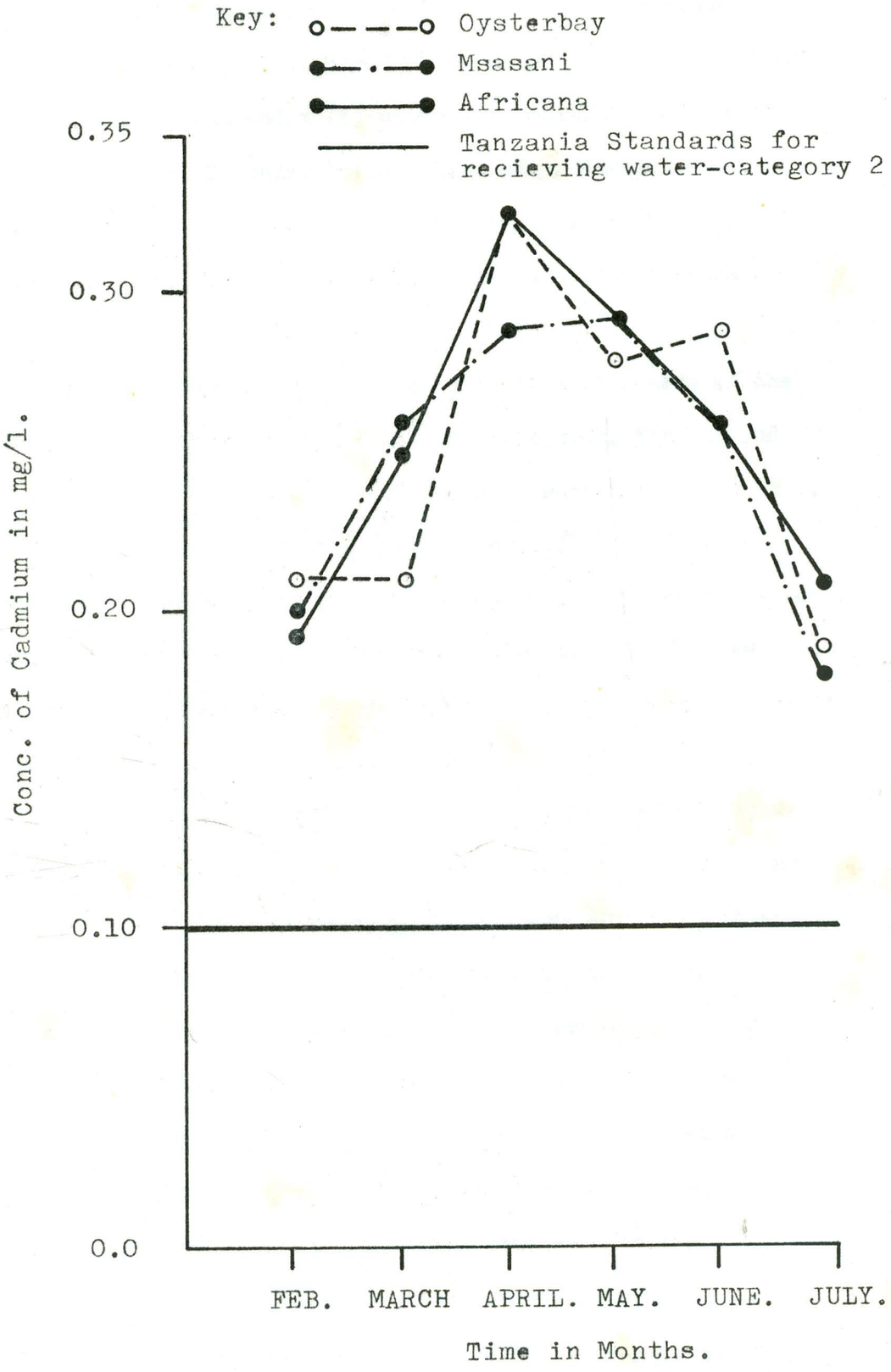


Fig. 6: VARIATION OF CADMIUM IN mg/l WITH TIME (IN MONTHS) (FOR 3 SITES NORTH).



Discussion

Total coliforms show that only in February the harbour was above expected safe level with reference to the mandatory European Economic Community (Appendix II) water requirements for bathing water. Banda beach, Selander bridge, Oysterbay, Msasani and Africana were safe for Swimming. With reference to the quide line standards only Oysterbay, Msasani and Africana did not reach this level.

According to faecal streptococci guideline standards of the same community (100 colonies/100 ml) only Africana, Msasani and Africana did not reach this level. The rest were much above this.

Faecal coliform standards (100 colonies/100 mls) again for the above community was not reached by Oysterbay, and Africana throughout the study period. The other sites ranged from 8 to 10 times above this standard. Selander bridge was one worst especially in the months of March, April, May and June the rainy period. The mandatory standard for this indicator (2,000 colonies/100 ml) was not reached by Oysterbay, Msasani and Africana. The rest of the sites were much above this reaching up to about 40 times; this standard especially in the months of April, May and June.

Comparing these results with inland surface water gives interesting results. In for instance using faecal coliform indicator; according to Brokonsult (1979) results a level of 1000 faecal coliform per 100 mls is reached by about 22% of the inland streams. None of the spring reaches such a pollution level, such kinds of pullution involves health risks.

In for instance, fish harvested or washed in any of the three sites, The harbour, Banda beach and Selander bridge are more likely to be contaminated especially in the months of March, April, May and June.

Washing of hands using sea water as practiced at the Harbour, and Banda beach is another route of disease transmission. This in the line with the findings by Mahalu et al (1982) that poor personal hygiene at the beach through contaminated hands - (sea water as source) had lead to transmission of disease.

While faecal coliform indicate recent faecal pollution, - thus correlating with enteric bacteria; faecal streptococci with viruses. Shuval H.I. (1983) which have a higher survival rate. As two indicators showed polluted levels it then follows that the health risks are ranging from ascaris as found in Samoa beach (Muller 1975); bacteria likes Salmonella, Cholera to virus like Polio, Hepatitis A, and Echovirus. All the six sites throughout the study period showed levels of lead to be above the recommended standard for receiving waters in Tanzania of 0.1 mg/L (MOH 1977). Table IV and figures 3 and 4 show this clearly.

For all the sites, levels of cadmium were very much above the recommended Tanzania standards for receiving waters of 0.1 mg/L (MOH 1977). This is demonstrated in table V and figures 5 and 6.

It then follows that these two metals are present in the coast sea water of Dar es Salaam and are well above the recommended standards and hence increasing the chances of finding higher values in fish, originating from these water and hence acting as potential health hazards. The fact that the earlier symptoms of poisoning by such toxic metals are non specific, the chronicity of the development of the toxicity and the unavailability of antidote warrants all the precautions of remaining within the recommended standards.

Conclusion

1. Microbiological pollution

All the three indicators give evidence of pollution for the three sites; the Harbour, Band Beach and Selander Bridge; while Oysterbay, Msasani and near Africana were non polluted This was throughout the study period of six months. This variation by site was statistically signficant $P < 0.05$.

2. Chemical pollution

Lead and cadmium are found in Dar es Salaam coast sea water and in concentration above the proposed Tanzania standards (Appendix III). It then follows that fish originating from this water like Shellfish, Cuttle fish, and other marine animals are likely to pose health risks when eaten by man and by other animals.

Recommendations:

1. Similar studies covering all seasons, taking more samples per site each time of sampling and from the three levels of sediment, column and surface are recommended as a better approach for a better picture.
2. Analysis of fish, crustacea, and molluscs for bacterial contamination and content of lead and cadmium is recommended.
3. Epidemiological studies in for example fishermen, regular swimmers for signs any symptoms of the likely diseases like hepatitis, diarrhoea, lead and cadmium toxicity are recommended.
4. Monitoring of effluents to ensure that appropriate standards are kept is recommended.
5. The public should at least be informed of the pollution level of the sites and times; and the health risks involved.

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