PESTICIDES AND PHOSPHORUS DYNAMICS IN LAKE VICTORIA BASIN

By

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DECLARATION

This is my original work and has never been submitted for award of a degree in any University.

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This thesis has been submitted for examination with our approval as the University supervisors.

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DEDICATION

This thesis is dedicated to my mother Christine A. Madadi, my sisters and brothers for their support and prayers throughout my research work, and to my Lord and Saviour Jesus Christ for moral and spiritual support.

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ABSTRACT

1890 field samples comprising of 630 sediments, 630 soils and 630 water samples were collected quarterly over a period of 21 months covering the wet, dry and short rain seasons experienced in Lake Victoria Basin. Sampling sites covered lakeshores, river mouths and effluent discharge points. Physico-chemical parameters, total reactive phosphorus, total hydrolysable phosphorus, total phosphorus and pesticides residues were analysed in water, sediment exchangeable phosphorus and sediment bio-available phosphorus were analysed in sediments, whereas available phosphorus was measured in soil. Pesticides residues were analysed in all the three matrices.

Most of the water samples from both the rivers and the lake were found to contain phosphorus levels higher than the recommended guidelines for aquatic life indicating the influence of anthropogenic sources, whereas soils contained 10 to 100 times higher concentrations than sediments and water. The total phosphorus in water samples had mean concentrations of 4.61, 3.43, 2.45 and 2.30 mg/l for wet, short rain and dry seasons 1 and 2, respectively, whereas the total reactive phosphorus had mean concentrations of 2.22, 2.08, 1.12 and 1.61 mg/l for the same seasons.

Sediment bio-available phosphorus was higher than exchangeable phosphorus, with the highest mean concentrations of 24.45 and 8.22 mg/kg obtained during the dry season and wet season, respectively. The mean concentrations of soil available phosphorus ranged between

639 and 1,076 mg/kg. The high levels of phosphorus measured in sediments signified accumulation of phosphorus over time. Therefore, through exchange processes, the trapped phosphorus could continue to replenish the fraction in the water column over a longer period.

The concentration of pesticide residues varied from one season to the other in all the matrices analysed. Sediments contained the highest levels followed by soil and water. However, there was no clear temporal trend in terms of reduction of pesticide levels in the samples. This was attributed to the diffused nature of the source of pesticides in the catchment. The most dominant pesticides in the lake basin were *p,p'*-DDT, endrinaldehyde, β-HCH, dieldrin, methoxychlor, heptachlor, δ-HCH, γ-HCH and endrin.

Studies of pesticides fate in the catchment revealed a strong influence of soil organic carbon and other physico-chemical properties such as texture, pH and minerals composition, whereas calculation of phosphorus loading revealed that the contribution of phosphorus from the drainage basin into Lake Victoria is higher than the figures reported in the previous studies.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

°C:	Degrees Centigrade
BOD:	Biological Oxygen Demand
CBOs:	Community Based Organizations
CIFA:	Committee for Inland Fisheries of Africa
COWI:	Consultancy within Engineering, Environmental Science and Economics
DAAD:	German Academic Exchange Service
DDD:	Dichlorodiphenyldichloroethene
DDE:	Dichlorodiphenyldichloroethane
DDT:	Dichlorodiphenyltrichloroethane
EAC:	East Africa Community
EAFRO:	East Africa Fisheries Research Organization
ECOVIC:	East African Communities for the Management of Lake Victoria's Resources
EP:	Exchangeable phosphates
EPC	Equilibrium phosphate Concentration
FAO:	Food and Agriculture Organization
FOCUS:	FOrum for the Co-ordination of pesticide fate models and their Use.
GAPS:	Global Atmospheric Passive Sampling
GC-ECD:	Gas Chromatography equipped with Electron Capture Detector
GC-MS:	Gas Chromatography-Mass Spectrometer
GDP:	Gross Domestic Product

GEF: Global Environment Facility

GoK: Government of Kenya

GPS: Global Positioning System

HPLC: High Performance Liquid Chromatography

IDA: International Development Association

IFS: International Foundation for Science

IT: Information Technology

IUPAC: International Union of Pure and Applied Chemistry

KBS: Kenya Bureau of Standards

K_d: Adsorption Coefficient

KEMFRI: Kenya Marine and Fisheries Research Institute

KWASCO: Kisumu Water and Sewerage Company

KWS: Kenya Wildlife Service

LAVLAC: Lake Victoria Regional Local Authority Cooperation

LVDP: Lake Victoria Development Program

LVEMP: Lake Victoria Environment Management Programme

LVFO: Lake Victoria Fisheries Organization

LVFRP: Lake Victoria Fisheries Research Programme

LVFS: Lake Victoria Fisheries Services

MEMR: Ministry of Environment and Mineral Resources

MONET AFRICA: Monitoring Network of Africa

NELSAP: Nile Equatorial Lakes Subsidiary Projects

NEMA: National Environment Management Authority

NGO: Non Governmental Organization

NRBP: Nairobi River Basin Project

OCPs: Organochlorine Pesticides

OPs: Organophosphorus Pesticides

P: Phosphorus

PAHs: Poly-aromatic hydrocarbons

PCB: Polychlorinated Biphenyl

pH: Power of Hydrogen

QC: Quality Control

RECETOX: Research Center of Environmental Toxicology and Chemistry

SAP : Soil Available phosphates

SBP: Sediment Bio-available Phosphates

SPSS: Statistical Package for Social Scientists

START: SysTem for Analysis Research and Training

t-BOD: Ton Biological Oxygen Demand

THP: Total Hydrolysable phosphorus

TP: Total Phosphorus

TRP: Total Reactive Phosphorus

UNEP: United Nations Environment Programme

UON: University of Nairobi

USA: United States of America

USEPA: United State Environment Protection Authority

UV: Ultraviolet

WARMA: Water Resources Management Authority

WHO: World Health Organization

UNITS OF MEASUREMENT

μg: Microgram

μL: Micro liter

cm: Centimeter

g: Gram

kg: Kilogram

L: Litre

m: Metre

mg: Miligram

ml: Milliter

ng: Nanogram

nm: Nanometer

ppb: Parts per billion

ppm: Parts per million

rpm: Revolutions per minute

CHEMICAL ACRONYMS

α-HCH: alpha hexachlorocyclohexane

β-HCH: beta hexachlorocyclohexane

γ-HCH: 1,2,3,4,5,6-hexachlorocyclohexane

δ-HCH: delta hexachlorocyclohexane

Aldrin : (1R,4S,4aS,5S,8R,8aR)-1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-dimethanonaphthalene

BHC : Benzene Hexachloride

DDD : 1-chloro-4-[2,2-dichloro-1-(4-chlorophenyl)ethyl]benzene

DDE : 1,1-Dichloro-2,2-bis(4-chlorpohenyl)ethane

DDT : 1,1,1-Trichloro-2,2-bis(4-chlorophenyl)ethane

Dieldrin: (1R,4S,4aS,5R,6R,7S,8S,8aR)-1,2,3,4,10,10-Hexachloro-1,4,4a,5,6,7,8,8aoctahydro- 6,7-epoxy-1,4:5,8-dimethanonaphthalene

Endosulphan: 6,7,8,9,10,10-Hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-bezodioxathiepin3-oxide

Endrin: (1R,4S,4aS,5S,6S,7R,8R,8aR)-1,2,3,4,10,10-Hexachloro-1,4,4a,5,6,7,8,8aoctahydro-6,7-epoxy-1,4:5,8-dimethanonaphthalene

Endrin aldehyde: 2,2A,3,3,4,7-Hexachlorodecahydro-1,2,4-metheno-Cyclopenta (c,d)pentalene-5-caboxaldehyde

HCl : Hydrochloric acid

Heptachlor: 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-4,7-methanoindene

Heptachlor epoxide: 1,4,5,6,7,8,8-heptachloro-2,3-epoxy-3a,4,7,7a-tetrahydro-4,7-methanoindan

Methoxychlor: 2,2-bis(p-methoxyphenyl)-1,1,1-trichloroethane

$MgCl_2$: Magnesium Chloride

Al_2O_3: Aluminium Oxide

SiO_2: Silica Oxide

NaOH: Sodium hydroxide

NH_4F: Ammonium flouride

Na_2SO_4: Sodium Sulphate

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the study

The agricultural sector is the backbone of Kenya's economy and contributes approximately 24 percent of GDP and about 19 percent of the formal wage employment [KIPPRA, 2009]. About 60 percent of all households are engaged in farming activities, whereas 84 percent of rural households keep livestock. Through linkages with agro-based sectors and associated industries, the sector also indirectly contributes a further 27 percent to Kenya's GDP. It is estimated that approximately 8% of the country's arable land is under permanent crops. This constitutes only 0.97% of the total national land area.

Agricultural production areas in the country are divided into seven distinct ecological zones: The Tropical Alpine, Upper Highland, Lower Highland, Upper Midland, Lower Midland, Low Land and Coastal Lowlands. Based on rainfall pattern, the country is divided into three main production zones. The first is the high rainfall zone which receives over 1000 mm of rainfall annually and occupies less than 20% of the productive agricultural land. It is mainly used for production of cash and food crops such as tea, coffee, pyrethrum, potatoes and vegetables, under semi-intensive and intensive systems. The second is the medium rainfall zone which receives between 750-1000 mm of rainfall annually, and occupies between 30-35% of the total country's land area [GoK, 2009b]. This zone is characterised by drought resistant crops, trees and shrubs and is a home for 30% of the national population. The third zone is the low rainfall zone which receives between 200-750 mm annually and supports 20% of the national population [GoK, 2010]. In general, most of the country's agricultural goods are produced by small scale private farms that export only a few commodities such as tea, coffee, cut flowers, sugar, corn, beef and cotton. In addition, the sector also provides the raw materials for emerging agro-based industries in the country [GoK, 2010].

The country depends on the use of fertilizers and pesticides for economic management of crops and livestock (Annext Tables 1.1A-1.2A, and Annex Table 2.1A). However, for the last two decades, unsustainable agricultural practices have contributed to widespread environmental degradation, which has been identified as an underlying cause of food insecurity in most agriculture based livelihoods in the country [GoK, 2009a]. Such practices have also contributed to influx of nutrients and agrochemicals such as pesticides into the Kenyan lakes and rivers. By and large, poor management of socio-economic activities coupled with weak regulatory frameworks have subjected the country to serious environmental challenges that include deforestation, soil erosion, desertification, loss of biodiversity, water scarcity and degraded water quality, poaching and domestic and industrial pollution. The analysis of various natural resources including land, water, wildlife, forestry, fisheries, biodiversity and climate change reveal different challenges that require immediate technical and legislative attention to ensure the country's sustainable socio-economic development [KIPPRA, 2009]. This study was set to establish the magnitude and extent of human activities on the temporal and spatial dynamics of organochlorine pesticides and phosphorus in the Lake

Victoria basin. The data generated will support formulation of appropriate policy for proper management of the lake water resources.

1.2 Historical background of Lake Victoria

Lake Victoria was formed during the mid Pleistocene concomitant with the rifting and back-tilting of the exterior flanks of the rift wall that progressively decreased the steepness of the long profiles of the westward bound streams creating swamps that finally overflowed to form Lakes [Ouma, 1970]. It was discovered in 1758 by the explorer John Speke who renamed it in honour of the reigning British Queen. At that time, the lake water was clear and surrounded by extensive fringing wetlands and tropical savannah. With the construction of a railway line from Mombasa to Kisumu between 1895 and 1903, the areas close to the railway were settled by the Europeans, who replaced natural vegetation by croplands. Wheat, maize, tobacco, coffee and tea were extensively planted on the highlands, while the wetlands were cleared for sugarcane, rice and cotton plantations in the lowlands near the lake. Urban centres developed gradually on the lakeshore as population increased, building pressure on the lake. The increased human population coupled with the agricultural and industrial activities have altered the ecology of the lake. Currently the lake is confronted with environmental degradation threatening ecosystem health and biodiversity.

1.3 Hydrology and Morphometry of Lake Victoria

Lake Victoria is the largest fresh water lake in Africa and the second largest in the world with a surface are of 69,000 km^2 [LVBC, 2011]. It is situated at an elevation of 1134 meters above sea level, and between latitudes 0°21'N and 3°00'S, and longitudes 31°39'-34°53'E. It has a total volume of 2,760 km^3 and a catchment area of 251,000 km^2 [UNEP/PASS, 2006], which is distributed among the East African countries, with 44% in Tanzania, 22% in Kenya, 16% in Uganda, 11% in Rwanda and 7% in Burundi [Matsuishi *et al.*, 2006].

The lake mean depth is 40 m, whereas the maximum depth is 84 m. It has a maximum width of 240 km and length of 400 km. The lake shoreline is highly indented, and stretches up to 3,450 km of which the Kenyan side is 550 km. The water retention time is 123 years whereas the residence time is 23 years. The documented rate of inflow from the rivers is 596 m^3/s, whereas the rate of outflow is 23.4 km^3/year through the White Nile [MacDonald and Associates, 2001].

The western catchments of Lake Victoria covering Uganda, Rwanda and Burundi have a gentler slope compared to the Eastern catchments in Kenya. As a consequence, water resources development in the eastern catchment face more difficulties compared to the western catchments. Earlier studies have reported that compared to the immense hydroelectric power potential of the outflow of the Nile at Jinja, the Kenya's steep and perennial rivers have more potential for hydroelectric power plants in the lake basin [Ouma, 1970]. In addition, a well planned and rational flood control can strongly enhance gravity fed irrigation projects.

1.4 Significance of Lake Victoria

Lake Victoria supports over 38 million people, constituting approximately 4% of the population of the African continent, that live in the lake basin and directly or indirectly depend on the lake's resources. The lake also contributes significantly towards ecological and biophysical processes in the sub-region, and to cultural and socio-economic development of the riparian communities. In general, Lake Victoria is a source of food, transport, industrial and domestic water, recreation, biodiversity conservation and recipient of wastes [Cowx *et al.*, 2003].

1.5 Lake Victoria Resources

The main resources of Lake Victoria ecosystem include: water, algae, phytoplankton, invertebrates, wetlands and fish. Due to these resources, the lake basin has high potential for investment in fisheries and tourism, transport and communication, water and energy, agriculture, trade and industry [Albinus *et al.*, 2008]. However, despite the fact that the lake was originally self purifying, the resources are currently under pressure due to over extraction and unsustainable human activities in the catchment.

1.5.1 Water resources

Water is the most important resource for Lake Victoria ecosystems and supports all the other five resources. Approximately 80% of the lake water is from direct rainfall [LVEMP, 2003].

The remaining 20 % is drawn from the catchment rivers, the major ones being: Kagera, Mara, Simiyu, Gurumeti, Yala, Nyando, Migori, and Sondu-Miriu rivers. Losses due to evaporation account for 76 % of the water leaving the lake [Okonga, 2001; COWI, 2002], while losses through River Nile account for 24%, leaving a positive inflow of 33 m^3s^{-1}.

Lake Victoria water resources are shared by three East African countries with Tanzania occupying 51%; Uganda, 43%; and Kenya, 6% [Balirwa *et al.*, 2003]. The lake water is essential for life, food production, economic development and the general well being of the riparian communities. It is also used for irrigation, industrial activities, drinking and domestic purposes, hydroelectric power generation, navigation, forestry, fisheries, recreational purposes and livestock production. In addition, Lake Victoria also plays important socio-economic and cultural roles to the riparian states.

Lack of proper governance of the exploitation and utilization of the lake water resources is one of the main impediments to proper management of the lake resources. This is partly due to the fact that majority of the agreements in place are over a century old and mainly dwell on ensuring the lowest riparian states get sufficient water throughout the year, but do not address sharing the benefits accrued from water use with the upper and remote riparian states that are bound not to obstruct or delay the water flow [Luilo and Kishe, 2005]. Considering the fact that the population in Lake Victoria catchments has grown drastically in the last 50 years to over 38 million, proper management of the lake water resources is urgent and requires national and international commitment, planning and operational systems addressing water allocation priorities covering drinking water, irrigation, hydropower, agricultural and nonagricultural industries, navigation and ecology as well as sharing the resources accrued.

1.5.2 Algae resources

Algae encompass any aquatic organisms capable of photosynthesis. They range from single-cell organisms to multicellular organisms, some with fairly complex forms such as the seaweeds. All algae lack leaves, roots, flowers, seeds and other organ structures that characterize higher land based plants. In general, the main forms of algae include green algae, red algae, blue green algae, yellow green algae, brown algae and sea vegetables [Bellinger and Sigee, 2010; Kato *et al.*, 2009].

Algal proliferation in the shores of Lake Victoria has increased in the recent years resulting in the deterioration of water quality and potable water production. Blooms have frequently interfered with abstraction of water from the lake resulting in the breakdown of water treatment processes. The riparian communities face challenges from algal blooms effecting their livestock and fishing activities. Other problems associated with the blooms include fouling, anoxia and algal toxins causing fish kills and contaminating the food web [Sitoki *et al.*, 2005].

A study conducted from 1994 – 2004 reported predominance of the blue-greens algae by over 50% of the algal composition, particularly in the inshore areas. The most common species of blue-green algae found in Lake Victoria included *Microcystis aeruginosa, Anabaena flos-aquae, A. sporoides, Planktolyngbya* sp., *Cylindrospemopsis africana,* and *Merismopediatenuissima,* all of which form blooms and produce toxins [Sitoki *et al.*, 2005].

1.5.3 Phytoplankton resources

Phytoplanktons are microscopic plants that live in the ocean, freshwater and other terrestrial based water systems. They are the main primary producers and form a vital basis for higher production. There are many species of phytoplankton, each of which has a characteristic shape, size and function. Documented phytoplanktons in Lake Victoria include: *Microcystis aeuginosa, Lyngbya limetica, Anaebena circinalis, Spirulina, Merismopedia, Chlorophyta (Green algae), Scenedesmus sp, Staurastrum sp, Ankistrodesmus falcatus, Coelastrum sp, Pediastrum sp, Bacillariophyta (*Diatoms*), Nitzchia sp, Navicula sp, Synedra sp, Melosira sp, Phyrophyta (Dinoflagellates),* and *Ceratium sp. Microcystis aeuginosa* is the most dominant species in Winam Gulf, whereas *Lyngbya limetica and Anaebena circinalis* are also common species in the Gulf. In the open lake, *Nitzchia sp* has been reported as the most dominant species, whereas *Navicula sp and Synedra sp* are also common [Nzomo, 2005].

Other studies on phytoplankton distribution in the lake have reported the dominance of blue-green algae (*Cyanophyceae*) over diatoms (*Bacillariophyceae*) while the green algae *Chlorophyceae*) is the least abundant. An increase in phytoplankton biomass by a factor of three to five has been reported in the lake compared to the 1960's; implying the tendency to nutrient limitation of phytoplankton productivity particularly by nitrogen, in near shore environments of the lake, and also the occurrence of serious oxygen deficits due to eutrophication [Nzomo, 2005].

The dominance and high proliferation of *Cyanophyceae* has been reported in the near-shore zones of the lake, mainly in bays associated with large settlements and industrial establishments such as Kisumu, Kampala and Mwanza. The most frequently reported Cyanophyceae are *Anabaena, Planktolyngbya, Aphenotheca, Microcystis, Chroococcus, Coeleopharium* and *Merismopedia* [Mzime *et al.*, 2010; Nzomo, 2005].

1.5.4 Invertebrate resources

The aquatic invertebrates of Lake Victoria include zooplankton, which reside mostly within the water column and the macro-invertebrates or macro-benthos associated mainly with benthic debris and the underwater part of aquatic plants. The zooplankton in Lake Victoria is the major dietary component in the early life of most young fishes, whereas some fish such as *Rastrineobola urgentia* feed almost exclusively on zooplankton. Many zooplankton taxa are algal grazers therefore constituting a vital link between primary and higher production along the grazer food chain. On the other hand, the macro-invertebrates that convert detritus are consumed by higher organisms such as fish, hence playing a similar role along the detritus food chain [Attayde and Ripa, 2008; Moore *et al.*, 2004].

Occurrence of particular aquatic invertebrates may also provide a biological indicator on the environmental health of a given system. For instance, the annelids and chironomids have evolved to tolerate low oxygen levels. The chironomids, in particular, have been noted to respond in specific ways to chemical pollutants and can be used as biological indicators of environmental degradation [Tang, *et al.*, 2009].

Studies of aquatic invertebrates in Lake Victoria have reported marked temporal decline, especially in the abundance of calanoid copepods and the cladocera, contrasted by a marked increase in the abundance of cyclopoid copepods. In the deep open lake, the calanoid populations tend to outstrip those of the cyclopoids [LVBC, 2011b].

1.5.5 Wetland resources

Wetland resources of Lake Victoria include the floodplain and fringing emergent macrophytes often dominated by papyrus (*Cyperus papyrus*) or *Miscunthus,* in the shallow near-shore zone of the lake up to three metres deep. The two categories of wetlands play significant roles in the lake ecosystem conservation. For instance, the emergent wetlands regulate the flow of water through their spongy underwater biomass and in the process contribute to water quality conservation. The wetlands also strip and retain incoming sediments and nutrients from the catchments, and contribute to climate modification through evapo-transpiration [Simonit and Perrings, 2011]. In addition, the wetlands act as habitats for biodiversity, including the rare sitatunga, shoe-bill, the crowned cranes and the swamp warblers. Papyrus also provides materials traditionally used for various purposes including thatching, mat and basket making [LVBC, 2011b].

The floodplain wetland zones are often used for grazing livestock and wild animals like waterbucks, especially during the dry season. The near-shore wetlands of Lake Victoria host a variety of biodiversity including encrusted algae, submerged and floating macrophytes, macro-invertebrates and fishes. In addition, the zone not only provides environment for nurseries for some fish species such as tilapia but also forms conducive feeding habitat for most juvenile fishes including the Nile perch. Lake Victoria wetlands are currently facing serious degradation problems due to excessive resource harvesting, over grazing and conversion for agriculture and industrial development; dairy and rice farming and increasing horticultural activities [Odada *et al.*, 2004].

Disposal of poorly treated municipal sewage and industrial effluents, especially when the input outstrips the 'treatment' capacity, also contributes to degradation of the wetland. In addition, the near-shore zones are also affected by destructive fishing practices such as the use of boat seines, which scoop out the macrophytes destroying spawning grounds and fish nurseries. Furthermore, the proliferation of water hyacinth is also contributing to Lake Victoria wetland degradation. In general, the degradation of the riparian and floodplain wetlands of Lake Victoria reduces the efficiency of these environments to act as natural guardians of the lake against nutrient enrichment and siltation [Odada *et al.*, 2004].

1.5.6 Fishery resources

Lake Victoria supports the largest freshwater commercial fishery in the world [Simonit and Perrings, 2005]. The fishery is diverse, highly dispersed and fragmented with about 1500 landing sites and more than 120,000 fishersmen [Balirwa *et al.*, 2003]. The fishery resources of the lake are a source of protein and employment opportunities, especially for the lakeside communities. Among the fish types, Nile perch is the major foreign exchange earner for the riparian states while the other fishery resources have ready regional markets. In general, the fisheries of the lake contribute up to 3% to the gross domestic product of the riparian states and they are a major source of income, food and employment.

The temporal trends of the fishery resources of the lake show that until the 1970s, the fish fauna was dominated by about 500 endemic haplochromine cichlid species, which constituted about 80% of the demersal fish mass [Kudhongania and Cordone, 1974]. The Nile tilapia *Oreochromis niloticus*, and the Nile perch, *Lates niloticus*, were introduced into the lake in the 1950s to support commercial fishery. The first half of the 1980s saw the sudden boom of the Nile perch and dramatic decline in haplochromines in the sublittoral and offshore areas [Barel *et al.*, 1985, 1991; Ogutu-Ohwayo, 1990; Witte *et al.*, 1992]. At about the same time, blooms of blue-green algae increased greatly due to eutrophication [Ochumba and Kibaara, 1989; Hecky, 1993; Mugidde, 1993; Verschuren *et al.*, 2002] resulting into decreased levels of dissolved oxygen [Kaufman, 1992; Hecky *et al.*, 1994; Wanink *et al.*, 2001].

In the 1990s, Nile perch catches declined and a slow resurgence of some haplochromine species was observed [CIFA 1990; Witte *et al.*, 1995, 2000; Seehausen *et al.*, 1997; Balirwa *et al.*, 2003; Getabu *et al.*, 2003]. These events triggered many studies and debates about the severity and causes of the decline, out of which a lake-wide Nile perch predation and eutrophication were considered as the strongest factors [Witte *et al.*, 2007].

1.6 Challenges facing Lake Victoria

Increase in subsistence agriculture, deforestation, municipal and industrial effluents, and human encroachment on the shoreline in the latter half of the twentieth century are alleged to have caused wetland degradation and collectively given rise to historically unprecedented nutrient loadings into the lake [Hecky, 1993; Vershuren *et al.*, 2002]. The eutrophication is reported to have caused a four-fold and eight-fold increase in chlorophyll a (Chl a) in the offshore and inshore, respectively [Mugidde, 1993]. In addition, the disproportionate increase in phosphorus loading relative to non-biologically fixed nitrogen and soluble reactive silica loadings have allegedly caused a taxonomic shift from green algae and siliceous diatoms to nitrogen-fixing cyanobacteria [Hecky, 1993; Kling *et al.*, 2001].

The increase in algal biomass has further altered the physical, chemical, and biological environments of Lake Victoria. For instance, the Secchi depth measurements declined in the offshore from a range of 5.5 to 8.2 m in the 1920s [Worthington, 1930] to a mean value of 2.0 m in the early 1990s [Mugidde, 1993]. The associated narrowing of the light-transmission spectra allegedly devastated the diversity of the endemic cichlid fauna that rely upon visual coloration for sexual selection [Seehausen *et al.*, 1997]. Furthermore, increased stability of stratification, together with higher organic sedimentation to the hypolimnion, has significantly augmented the volume of seasonally anoxic water [Hecky *et al.*, 1994], caused loss of fish habitat and a shift in the benthic invertebrate community toward anoxia-tolerant species [Verschuren *et al.*, 2002].

The high mean concentrations and a large range of Chl 'a' and macronutrients observed in modern-day Lake Victoria are unprecedented among the world's large lakes [Hecky 1993; Guildford and Hecky, 2000]. According to Mugidde [1993, 2001], phytoplankton populations in Lake Victoria are self-shaded by high-chlorophyll standing crops in the shallowest portions of the lake.

Poor fishing methods such as the use of under sized meshes, beach seines, use of poison and dynamite also exert high pressure on the lake fisheries resources. The excessive number of fishermen is often enhanced by poverty and the quest for money, lack of the sense of ownership of the fishery exacerbated by the 'open access policy' syndrome, insufficient research information on fish stocks and insufficient sensitization. The use of noneselective fishing methods such as trawling exert pressure on environment and fishery including spawning, nursery and feeding habitats [Odada *et al.*, 2004].. This leads to decline in fish stocks and may eventually culminate into the ultimate collapse of the fisheries industry.

Rapid proliferation of water hyacinth is another major problem facing the lake water resources management. Previous reports show that water hyacinth has been in the River Nile since the 1870s but was not reported in Lake Victoria until 1989 [Twongo and Balirwa, 1995], whereas the problems associated with the macrophyte became apparent in the early 1990s. By 1995, 80% of the Ugandan coastline was inundated with the plant [Matagi, 2002]. Three categories of impacts due to infestation with water hyacinth were identified as disruption of socio-economic activities such as fishing (obstructed fishing grounds and transport routes to and from landing sites), fouling of water abstraction sites (with colour, odour and debris) and disruption of hydropower generation by clogging the cooling systems and blocking water-flow at screens to turbines.

The extensive shoreline mats inflicted mostly environmental, ecological and health impacts. These include smothering of biodiversity (native floating and submerged vegetation and some invertebrates), smothering of fish hatcheries, nurseries, feeding and sheltering grounds, fouling of shoreline watering points, the most accessible source of water for the lakeside communities (with odour, debris and colour), and introduction of disease pathogens and vectors (bilharzia, skin rash and dysentery). Narrow strips of stationary water hyacinth and small mobile mats were, however, credited with enhancing biodiversity, which in turn attracted young and small fishes, whereby the fish species that tolerate low oxygen tension flourished in narrow stationary mats [Balirwa *et al.*, 2009].

1.7 Regional efforts to manage Lake Victoria ecosystems

Regional efforts to manage the fisheries of Lake Victoria dates back to the late 1920s when the need for fisheries research and lake-wide collaborative effort for regulation and collection of catch statistics of the lake's fisheries was recognized. The East African Fisheries Organization (EAFRO) was started in 1947 at Jinja to conduct research on fisheries and hydrology on Lake Victoria and other freshwater systems all over East Africa. The Lake Victoria Fisheries Service (LVFS) started work in 1949, to supplement the activities by EAFRO on Lake Victoria mainly through experimental fishing, processing, collection of catch statistics and marketing data. Efforts by the LVFS including coordination of administrative activities especially integration and enforcement of legislation imposed on the industry, were not very successful due to lack of long term data on fish stocks and their dynamics, and the problems of coordinating regimes of different countries. The more successful endeavour, however, was through fisheries research, although lake-wide research on Lake Victoria started after the birth of the East African Community in 1967 [LVFO, 2001].

The EAFRO was transformed into the East African Freshwater Fisheries Research Organization (EAFFRO) in 1960. The first lake-wide stock assessment survey was undertaken between 1968 and 1970. An active lake-wide research was boosted by the establishment of substations at Kisumu in Kenya and Mwanza in Tanzania. However, the subsequent collapse of the East African Community in 1977 scuttled the formal efforts at lake-wide fisheries research on Lake Victoria. But the spirit of collaboration to manage the lake remained alive among the three riparian States, who welcomed and supported the formation by FAO of the Sub-committee on Lake Victoria, the Committee for Inland Fisheries of Africa (CIFA) in 1980. The CIFA Sub Committee on Lake Victoria was mandated to provide a forum for regional collaboration in the management and development of the lake fisheries [LVFO, 2001].

Bilateral initiatives between individual national research institutes around Lake Victoria and visiting scientists from Universities in North America and Europe promoted some form of regional research. The most notable research initiatives were made with the support from IDRC of Canada to the Fisheries Resources Research Institute (FIRRI) at Jinja, the Kenya Marine and Fisheries Research Institute (KMFRI) at Kisumu and the Tanzania Fisheries Research Institute (TAFIRI) at Mwanza in the late 1980s and 1990s. The research supported by IDRC contributed significantly to the appreciation of the dramatic changes that were underway in the Lake Victoria environment and resources, which provided part of the basis for committing funding for regional research projects, including the European Union funded Lake Victoria Regional Fisheries Project (LVFRP) and Lake Victoria Environmental Management Project (LVEMP) funded by GEF and IDA of the World Bank [Cowx *et al.*, 2003].

1.7.1 The Lake Victoria Fisheries Organization

The riparian States entrenched the collaboration in the management and development of the Fisheries of Lake Victoria in 1994, when the Convention establishing the Lake Victoria Fisheries Organization (LVFO) was signed [LVFO, 2001]. The FAO supervised the process that formulated the LVFO, to take over from the CIFA Sub Committee on Lake Victoria, with the following objectives:

i) To further co-operation amongst Contracting Parties (riparian States) in matters regarding Lake Victoria;
ii) To harmonize national measures for the sustainable utilization of the living resources of the lake;
iii) To develop and adopt conservation and management measures to ensure the lake's ecosystem health and sustainability of the living resources.

The overall goal of LVFO is "fostering a common system/resource management approach amongst the contracting States in matters regarding Lake Victoria, with a goal of restoring and maintaining the health of its ecosystem, and ensuring sustainable development for the benefit of the present and future generations" [Nyekoi *et al.*, 2009].

1.7.2 Lake Victoria Regional Fisheries Research Project (LVFRP)

The Lake Victoria Regional Fisheries Research Project, funded by the European Union (EU), was conceived to run in several phases. The first phase was used to improve water and land transportation and provide a selection of research equipment and materials, to build capacity at the fisheries research institutions of the riparian countries (Kenya, Tanzania and Uganda) around Lake Victoria [LVFO, 2001]. The second phase of the LVFRP had two immediate objectives:

i) to assist the newly established LVFO in the creation and initial functioning of a viable management framework for the fisheries of Lake Victoria.
ii) to create and develop the knowledge basis required for the rational management of the fisheries of Lake Victoria;

The second phase of the project conducted fish stock assessment and biology, socio-economic research, database management, training and infrastructure support. A Fisheries Management Plan for Lake Victoria was also developed. The project sought to conduct further work on socio-economic aspects of fisheries management and on monitoring under the coordination of the EAC [Cowx *et al.*, 2003].

1.7.3 Lake Victoria Environmental Management Project

Lake Victoria Environmental Management Project (LVEMP) was the most comprehensive regional program on Lake Victoria [GoK, 2008]. It was aimed at restoring the lake ecosystem to a stable state, capable of supporting and sustaining human activities in the catchments. The project was initiated through a tripartite agreement by the riparian states in 1994, whereas implementation started in 1995. The main objectives of the project were to:

i) maximize sustainable benefits of the riparian communities from using the resources within the lake basin to generate food, employment and income, supply safe water and sustain a disease free environment;

ii) conserve biodiversity and genetic resources for the benefit of the riparian and the global communities;

iii) harmonize national and regional management programs in order to achieve the maximum possible ecosystem, the reversal of environmental degradation.

LVEMP comprised of various components namely: a) establishment of operations of the LVFO; b) improvement of fisheries research and its information base; c) strengthening fisheries extension, policies, monitoring and enforcement capabilities; d) Supporting control and management of water hyacinth infestation; e) management of lake pollution and water quality including improvement of information base for pollution control; f) strengthening industrial and municipal waste management including priority waste management investment; g) management of land use in the catchments including improvement of research and information database for pollution loading and assessment of agrochemicals; h) investment in catchment afforestation to facilitate soil and water conservation; i) wetland management including improving the information base; and j) supporting lake-wide research and management initiatives [GoK, 2008; LVEMP, 2003].

1.7.4 Nile Equatorial Lakes Subsidiary Project

The Nile Equatorial Lakes Subsidiary Projects (NELSAP), under the umbrella of the Nile Basin initiative (NBI), sought to achieve joint action on the ground to promote poverty alleviation, economic growth, and the reversal of environmental degradation in the Nile Equatorial Lakes Sub-Basin [Mohamed and Loulseged, 2008]. It identified several regional projects in the Kagera River catchment (to involve Burundi, Rwanda, Tanzania and Uganda), and the Malakisi-Malaba-Sio River Basins (to involve Kenya and Uganda). Two NELSAP projects in the Kagera River catchment (the principal land source of water into Lake Victoria), are the Kagera River Basin Integrated Water Resources Management Project and the Water Hyacinth Abatement in the Kagera River Basin [WSP, 2003].

The objectives of the Kagera River Basin Integrated Water Resources Management Project was to develop tools and permanent institutions for the joint and sustainable management of the water resources of the Kagera River Basin in order to prepare for sustainable development-oriented investments to improve the living conditions of the people and to protect the environment. Water hyacinth abatement in the Kagera River Basin sought to eliminate the adverse effects of the weed on environment, health and socio-economic activities by reducing, to manageable levels. This is because the infestation of water hyacinth in the Kagera River Basin leads to a constant supply of water hyacinth biomass into Lake Victoria [Agaba *et al.*, 2009].

1.7.5 Lake Victoria Development Program under the EAC

The Lake Victoria Development Program (LVDP) is an institutional arrangement established pursuant to the provisions of the Treaty for the establishment of the East African Community. The LVDP was responsible for the promotion, coordination and harmonization of the various programs and projects (such as LVFO, LVEMP and others to be established) in the lake region. The ultimate expectation of the programme was to make a significant contribution towards reduction of poverty by uplifting the living standards of the people of the lake region, which was to be driven through economic growth, investments and sustainable development practices that are cognizant of a healthy and productive environment. A unit was created at the EAC Secretariat to manages LVDP activities and provide policy guidance [World Bank, 2006].

1.7.6 Osienala

Osienala is an acronym of dhoLuo words *Osiep nam Lolwe* meaning friends of the lake.It is a Non-Governmental Organization which operates within the Lake Victoria basin focusing on the issues affecting the fisher-folks around the lake. It was established in 1992 to provide interventions on environmental management but emerging social, cultural, economic and ecological issues have mandated it to become a regional NGO [GoK, 2008].

The organization's vision is to restore Lake Victoria and its environs for sustainable livelihoods of its inhabitants, and its mission is to promote sound environmental management measures for sustainable utilization of the resources within and around Lake Victoria. The main objectives of OSIENALA are to:

i) Lobby and advocate for sound environmental management policies and practices,

ii) Build capacity of the local communities around Lake Victoria in order for them to become custodians of their own environment,

iii) Promote sustainable livelihoods for the communities,

iv) Address the problem of poverty and potential resource conflicts in the region.

1.7.7 Other organizations working on Lake Victoria

Other government and non-governmental institutions, which contribute to the management of the resources of Lake Victoria, include the Lake Victoria Regional Local Authority Cooperation (LAVLAC), and the Network of Environmental Journalists for Lake Victoria. The major urban authorities around Lake Victoria, including Kisumu, Mwanza, Entebbe, Bukoba, Kampala and Jinja, constitute membership of LAVLAC [GoK, 2008].

The main contribution of LAVLAC was lobbying and advocacy for sustainable utilization of Lake Victoria Resources [GoK, 2008]. Activities undertaken included awareness creation among the riparian communities on causes and consequences of environmental degradation of the lake. This collaborative initiative appeared to have generated the drive to go beyond stakeholder sensitization to involvement in measured implementation of environmental management initiatives. East African Communities for the Management of Lake Victoria's Resources (ECOVIC), on the other hand, was a forum for NGOs and CBOs around Lake

Victoria. The forum comprised three chapters, one in each of the riparian states of Kenya, Tanzania and Uganda, with headquarters in Kisumu, Mwanza and Jinja, respectively. The primary purpose of ECOVIC was mobilization, coordination, sensitization and monitoring and evaluation of stakeholder communities around Lake Victoria with respect to various socio-economic and environmental issues [GoK, 2008]. Those activities were undertaken mainly through NGOs and CBOs involving lakeside communities. ECOVIC also aspired to be the voice of community based NGOs and CBOs in the Victoria Lake Basin.

1.8 Problem statement

Lake Victoria resources are undergoing serious decline due to unsustainable human activities. Serious effects of eutrophication are now evident at the near-shore zones, especially the bays associated with large human settlements and industrial establishments, leading to enhanced phytoplankton production, accumulation and decomposition of phyto-biomass. Decomposition of phyto-biomass consumes huge amounts of dissolved oxygen causing deficits in bottom waters resulting into the accumulation of toxic gases such as hydrogen sulphide in the lower water column.

Currently, the lake is the final destination of factory effluents, oils and grease, and sewage from the urban centers as well as oil spillage from the extensive transport activities within the lake [UNEP/GEMS, 2005]. Other major challenges include the unsustainable riparian population and fishermen/women pressure (estimated at 38 million riparian population and 120,000 people fishing per day), poorly planned industrialization, unsustainable utilization of water resources to generate hydroelectric power, outdated cultural practices such as superstitions towards the use of pit latrines, unsustainable agricultural practices, loss of freshwater biodiversity, overexploitation of the fisheries resources and introduction of aquatic invasive alien species.

Deforestation coupled with poor agricultural practices have led to an accelerated rate of sediment transport and sedimentation in aquatic environments around the Lake. The high sedimentation rate has been contributed mainly by the Kenyan rivers and the Kagera River [UNEP, 2005]. The quality of Lake Victoria's water is further exacerbated by discharge of untreated sewer and chemical wastes from urban centers as well as micro-bacterial and nutrient runoff from pastoral and agricultural land, suburb-lands and municipal slums. Pesticides residues from agricultural land have also been detected in some studies [Getenga *et al.,* 2004; Henry and Kishimba, 2000] and could be contributing to the loss of biodiversity. The extent and magnitude of contribution from each sector has not been properly delineated due to lack of adequate scientific data. The major sources of chemical pollution in Lake Vctoria include agrochemicals such as pesticides and nutrients. Pesticide pollution leads to aquatic toxicity, whereas influx of nutrients into the lake leads to eutrophication. Nitrogen and phosphorus are the main nutrients that control eutrophication [Jianga and Shen, 2006], however, nitrogen is widely ubandant in the atmosphere, whereas the only source of phosphorus is from activities from the mainland. According to Avile´s and co-workers [2006], phosphorus is usually considered the limiting nutrient for primary producers such as phytoplankton, bacteria, epiphytic and epibenthic algae in freshwater.

The current study investigated the impact of human activities on the influx of phosphorus and pesticides into Lake Victoria. Specifically, the study sought to investigate the levels of phosphates and pesticides in river mouths, the shoreline and direct discharge points into the Lake Victoria.

1.9 Research hypothesis

Human activities around Lake Victoria catchment are contributing to the environmental degradation and overall decline in the quality of Lake Victoria water resources. Studies of pesticides and phosphorus dynamics in water, soil and sediment systems would provide useful information on the influence of human activities on the fate and transport of pesticides and phosphorus in the catchment and hence support the formulation of relevant policies and regulations for proper management of the lake water resources.

1.10 Research objectives

1.10.1 Overall objective of the study

The overall objective of this was to identify the sources and fate of phosphorus and pesticides in the Kenyan part of Lake Victoria catchment.

1.10.2 Specific objectives

i) To establish the baseline data on the levels of pesticides and phosphorus in the Kenyan catchment of the Lake Victoria drainage systems.

ii) To investigate the physio-chemical parameters of soils and sediments from key point and non-point sources of pesticides and phosphate residues in the Kenyan part of Lake Victoria.

iii) To investigate pesticide and phosphorus transport and persistence in selected soils from the Kenyan catchment of Lake Victoria.

1.11 Justification of the study

Previous studies have reported residue levels of pesticides and phosphorus in the Kenyan environment [Wandiga *et al.*, 2006; Getenga *et al.*, 2004b; Wandiga *et al.*, 2002b; LVEMP, 2003]. The current levels of phosphorus and pesticides in the Lake Victoria catchment can be attributed to persistence and transport from point and non point sources. However, characterization of these sources has not been done in Lake Victoria catchments. In addition, the impact of agricultural practices on transport and persistence of pesticides and phosphorus in Lake Victoria catchments has not been evaluated. The study of the impact of land use practices on the movement and persistence of pesticides and phosphorus in the catchments is necessary to provide data for policy formulation to support proper management of pesticides and phosphorus challenges in the Lake Victoria catchments.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Review of research activities on Lake Victoria

Pesticides and fertilizers constitute the largest groups of chemicals intentionally applied in environment for economic management of crops and livestock. Phosphorus is not only essential to growth of organisms but also limits the primary productivity of the living body of the water. In most of the cases, where phosphorus is the growth limiting nutrient, the discharge of raw or treated wastewater, agricultural drainage or certain industrial wastes may stimulate the growth of aquatic micro- and macro-organisms in nuisance quantities due to eutrophication [Zhou and Struve, 2004]. The phosphorus in the bottom sediments and biological sludge is precipitated into inorganic forms and incorporated into organic compounds [Koschel *et al.*, 2005; Avile's *et al.*, 2006]

Previous research findings on Lake Victoria have shown that the lake resources have undergone drastic changes in the latter half of the twentieth century due to unsustainable human activities. For instance, according to Hecky and co-workers [1994], increased stability of stratification and high levels of organic sedimentation to the hypolimnion, have significantly augmented the volume of seasonally anoxic water. This has, in part, caused the loss of fish habitat and a shift in the benthic invertebrate community toward anoxia-tolerant species [Verschuren *et al.*, 2002]. At the moment, the Lake Victoria's water resources are considered overexploited [Simonit and Perrings, 2005]. Vershuren *et al.* [2002] showed through paleontological studies that human activities have contributed to wetland degradation due to unprecedented loading of sediment and agrochemicals into the lake. However, the comprehensive identification and quantification of the causes of phosphorus and pesticides loading that contribute to environmental change and biodiversity loss has not been done.

2.2 Phosphorus and nutrients in water, soil and sediments

Phosphorus constitutes the limiting nutrient due to its role, in biological productivity, of fixing carbon in living organic matter:

$$106CO_2 + 16NO_3^- + HPO_4^{2-} + 122H_2O + 18H^+ \underset{R}{\overset{P}{\rightleftarrows}} C_{106}H_{263}O_{110}N_{16}P + 138O_2$$

Where, ***P*** stands for photosynthesis and **R** for respiration [Stumm and Baccini, 1978]. Phosphorus from extended fertilization of arable land, industrial and municipal sources (detergents) causes eutrophication leading to algal blooms, suffocation and other undesired effects. Consequently, if more phosphorus is available to a riverine, lake or oceanic system, more biomass is formed, which on decomposition removes a corresponding amount of oxygen from the water, reducing the amount of oxygen available for higher organisms.

Phosphorus occurs in natural water and wastewaters almost solely as phosphates. These are classified as orthophosphates, condensed phosphates (pyro-, meta- and other polyphosphates), and organically bound phosphates. They occur in solutions, in particles or detritus, or in bodies of aquatic organisms. Small amounts of certain condensed phosphates are added to some water supplies during treatment, whereas larger amounts are added to water during laundry or other cleaning processes since they form major constituents of many commercial cleaning preparations. Phosphates are also used extensively in the treatment of boilers water.

The orthophosphates are mainly applied to agricultural land as fertilizers and may be carried to the surface water through storm runoff. On the other hand, organic phosphates are formed mainly by biological processes and are contributed to sewage by body wastes and food residues [Jianga and Shen, 2006]. They may also be formed from orthophosphates in biological treatment processes or by the receiving water biota.

According to the LVEMP [2001, 2002 and 2003] reports, nutrients are now choking Lake Victoria. The reports estimated pollution loading into the lake at 6,955 t-BOD/y, 3028 t-Total-N/y and 2,686 t-Total P/y. These reports only included the pollution loading from the urban areas close to the lakeshore without consideration of the pollution loading originating from agricultural fields and towns located some distance from the lakeshore, which also drain into Lake Victoria via streams and rivers. The same reports estimated atmospheric deposition (including wet and dry deposition) into the lake at 102,000 t/y of Total-N and 24,000 t/y of Total-P. The studies attributed atmospheric deposition to about 45% and 64% total nitrogen and total phosphorus loading, respectively [COWI, 2002; LVEMP, 2003]. However, the data has been disputed based on the methodology applied, which could have caused overestimation of the loading from atmospheric deposition and underestimation of the catchment loading from the drainage system.

Previous studies conducted in other places reported that phosphorus input from agricultural sources may arise from intensively managed agricultural land. For example, according to

Morgan *et al.* [2000], the losses of phosphorus from point sources within the farmyard can induce eutrophication of surface waters that are linked to the field system through the drainage network. Excessive accumulation of phosphorus in soils has been attributed to long-term inputs of inorganic fertilizers and manure [Hooda *et al.*, 2000; Sharpley *et al.*, 2000]. In other studies, diffuse agricultural sources have been reported to contribute large amounts of phosphorus to surface waters in many parts of the USA [Sharpley *et al.*, 1995] and Europe [Tunney *et al.*, 1998; Lucey *et al.*, 1999].

The phosphorus load from agricultural fields is controlled by two key factors: soil biochemical processes which control the forms of phosphorus available for transport; and hillslope hydrology which defines the transport mechanisms and pathways [Heathwaite and Dils, 2000]. Inputs to the soil phosphorus pool include plant residues, inputs from grazers, commercial fertilizers and organic manures. The ability of a soil to hold phosphorus within the soil matrix depends on particle size distribution, organic content and iron and aluminium content [Corck-Leinweber *et al.*, 1999; Daly, 2000]. Therefore, sandy and organic soils have a lower capacity to bind phosphorus than those with high clay content [Cork-Leinweber *et al.*, 1999; Daly, 2000]. Maguire *et al.* [1997] reported a higher level of resin-extractable phosphorus in the silt fraction of a fertilized soil than in the sand fraction while Cork-Leinweber *et al.* [1999] found that the risk of phosphorus leaching increased with decrease in soil clay content. In another study of phosphorus runoff in Oklahoma (USA) soils, Sharpley [1995] found that dissolved phosphorus in runoff was related to soil sorption capacity, with the release of phosphorus increasing as sorption capacity decreased.

Phosphorus is often the limiting factor in controlling primary production especially of algal growth in terrestrial aquatic ecosystems. Therefore, detailed understanding of transport and transformation dynamics of phosphorus in both lentic and lotic systems is of great importance. Phosphorus transport is controlled by several factors including soil properties, land use practices and climatic conditions. Soils with low phosphorus sorption capacity or phosphorus-saturated soils have low capacity to retain phosphorus. Thus, identification of areas within the catchment with low capacity to hold phosphorus coupled with proper land management practices can help control phosphorus transport. On the other hand, combination of seasonal factors and poor land use practices that increase availability of mobile phosphorus in soil may contribute to phosphorus loading into aquatic systems and accelerate eutrophication.

The understanding of the characteristics of point and non-point sources plays a significant role in controlling phosphorus pollution. This may be accomplished through determination of sorption index, equilibrium concentration, benthic sediment concentration, exchangeable phosphorus, and analysis of phosphorus levels in environmental matrices.

2.3 Phosphorus sorption in soil

Phosphorus (P) is an essential for growth of organisms in most ecosystems and directly implicated in controlling eutrophication processes in freshwater systems [Hengpeng *et al.*, 2006]. This has catalysed a lot of research towards removal of phosphorus from aqueous system using chemical, biological and adsorption techniques. In principle, phosphorus adsorption is defined as the net accumulation of phosphorus at the inter-face between a solid phase and an aqueous solution phase [Sposito, 1989].

Phosphorus adsorption process can be investigated using different equations: the Langmuir, Freundlich and the Temkin adsorption isotherms [Sanyal and De Datta, 1991; Rhue and Harris, 1999; Graetz and Nair, 2000]. The Langmuir adsorption isotherm equation is given by:

$$\frac{C}{x/m} = \frac{1}{kb} + \frac{C}{b}$$

Where, b is the maximum adsorption per unit mass (or the maximum adsorption capacity) and K is an affinity parameter related to the bonding energy of the surface adsorption. The b is calculated by regressing $C/x/_m$ versus C, where C is the equilibrium solution P concentration (mg L^{-1}) and x/m is adsorbed P (mg) per soil (kg) after 24 hours equilibration. The reciprocal of the slope of mean regression gives b [Zhang *et al.*, 2005], and k = slope/intercept.

The Freundlich adsorption isotherm equation is the oldest of the nonlinear isotherms and its use implies heterogeneity of adsorption sites. The Freundlich isotherm equation is:

$$x/m = KC^{\beta}$$

Where, β is a heterogeneity parameter, and the smaller the β, the greater the expected heterogeneity [Kinniburgh, 1985]. The expression reduces to a linear adsorption isotherm when β = 1. By taking the log of both sides, the equation becomes:

$$\log(x/m) = \log k + \beta \log C$$

Where, x/m is the amount of P adsorbed (mg) per soil (kg), C is the equilibrium P concentration (mgL^{-1}) and k and β are constants. Similarly, the plot of log *x/m* versus logC leads to calculation of k and β from the intercept and the slope, respectively.

Although the Freundlich equation is strictly valid only for ion adsorption at low solution ion concentration [Sposito, 1984], it has often been used to describe ion adsorption by soils across the entire ion concentration range investigated. The Freundlich adsorption isotherm does not obey Henry's law at low ion concentration nor does it reach an adsorption maximum at high ion concentration [Kinniburgh, 1985].

The Temkin adsorption isotherm equation assumes the energy of adsorption is a linear function of the surface coverage [Travis and Etnier, 1981] and is suitable for an intermediate range of ion concentrations [Kinniburgh, 1985]. It takes the form:

$$x/m = k + b\ln C$$

Where x/m is the amount of P adsorbed on the unit mass of soil (mg/kg), C is the equilibrium P concentration (mgL^{-1}) and 'k' and 'b' are constants representing intercept and regression coefficient respectively. Thus, a plot of x/m against lnC gives a straight line, and the value of b is considered as the P buffering capacity [Masud *et al.*, 2006].

2.4 Pesticides residues in water, soil, fish and sediments.

Pesticide residues in the environment display varying trends in levels and spatial distribution, mainly influenced by different socio-economic activities in the regions, and fate and transport processes. A previous study of pesticide residues in rivers Nzoia and Sio, within Lake Victoria Basin, revealed the presence of *p,p'*-DDT, *o,p'*-DDE, *p,p'*-DDD, α-, β-, γ-HCH, aldrin, dieldrin, endrin, α-, β-endosulfan, endosulfan sulphate, heptachlor, heptachlor epoxide, ethyl parathion, malathion, fenitrothion, dimethoate, and diazinon [Madadi, 2005]. The study reported residue levels ranging from <0.002-0.439 μg/l in water, <0.002-65.478 μg/kg in sediments, <0.001-10.073 μg/kg in weeds and <0.001-481.178 μg/kg in fish. Most of the residues in water were below WHO maximum residue levels for drinking water [IUPAC, 2003], whereas sediments, weeds and fish had higher residue levels.

In another study by Getenga *et al.* [2004b], α-BHC, β-BHC, lindane, endosulfan, heptachlor, aldrin, heptachlor epoxide, dieldrin, endrin and methoxychlor residues were detected in water samples collected from River Nyando tributaries and soils from sugarcane fields that constitute the Lake Victoria basin. Mitema and Gitau [1990] reported levels of α-BHC, β-BHC, aldrin, dieldrin, lindane, and *p,p'*-DDT in Nile perch from Lake Victoria. DDT and its metabolites formed the largest proportion of the organochlorine pesticide residues in the fish samples. They attributed the presence of these residues to the previous use of the pesticides in agriculture and aerial control of mosquitoes in the Lake Victoria region.

A study conducted by Barasa [1998] in other parts of the country revealed comparable levels of pesticide in water, sediments and biota. Wandiga *et al.* [2002b] reported residues of aldrin, α-endosulfan, dieldrin, endrin, *p,p'*-DDT, *p,p'*-DDE, *p,p'*-DDD and lindane in seawater, seaweeds, sediments and fish from the Kenyan coastal environment. They found levels ranging from 0.503 to 9.025 ng/g in sea water, from 0.584 to 59.00 ng/g in sediments, and concentrations of 1,011 ng/g and 418 ng/g of *p,p'*-DDT and *p,p'*-DDD in fish, respectively. Everaarts *et al.* [1997] detected presence of PCBs and cyclic pesticides in benthic organisms from the Kenyan Coast. They reported higher concentrations of PCB congeners and cyclic pesticides at the mouth of Sabaki River than the mouth of Tana River. The bivalve molluscs from the mouth of Sabaki River and Kiwaya Bay had the highest levels of PCBs. Residues of p,p'-DDE were detected in all the samples at levels ranging from 15 to 48 ng/g of lipid in both bivalve and gastropod molluscs. The contamination was attributed to washout effect from the river flow, as evidenced from the gradient (increasing) across the continental slope toward deep water.

Additional studies have detected varying levels of pesticide residues in the food chain including cows and human milk, as well as birds. Kituyi *et al.* [1997] found contamination of the cows' milk by chlorofenviphos residues in levels ranging between 0.52 and 3.90 mg/kg in dry season and 1.58 to 10.69 mg/kg during wet season. The same study showed that milk collected from plunge dipped cows had higher levels of pesticide residues than milk obtained from hand sprayed cows. Pesticide residues have also been detected in other countries outside Kenya. Bhatnagar *et al.* [2004] reported high levels of *p,p'*-DDT and HCH isomers in human serum samples in India. They found *p,p'*-DDE, *o,p'*-DDT, *p,p'*-DDD, *p,p'*-DDT, ($\sum$DDT= 32.61 μg/l), and α-HCH, β-HCH, and γ-HCH ($\sum$HCH = 41.23 μg/l), whereas HCB residues were 0.20 μg/l. Studies conducted in Canada reported medium and maximum whole blood levels of HCB as 0.11 and 0.34 ppb, respectively [Mes, 1992]. Pesticides have been reported in Uganda [Wasswa *et al.*, 2011] and Tanzanian environment [Mwevura *et al.*, 2002]. In the Ugandan study of pesticide residues in sediment from Lake Victoria, they reported endosulphan sulphate, in the range of 0.82–5.62 μg/kg, whereas as aldrin and dieldrin were in the ranges of 0.22–15.96 and 0.94–7.18 μg/ kg, respectively. DDT and its metabolites had concentrations between 0.11–3.59 for *p,p'*-DDE, 0.38–4.02 for *p,p'*-DDD, 0.04–1.46 for *p,p'*-DDT, 0.07–2.72 for *o,p'*-DDE and 0.01–1.63 μg/kg for *o,p'*-DDT. The levels of γ-HCH varied from 0.05 to 5.48 μg/kg, whereas heptachlor was detected only once at a concentration of 0.81 μg/kg and heptachlor epoxide ranged between non-detectable (ND) to 3.19 μg/kg. Other pesrticide residues reported included chlordane which ranged from ND to 0.76 μg/ kg[Wasswa *et al.*, 2011]. In a study by Orata and co-workers [2008], they reported PFOS in musles and liver of fish from Lake Victoria, whereby, Nile perch recorded concentrations of 10.5 ng/g in muscles and 35.7 ng/g in liver, whereas the Nile Tilapia recorded concentrations of 12.4 ng/g and 23.7 ng/g in muscles and liver, respectively.

A number of simulation studies and field experiments carried out on the behaviour of pesticides in the Kenyan environment showed that persistence of pesticides differs from one region to the other [Getenga and Kengara, 2004a; Getenga *et al.*, 2004c; Wandiga *et al.*, 2002a; Getenga *et al.*, 2000; Bereket, 1999; Lala and Wandiga, 1998; Lala *et al.*, 1996; Lala *et al.*, 2001; Mbuvi, 1996; Kiflon *et al.*, 1998; Ng'ang'a, 1994].

The presence of various pesticide residues in the water bodies is of great concern since most of the synthetic pesticides have high ability to bioconcentrate and bioaccumulate in the food chain and thus their long-term impact to ecosystem integrity cannot be underestimated.

2.5 Fate and transport of chemicals in the environment

Pesticide fate studies are important since they contribute to understanding of the factors controlling persistence of pesticides in environment and provide critical information that can aid mitigation measures. Fate models are now increasingly being used in combination with geospatial information to assess the risk of pesticide contamination of surface and groundwater [Nolan *et al.*, 2008; Karpouzas and Singh, 2006 and Matamoros *at al.*, 2005]. Pesticides mainly occur in soluble or particulate phase in which transport occurs, and either form depends on the physicochemical properties such as solubility and partition coefficient [Boithias *et al.*, 2010]. From the point of application, pesticides may reach the soil either directly or indirectly from aerial and ground sprays. In addition, significant amount of losses may occur during application, depending on the nature of the pesticide, formulation, atmospheric conditions, method of application and application characteristics.

Factors such as vapour pressure, photodegradability and weak adsorption by soil may contribute to losses of pesticides after application [Guenzi and Beard, 1976]. But once in the soil, the main processes affecting the ultimate fate of a pesticide are retention by soil particles (adsorption-desorption processes), transformation (biological and chemical degradation), transport through the soil and plants, atmosphere and surface water.

According to Heatwole *et al.* [1992] retention does not affect the amount of pesticide present in the soil, but can decrease the amount available for transport; whereas transformation reduces the amount of pesticide present in the soil. The main transport processes include leaching, surface runoff, volatilization and uptake by plants, whereas fate processes include biological, chemical and photochemical transformations. In the current study degradation experiment were carried out in amended and non-amended soil to determine the effect of composting on fate and transport of pesticides in the basin.

Proper management of chemicals requires an understanding of the fate and transport of these compounds in the environment. Chemical properties, soil characteristics and environmental conditions are the key factors that control the fate and transport of pesticides and phosphorus in the environment. Transport processes are controlled by factors such as permeability, water table, organic matter, and the clay content. In particular, soil permeability and water table control the leaching potential of contaminants through the soil, whereas organic matter and clay content control sorption potential. The interaction between leaching potential and sorption potential describe the overall sensitivity of the soil to chemical transport. In this regard, soils that have low leaching and high sorption potential are regarded to be less sensitive [Dubus *et al.*, 2003].

The major processes that control chemical persistence and transport in the environment include adsorption, absorption, volatilization, runoff, leaching, microbial and chemical degradation. The extent of adsorption of chemicals varies with particle properties, moisture content, acidity and soil texture. Soils high in organic matter or clay are the most adsorptive; whereas coarse-sandy soils that lack organic matter or clay are much less adsorptive. The soil-sorbed particle is less likely to volatilize, leach or be degraded by microorganisms. Therefore, chemicals that are tightly bound by the soil particles are less available for absorption by plants or animals and also to other chemical processes, which leads to their prolonged persistence in the environment [Este′vez *et al.*, 2008].

Other processes that contribute to pesticide movement are runoff and leaching. Runoff usually carries pesticides that are either dissolved in the water or bound to the eroding soil. It occurs after the spill, when an agricultural application is followed by heavy rain or when the contaminated water from the animal dip is discharged to an inappropriate site. On the other hand, leaching describes the downward movement of the chemicals through the soil column. This is influenced by several factors including chemical solubility, soil structure, texture and adsorption characteristics. In general, pesticides that dissolve in water can move very rapidly with the water as it seeps through the soil. The soil structure and texture influence soil permeability and determine how fast the water moves through the soil, together with the chemical contaminants [Este′vez *et al.*, 2008].

Persistence of the chemicals in the environment is described by rates of degradation, mineralization and photodecomposition. It occurs as a result of the integrated effect of transformation and eventually mineralisation of the compound through microbial degradation, chemical hydrolysis and photochemical reactions. Factors influencing persistence of the pesticide are characteristics of the active substance, such as Henry's law constant, water solubility, susceptibility to physical, chemical, and biological transformation processes, and environmental conditions which include rainfall, wind, humidity, temperature and light-intensity [Himel *et al.*, 1990].

Once in the soil or water, pesticides can be degraded through biotic or abiotic pathways [Roberts, 1998; Roberts and Hutson, 1999], however biodegradation by microorganisms is the primary mechanism of pesticide breakdown and detoxification in many soils [Ortiz-Herna'ndez and Sa'nchez-Salinas, 2010; Surekha *et al.,* 2008]. Biodegradation is a common method for the removal of organic pollutants because of its low cost and low collateral destruction of indigenous animal and plant organisms [Liu *et al.*, 2007]. Thus studies of microbial biodegradation are useful in the development of strategies for detoxification of pesticides by microorganisms [Qiu *et al.*, 2006].

Microbial degradation occurs when microorganisms such as fungi and bacteria use pesticides as food sources or through co-metabolism. The process can be slow or rapid depending on whether the soil conditions (temperature, pH, soil moisture, aeration and fertility) favour microbial growth. The amount of adsorption also influences microbial degradation since the adsorbed pesticides are less available to some microorganisms and therefore more slowly degraded.

Chemical degradation on the other hand is the breakdown of pesticides by processes not involving living organisms. This is affected by the extent of adsorption to the soil, soil pH, temperature, and moisture content. The transformation products are expected to have lower toxicity to biota than the parent compound [Day and Hodge, 1996]. However, in some instances a transformation product may be more toxic [Osano *et al.*, 2002a; Osano *et al.*, 2002b] and consequently pose a greater risk to the environment than the parent compound.

In general, soil properties play a significant role in determining the movement and persistence of chemicals introduced in environment. This means that any factor that changes the soil properties (such as land use practices) may adversely affect the extent of pesticide and phosphates interaction dynamics and influence their transport and persistence in the environment. However, the impact of these factors has not been studied to a greater extent in the Kenyan catchements of Lake Victoria.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study design

The study area covered the river mouths, direct discharge points from water treatment and effluent treatment plants and the lake shore around the urban centers located on the Kenyan catchments of Lake Victoria. A total of 32 sampling sites were selected of which 11 constituted the mouths of Rivers Kuja, Sondu, Awach, Nyando, Nyamasaria, Kisian, Awach-Seme, Muguruk, Yala, Nzoia and Sio; 6 sites were direct discharge canals namely Homa Bay Discharge, Homa Bay S. E., Nyalenda, KWASCO, Kisati, and Saka; whereas 15 were sites along the lake shores at Muhuru Bay, Sori, Mbita main Lake, Mbita Winam Gulf, Homa Bay, Kendu Bay, Kusa, Dunga Beach, Hippo Point, Car Wash, Luanda Kotieno, Misori, Usenge, Port Victoria and Sio Port. A GIS map of the Kenyan catchments showing different land use practices was developed and followed in the identification of sampling sites (Figure 3.1.1 and Annex Table 3.1A).

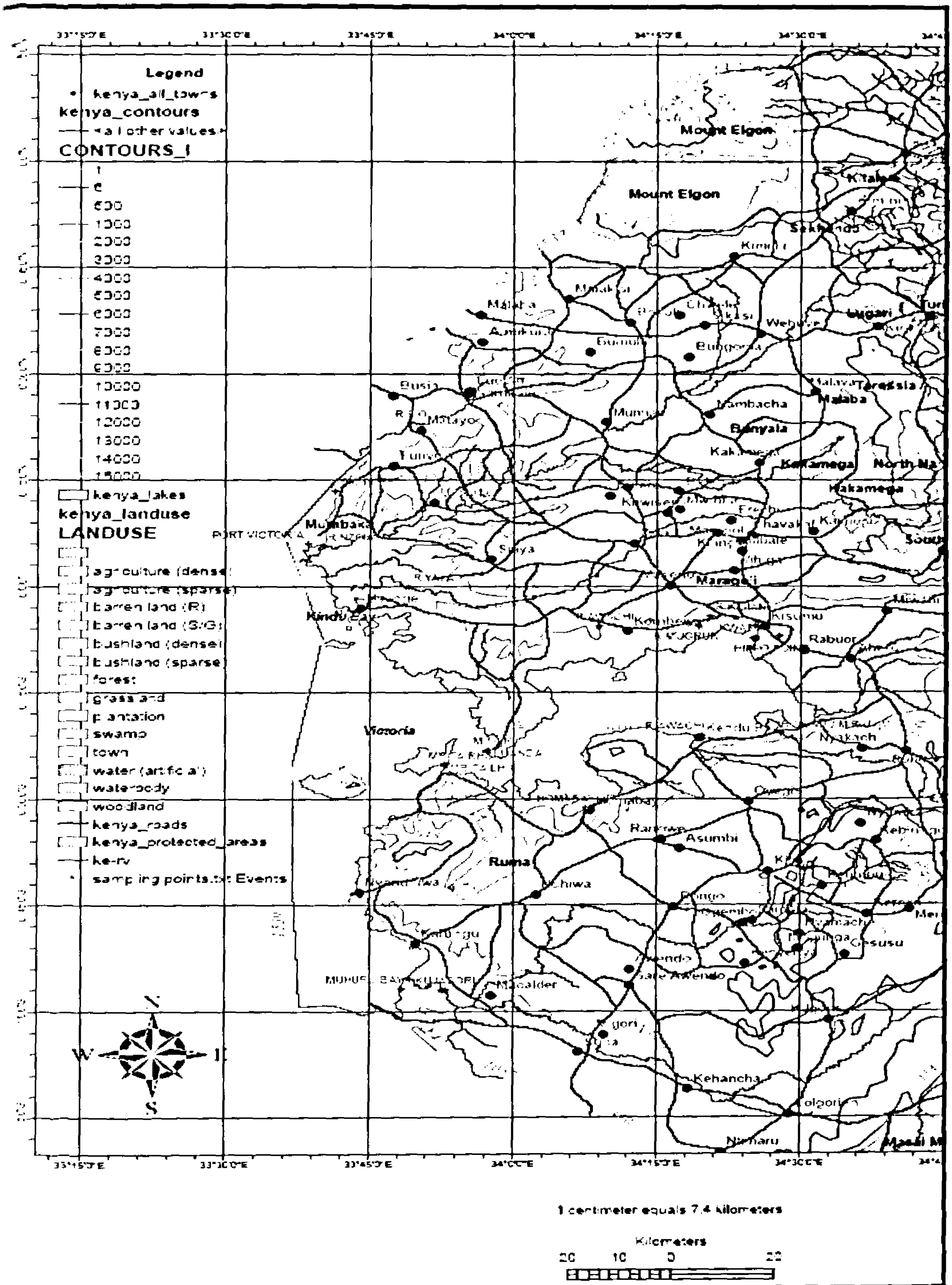

Figure 3.1.1 Map of study area showing sampling sites

Water, soil and sediments were sampled every three months for a period of 21 months covering the wet season (April-June), dry season II (July-September); short rain season (October-December) and the dry season I (January-March). Water was collected by grab method into pre-cleaned 2.5 L amber bottles, preserved with 10 mg/l mercuric chloride and stored in cooler boxes containing wet ice. Sediment samples were collected from a radius of 50 m by scooping from 0-15 cm deep using stainless steel shovel, transferred onto aluminium foil and composited. The composite samples were divided into three replicates, each approximately 500 g, packed in fresh aluminium foil and wrapped in self-sealing polythene bags before being transferred into cooler boxes. Soil samples were collected from the farms near the river mouths, lake shore towns and direct discharge points around the lakeshores. From each site, soil was collected from a minmum of three points within a radius of 50 m, by digging 0-15 cm deep. The collected soil was transferred onto aluminium foil and composited. Three replicates of about 500 g were wraped in fresh aluminium foil, packed in zip-lock polythen bags, placed in Colman cooler boxes with wet ice and transported to Nairobi for preservation prior to extraction and analysis. Once in the laboratory, sediment and soil samples were transferred from the iceboxes and frozen in deep freezers at -20 °C until extraction time.

3.2 Analysis of phosphorus in water, soil and sediments

3.2.1 Phosphorus in water

Phosphorus analysis in water samples embodied two major steps: the conversion of the phosphorus into dissolved orthophosphates and calorimetric analysis of the dissolved phosphorus. Three major classes of phosphorus were analysed in the water samples: the total reactive phosphorus- the class of phosphorus that responds to colorimetric test without preliminary hydrolysis or oxidative digestion of the sample and is mainly the measure of orthophosphorus; total hydrolysable phosphorus – obtained after the acid hydrolysis at boiling water temperature to convert the dissolved and particulate condensed phosphorus into dissolved orthophosphorus; and thirdly the total phosphorus-obtained after the oxidative distraction of all organically bound phosphorus.

3.2.1.1 Total reactive phosphorus

Total reactive phosphorus in the samples was determined in triplicate per sampling site. To 50 ml samples, 0.05 ml of phenolphthalein indicator was added and the red color discharged by adding drops of 1:1 dilute hydrochloric acid solution before diluting to 100 ml mark. Excess coloration was removed by shaking the sample with 200 mg activated carbon in 250 ml Erlenmeyer flask for 5 minutes and filtering through Whatman filter paper number 42. All the standards and the blanks were treated in the same manner to eliminate the interferences due to carbon. Color development in the sample was achieved by transferring 35 ml of the filtrate into 50 ml volumetric flask before adding 10 ml of Vanadate-molybdate reagent to form a yellow complex. The mixture was topped to the mark with distilled water and thoroughly mixed. Absorbance was measured after 15 minutes at 470 nm using Shimadzu 1700, UV-Visible spectrophotometer for the determination of total reactive phosphorus using the Vanado-molybdophosphoric acid calorimetric method [Kitson and Mellon, 1944; AWWA, 1958; Abbot et al., 1963; Proft, 1964].

3.2.1.2 Total hydrolysable phosphorus

Total hydrolysable phosphorus in water was determined after hydrolysis with sulphuric acid solution. To 50 ml water sample was added 0.05 ml phenolphthalein indicator. The red colour in the samples was discharged by adding drops of 30 % sulphuric acid solution, then 1 ml of 30 % dilute sulphuric acid solution before diluting the sample to 100 ml. All samples were boiled for at least 90 minutes on a hot plate and the final digest reduced to about 25 to 50 ml. Drops of 6 M sodium hydroxide solution were added to each digest until formation of a faint pink color. The colour was then discharged by adding 1 ml of 1:1 dilute hydrochloric acid before determination of the phosphate using using the Vanado-molybdophosphoric acid calorimetric method [Kitson and Mellon, 1944; AWWA, 1958; Abbot et al., 1963; Proft, 1964]. In all cases, the standards and blanks for determination of total hydrolysable phosphorus were treated in the same manner as the samples.

3.2.1.3 Determination of the total phosphorus

Determination of the total phosphorus in the water samples was conducted using the persulphorus method. To 50 ml of the sample, 0.05 ml phenolphthalein indicator was added until formation of a red colour. The colour was discharged by adding drops of 30 % sulphuric acid solution. The sample was then diluted to 100 ml and transferred into 250 ml Erlenmeyer flask. To each sample was added 0.5 g potassium persuphate and boiled on the hot plate for 90 minutes. The digest was treated with 6 M sodium hydroxide solution until faint pink colour was observed. The colour was discharged by adding drops of 1:1 hydrochloric acid solution before diluting to 100 ml. 1 ml of 1:1 dilute HCl solution was added to all the samples and the total phosphorus determination conducted using the Vanado-molybdophosphoric acid calorimetric method [Kitson and Mellon, 1944; AWWA, 1958; Abbot et al., 1963; Proft, 1964].

3.2.2 Phosphorus in soil

3.2.2.1 Soil available phosphorus

Soil available phosphorus was determined following the BRAY 2 Method [Bray and Kurtz, 1945]. The method involves combination of hydrochloric acid (HCl) and ammonium fluoride (NH_4F) to recover easily acid-soluble forms of phosphorus which are largely the calcium-phosphates and portions of aluminum and iron bound phosphates. The NH_4F dissolves aluminium and iron phosphates by its complex formation with these metal ions in acid solution. Extraction was achieved by shaking 2.5 g of air-dried soil (previously sieved through 2 mm sieve) in 50 ml of 0.025 M HCl and 0.03 M NH_4F for 5 minutes. The samples were then filtered through double Whatman filter paper number 42. To 50 ml volumetric flask, 35 ml of the filtrate was added, then 10 ml of Vanado-molybdate reagent and topped to the mark with distilled water. Absorbance measurements were taken after 15 minutes at 470 nm for available phosphorus determination.

3.2.3 Phosphorus in sediments

Analysis of phosphorus in sediments was done for two fractions: the sediment exchangeable and bio-available phosphorus.

3.2.3.1 Sediment exchangeable phosphorus

Sediment exchangeable phosphorus was determined using the method by Haggard and Co-workers [1999]. 20 g of pre-sieved sediments was placed in a 250 ml Erlenmeyer flask, and mixed with 100 ml of 1 M $MgCl_2$ solution. The samples were shaken for 1 hour on an orbital shaker at 150 rpm. 50 ml of the supernatant was diluted to 100 ml; thereafter pH was adjusted to acidic using 1:1 dilute hydrochloric acid. 0.2 g activated carbon was added and shaken for fifteen minutes. The sample was then filtered through double Whatman filter paper number 42. To 35 ml of the filtrate, 10 ml of Vanado-molybdate reagent was added and topped to the mark with distilled water. Absorbance measurements were taken after 15 minutes at 470 nm for sediment exchangeable phosphate determination using the Vanado-molybdophosphoric acid calorimetric method.

3.2.3.2 Sediment bio-available phosphorus

Sediment bio-available phosphorus was determined by Sonzogni and co-workers [1982] method. Approximately 20-30 g sieved wet sediments was extracted with 100 ml 0.1 M NaOH solution in 250 ml flask. The samples were mixed for 1 hour on an orbital shaker at a speed of 150 rpm. After incubation, 35 ml sample aliquots were taken and filtered through Whatman filter paper No. 42 into a pre-labeled 50 ml volumetric flask. 10 ml of Vanado-molybdate reagent was added to 35 ml of the filtrate and topped to the mark with distilled water. Absorbance measurements were taken after 15 minutes at 470 nm for sediment bio-available phosphate determination using the Vanado-molybdophosphoric acid calorimetric method.

3.3 Soil phosphorus adsorption experiments

Phosphorus sorption is described as the removal of labile phosphorus from the soil followed by its entry on or into the solid phases of the soil. Many tropical soils sorb large amounts of applied phosphates as fertilizers and in turn reduce the efficiency of the use of these nutrients. On the other hand, soils that poorly retain phosphorus are highly sensitive to environmental contamination since most of it is easily carried by the storm water into the aquatic systems causing eutrophication.

Three replicates (3 g each) of air-dried soil, that had been sieved through 2 mm mesh, were placed into 100 ml conical flasks and treated with 30 ml of 0.01 M $CaCl_2$ solutions containing different concentrations of phosphorus from 100, 80, 60, 40, 20 and 10 ppm. One to two drops of 0.1% mercuric chloride solution were added to each flask and shaken for 24 hours at 150 rpm. After equilibration, the suspension was filtered through Whatman no. 42 filter paper and the phosphorus concentration determined in 10 ml of each of the filtrates using the Vanado-molybdophosphoric acid calorimetric method [Khan *et al.*, 2008].

Phosphorus sorption by soils was quantified using sorption isotherms which describe the equilibrium relationship between the sorbed and dissolved phosphorus species at a given temperature. The isotherms were obtained by plotting the values of phosphorus sorbed by the soil against the phosphorus remaining in the equilibrium supernatant solution [Fox and Kamprath, 1970].

3.4 Sampling and analysis of pesticide residues.

Water samples for pesticide analysis were taken directly into 2.5 L amber bottles and stored in Collman cooler boxes containing wet ice. The samples were transported to the laboratory and extracted within 28 days. The samples were preserved by addition of 10 ppm mercuric chloride and stored untill extraction.

Sediment samples were collected from at least three points at every site using a stainless steel shovel and transferred onto aluminium foil. The samples were composited and three replicates of approximately 500 g packed in aluminium foil, put in zip-lock polythene bags and placed into cooler boxes containing wet ice. Soil samples were collected from a minmum of three points from each site, from a radius of 50 m, by digging 0-15 cm of soil using a hoe, and composting on aluminium foil. Three replicates, each weighing about 500 g, were wrapped in fresh aluminium foil, packed in zip lock polythene bags and stored in ice boxes containing wet ice.

3.4.1 Extraction and analysis of water for pesticide residues

Water samples were extracted following solvent-solvent extraction method using dichloromethane. 1 L of water was transferred into 2 L separatory funnel followed by 50 ml phosphate buffer of pH 7. Drops of 0.1 M hydrochloric acid or sodium hydroxide were added to adjust the pH to 7 before adding 100 g of analytical grade sodium chloride to salt out the pesticides from the aqueous layer. The sample was vigorously shaken to dissolve the salt before adding the extracting solvent. Methylene chloride (60 ml) was added to the original glass bottle to rinse the interior parts of the bottle plus the cap and the mixture transferred to the sample in the separatory funnel. The sample was shaken for two minutes while venting in the fume chamber to release excess pressure, and allowed to settle for 10 minutes to allow the layers to separate. The lower (organic) layer was drained into 250 ml conical flask and covered with aluminium foil. The remaining aqueous layer was re-extracted twice with 60 ml portions of methylene chloride and the extracts combined. The combined extract was filtered through glass wool and anhydrous sodium sulphate into 500 ml round bottomed flask. 2 ml of isooctane was added to the sample as a keeper and concentrated to 1 ml using rotary evaporator and a water bath at 40 °C. The extract was transferred into a 20 ml glass vial and the round bottomed flask rinsed 3 times with 1 ml portions of hexane. The sample was evaporated under a gentle stream of nitrogen to 1 ml before cleanup. The method was repeated for all water samples and recovery standards.

3.4.2 Extraction of soil and sediments

Soil and sediment samples were extracted by Soxhlet method. 20 g of homogenized soil or sediment sample was treated with 60 grams of baked out anhydrous sodium sulphate and ground to powder in a mortar. The sample was allowed to stay overnight to dry further before extraction. The dry sample was transferred into Soxhlet thimble and spiked with 100 μl of 1 ppm PCB155 solution as an internal standard. 130 ml of 3:1 hexane-acetone mixture was transferred into 500 ml round bottomed flask and placed onto the heating mantle. Two boiling cubes were added to the flask to facilitate smooth boiling. The sample was placed into Soxhlet extractor and fitted onto the round bottomed flask containing the extracting solvent mixture. A Soxhlet condenser was fitted on top of the extractor and extraction initiated for 16 hours.

After extraction, 2 ml of isooctane was added to the extract as a keeper before evaporating to 1 ml using a rotary evaporator. The extract was transferred into 20 ml glass vial and the round bottomed flask rinsed 3 times with 1 ml portions of n-hexane. The rinsates were combined with the sample in the glass tube before evaporating to 1 ml under a gentle stream of white spot nitrogen.

3.4.3 Clean up of water, soil and sediment samples

The concentrated sample extracts were cleaned by eluting through 15 g deactivated neutral alumina column and eluting with 165 ml of n-Hexane. A 25 cm glass column with sintered glass bottom was packed with 1 cm anhydrous sodium sulphate, followed by 15 g deactivated neutral alumina then topped with 1 cm anhydrous sodium sulphate. The column was conditioned with 15 ml n-hexane and discarded. The sample was gently transferred on top of the anhydrous sodium sulphate and allowed to elute through the stationary phase. The sample vial was rinsed three times with 1 ml portions of n-hexane and transferred into the column. The sample was then eluted further with 165 ml of n-hexane and collected in a 500 ml round bottomed flask. Isooctane (2 ml) was added to the cleaned sample and concentrated to 1 ml using rotary evaporator.

3.4.4 Fractionation of water, soil and sediment samples

Sample fractionation was done by eluting through a silica column. A chromatographic column of dimensions 1 cm internal diameter and 36 cm long was packed with 1 cm anhydrous sodium sulphate, followed by 1.8 g deactivated silica and topped with 1 cm layer of anhydrous sodium sulphate. The column was conditioned with 4 ml of isooctane before sample elution. The cleaned sample extract was transferred into the silica column using pasture pipette. The glass vial was rinsed three times with 1 ml isooctane and transferred into the column. Fractionation was effected by eluting eluting PCBs with 14 ml isooctane, in the first fraction, and organochlorine pesticides in the second fractions using 10 ml mixture of diethylether/isooctane in the ratio of 1.5: 8.5. Both fractions were analysed using GC-ECD and the concentrations of pesticides quantified using multi-level calibration curves.

3.4.5 Preparation of anhydrous sodium sulphate

Analytical grade anhydrous sodium sulphate (Na_2SO_4) was prepared by baking in an oven at 200 °C for 16 hours to remove contaminants. The reagent was cooled and stored in desiccators ready for use.

3.4.6 Preparation of alumina for cleanup

Analytical grade neutral aluminum oxide (Al_2O_3) for sample cleanup was prepared by baking in a Memmert oven at 200 °C overnight and cooled. Activated aluminium oxide was deactivated by treating with 8% (w/w) distilled water and allowed to stay overnight before use.

3.4.7 Preparation of silica for fractionation

Analytical grade neutral silica (SiO_2) for sample fractionation was prepared by baking in a Memmert oven at 200 °C overnight and cooled. The reagent was deactivated by treating with 1.5% (w/w) distilled water and allowed to stay overnight before use and mixed to obtain a homogeneous powder. The homoginised SiO_2 was allowed to stay for 12 hours to condition before use.

3.4.8 Testing alumina column

25 cm glass column (with frit) was packed with 1 cm layer of baked-out Na_2SO_4 on top of the frit, then 15 g of deactivated Al_2O_3 and another 1 cm of baked-out Na_2SO_4 on top. Packing of the column was done while gently tapping the side of the column to allow uniform settling of Al_2O_3 in the column.

The Al_2O_3 column was conditioned with 15 ml of n-hexane and eluted completely for discarding. 100 µl of a standard solution containing analytes of interest was transferred to the column and eluted with 170 ml n-hexane into a 500 ml round-bottomed flask as fraction 1. A second fraction was eluted with an extra 30 ml n-hexane and collected in a separate round-bottomed flask.

To each fraction, 2 ml isooctane was added as a keeper and mixture evaporated separately to 3 ml using a Labconco rotary evaporator. Each extract was transferred into a tube and the flask rinsed 3 times with 1 ml hexane. The extracts were reduced to 1 ml with a gentle stream of nitrogen and transferred into auto-sampler vials and reduced to 500 µl. To each vial, 100 µl/ml of PCB 198 was added as a syringe standard before GC analysis. A maximum of 2% of the total PCBs and OCPs was allowed in the second fraction to ascertain optimal performance of deactivated alumina.

3.4.9 Testing silica column

Silanised glass wool was plugged into a chromatographic column of dimensions 1 cm internal diameter and 36 cm long followed by 1 cm of baked-out Na_2SO_4, then 1.8 g of deactivated SiO_2 and topped with 1 cm of baked-out Na_2SO_4. The column was tapped on the side while adding SiO_2 to allow homogeneous settling in the column.

4 ml of isooctane was used to condition the column and discarded. 1 ml of a mixture of the PCBs and OCPs was added then eluted with 14 ml of isooctane to give fraction 1. Next, organochlorine pesticides were eluted with 10 ml of isooctane/diethylether (85/15 v/v) and collected separately as fraction 2. Finally the column was eluted with 5 ml of isooctane/ diethylether (85/15 v/v) and collected as fraction 3. The three extracts were evaporated to 1 ml each under a gentle stream of nitrogen. All the extracts were spiked with 100 μl of 1 μg/ml of PCB 198 as a syringe standard before injection into the GC.

Fraction 1 contained PCBs and some OCPs such as DDT and BHC, fraction 2 contained no more than 2% of the PCBs on the basis of peak height whereas OCPs were divided over the fractions 1 and 2. Less than 2% of the OCPs in fraction 3 confirmed well conditioned silica for fractionation hence the concentrations in fraction 3 were not factored into the calculations.

3.4.10 Preparation of the calibration curve

The calibration of the instruments was done using the stock solutions of PCBs and OCP standards. Nine level calibration series were prepared from stock solution and appropriate volume transferred directly into autosampler vials. Multilavel calibration curves were developed and used to calculate the concentrations of analytes in the samples using external and internal calibration methods. Measurement of standards and samples was conducted by taking appropriate volumes and confirming by weighing the exact masses using analytical balance.

3.4.11 Analysis of pesticide samples

Analysis of the samples was done using two gas chromatographic systems: Agilent 6890N loaded with Chemstation version 10.4 and VARIAN CP3800 loaded with Star Workstation version 5.3. The performance of each equipment was tested using level 1 of the calibration standards and the responses compared for all compounds to the response of the same level injected in the multi-level calibration of the previous sequences. Deviation of more than 5% was considered as maximum for preparation of a new calibration curve.

The samples injection sequence followed first, a solvent blank run (isooctane) followed by the most diluted standard from the calibration curve and the mid-calibration curve standard. Then the blank sample, the reference sample, the real samples and the other calibration standards were injected at random. The mid-calibration level standard was injected as the last sample at the end of the daily sample sequence to monitor the instrument performance. Samples with compounds in levels higher than the calibration window were re-injected after dilution.

3.4.12 GC conditions

Analysis of samples was conducted using Varian CP 3800 and Agilent 6890N GC instruments. Analyses of all samples were conducted in splitless mode using GC-ECD and GC-μECD instruments with the detectors temperature at 300 °C while the temperature for injectors was set at 250 °C for both Varian CP 3800 and Agilent 6890N, respectively.

For Agilent 6890N, analyses were conducted using HP5 capillary column of dimensions 30 m x 320 μm x 0.25 μm and a temperature program with initial temperature of 90 °C for 3 minutes, ramped to 150 °C at 15 °C/min with a hold time of 5 minutes, then ramped to 180 °C at 4 °C/min with a hold time of 5 minutes, then ramped to 250 °C at 2 °C/min with zero hold time and finally ramped to 275 °C at 10 °C/min with a hold time of two minutes. White spot nitrogen was used as both the carrier and makeup gas. A carrier gas constant flow rate of 2 ml/min was maintained throughout all the analyses, whereas the makeup gas was maintained at a constant flow of 30 ml/min.

For VARIAN CP 3800, analyses were conducted using BPX5 capillary column of dimensions 30 m x 250 μm x 0.25 μm and a temperature program with initial temperature of 90 °C for 3 minutes, ramped to 180 °C at 15 °C/min with a hold time of 10 minutes, then ramped to 250 °C at 5 °C/min with a hold time of 15 minutes and finally ramped to 275 °C at 10 °C/min with a hold time of two minutes. High purity helium gas (99.999%) was used as a carrier gas whereas white spot nitrogen was used as a makeup gas. A carrier gas constant flow rate of 1 ml/min was maintained throughout all the analyses, whereas the makeup gas was maintained at a constant flow of 30 ml/min.

3.4.13 Integration and interpretation of chromatograms

The system stability over the entire analysis was tested by doing an overlay of the middle point of the calibration curve and all the re-injections of this point during the sequence. All chromatograms with the same responses for all peaks within a margin of 5% confirmed the system stability. Calibration curves were constructed for all compounds using Chemstation (for Agilent 6890N) and Workstation version 5.3 (for VARIAN CP3800). The system linearity was checked for each compound before consideration of the calibration curve.

3.4.14 Quality Assurance and Quality Control (QA&QC)

Analysis of all samples was done in triplicate to verify the presence of the analytes in the samples. Sample blanks, reference materials, spiked samples were included in the sample extraction, cleanup and fractionation to verify the method performance. Also the use of internal standards (PCB 103 and PCB 155) was applied to check the recoveries.

The method detection limits were calculated by reviewing the noise in the chromatograms next to the peak of interest. The detection limit was set as three times the noise divided by the response of the compound in the lowest calibration point multiplied by the concentration of that point (in ng injected). All compounds found with concentrations below the detection limit were reported as less than the detection limit (BDL). The LOQ (limit of quantification) was calculated in the same way, using ten times the noise level.

3.5 Measurement of water temperature

Water temperature and pH were measured by IQ Scientific instruments Dual pH Technology model 1Q150. Water temperature was measured by dipping the temperature probe into the river water approximately 1 m from the river bank and taking the reading after stabilization. For pH measurements, the meter was first calibrated using buffer solutions of pH 7, 10 and 4. After calibration, the probe was dipped into the river water and allowed to equilibrate for 1 minute before taking the reading.

3.6 Conductivity and total dissolved solids in water

Conductivity and total dissolved solids were measured using WinLab Data Line Conductivity meter Model No: 1345069 from Windaus Labortechnik. Calibration was done by measuring the standard solutions before measurement of the real samples. The probe was dipped into the river water approximately 1 m from the river bank and adjusted to measure conductivity (µS/cm) and total dissolved solids in mg/L.

3.7 Laboratory experiments

Pesticide fate and transport was investigated through degradation and sorption experiments. Lindane was selected for laboratory experiments based on its high frequency in environmental samples. Soil samples from three different sites were used in degradation studies.

3.7.1 Degradation experiments

Pesticide degradation experiments were carried out using gamma hexachlorocyclohexane (γ-HCH). Experiments were carried out on three different soils from Nyando, Nzoia and Yala rivers. The soils were ground and sieved through 2 mm mesh. Triplicates of 100 g equivalent weights of oven dry soil were transferred into 200 ml flasks. The moisture of each soil was adjusted to 50%. The mass of soil needed for the set up was obtained from the equation: $MT_1 = Ms\theta w + Ms$, where MT_1 is the total mass of the air dry soil, Ms is the mass of oven dry soil, and θw is the percentage water content. Using the same relationship, the mass of the soil at 50% is given by equation: $MT_2 = Ms\theta Fc + Ms$, where θFc is the water content at 50%. The difference between MT_2 and MT_1 is the amount of distilled water added for the soil to have 50% water content.

For each type of soil, three different setups representing non-amended soil, soils amended with 5000 mg/kg of compost and sterile soil were prepared. Sterile soil was prepared by treating soil with mercuric chloride (10 mg/kg). The flasks were treated with 0.4 ml of 100 mg/l of pesticide solution to achieve the recommended application rate of 250-300 g/Ha. The predicted environmental concentration in soil (PECS in mg/kg) was calculated assuming a single application following the equation:

$$\text{Initial PECS} = A \times (1 - f_{int}) / (100 \times \text{depth} \times \text{bd})$$

Where A = application rate (g/ha), f_{int} = fraction intercepted by crop canopy, depth = mixing depth (cm) and bd = dry soil bulk density (g/cm^3). The soil bulk density of 1.5 g/cm^3 and a mixing depth of 5cm were assumed for all the soils. The intercepted fraction was set at zero for bare soil.

Biodegradation was described according to Lyman *et al.* [1990], Wang and Hoffman [1991], Haug [1993], and Eneji *et al.* [2002], using a first order equation below:

$$C_t = C_0 e^{(-kt)}$$

Where, C_t = concentration of the organic substrate in mg/kg at time t, C_0 = initial concentration of the organic substrate in mg/kg, and k = rate constant (day^{-1}). A plot of ln (C_t /C_0) versus time was made, where the slope equal to k. The rate constant was used to derive the half life ($t_{1/2}$): where $t_{1/2} = (\ln 2)/k$.

3.8 Statistical data analysis

Statistical analyses were performed using Excel, SPSS and SigmaPlot packages. Correlation analysis was done to establish seasonal variations and the levels of phosphates and pesticides in soils, sediments and water samples. sediment exchangeable phosphorus concentrations (EPCo), sediment bio-available phosphorus (SBAP), soil available phosphorus (EXP), total reactive phosphorus (SRP), total hydrolysable phosphorus (THP) and total phosphorus (TP) in water samples. Principal Compont Analysis (PCA) was carried out to identify the main factors affecting the water quality. SIGMA Plot statistical package was used to present data in comparative charts and error margins.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 PHYSICO-CHEMICAL CHARACTERISTICS OF WATER, SOILS AND SEDIMENTS FROM LAKE VICTORIA BASIN

The quality of an aquatic ecosystem is a function of either or both natural and anthropogenic activities within the basin and the surrounding catchment. The main natural drivers include the resources and processes such as minerals, weathering of bed rock and atmospheric factors. The anthropogenic drivers are mainly due to human activities. Therefore, the levels and changes in physiochemical characteristics of water, soil and sediment within the catchment can be used to identify the causes of deteroriation of water quality [Stoddard *et al.*, 1999].

4.1.1 Physico-chemical properties of Lake Victoria water

Basic water properties such as pH, specific conductivity, Total Dissolved Solids and temperature were measured using portable meters. The levels varied from one parameter to another; with spatial and temporal changes reflecting the diversified human activities within the catchment.

4.1.1.1 Conductivity

Water conductivity of the basin showed significant variations depending on the nature of the site. But generally, high conductivities were measured in effluents from wastewater treatment plants discharged into the lake; with highest levels detected in Homa Bay wastewater treatment effluent and Homa Bay Market effluent (Figure 4.1.1). The high levels of conductivity could be attributed to high levels of dissolved solids in the samples from these two sites. The river and lake samples had comparable conductivity; with most of the sites recording below 300 µS/cm. However, no clear consistent trend in conductivity was observed for the lake and river samples across all the seasons. But for direct discharge, the levels measured during wet season were lower than measurements during the dry and short rains, alluding to dilution of effluent water by the rain water.

The mean conductivity for dry season I was 235 µS/cm, with the median concentration of 118 µS/cm, whereas the lowest and the highest measured concentrations were 45 µS/cm and 1474 µS/cm, respectively. The short rain season had mean conductivity of 222 µS/cm with a median of 129 µS/cm, whereas the lowest and highest concentrations were 62 µS/cm and 1,562 µS/cm, respectively. Compared to the dry season II, the dry season I had a slightly elevated concentration, with the mean of 237 µS/cm and a median concentration of 137 µS/cm, whereas the lowest and highest levels were 89 µS/cm and 1,457 µS/cm, respectively (Annex Table 4.1.1A). Although the recorded levels of conductivity shows that the quality of the lake and river water may be good for human consumption, continuous discharge of effluent with high dissolved solids and conductivity may gradually impact the water chemistry and quality negatively, hence should be controlled.

Specific conductance measurements were carried out to establish the ability of water to conduct an electrical current; a property which is also associated with the ions concentration in water. In most cases, conductivity is used as a surrogate of salinity measurements and is considerably higher in more saline systems than in non-saline systems [Dodds, 2002].

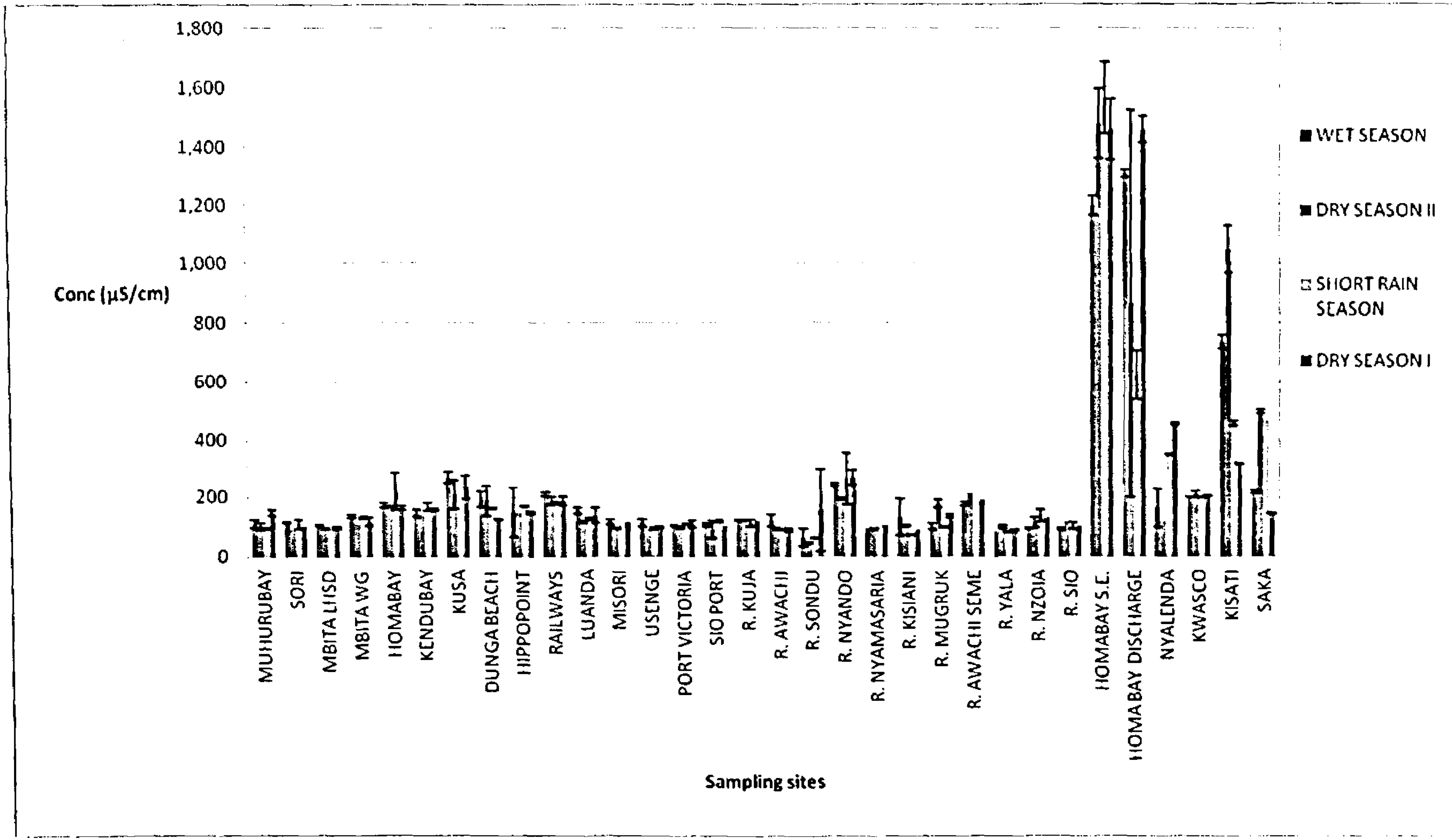

Figure 4.1.1: Conductivity of Lake Victoria Basin water

4.1.1.2 Total dissolved solids in water

Total dissolved solids (TDS) measures the amount of cations and anions dissolved in water. The most common salts include sodium and calcium sulphates, phosphates and chlorides. The trend in TDS was similar to that of conductivity; with Homa Bay discharge and sewerage effluents recording the highest concentration. Both river and lake water showed comparable TDS levels (Figure 4.1.2 and Annex Table 4.1.2A). Among the rivers, River Nyando recorded the highest TDS, followed by Awachi Seme and River Nzoia. On the other hand, Kusa, Homa Bay, Kisumu Railways and Dunga recorded the highest TDS among the shorelines.

The wet season recorded a mean concentration of 114.72 mg/l and a median concentration of 66.75 mg/l, whereas the highest and lowest levels were 26.91 and 649.5 mg/l. This was lower than the highest concentration registered in the short rain season (778 mg/l), with the mean concentration of 110.96 mg/l and median of 64 mg/l. Among the dry seasons, the dry season II (September) recorded the average concentration of 117.58 mg/l and median level of 59.5 mg/l. The lowest concentration was 22.5 mg/l whereas the highest was 734.5 mg/l measured in effluents discharged from Homa Bay sewerage treatment plant. For the dry season I, the mean concentration was 117.57 mg/l with a median concentration of 68.08 mg/l, whereas the highest and lowest concentrations were 726 mg/l and 34.82 mg/l, respectively.

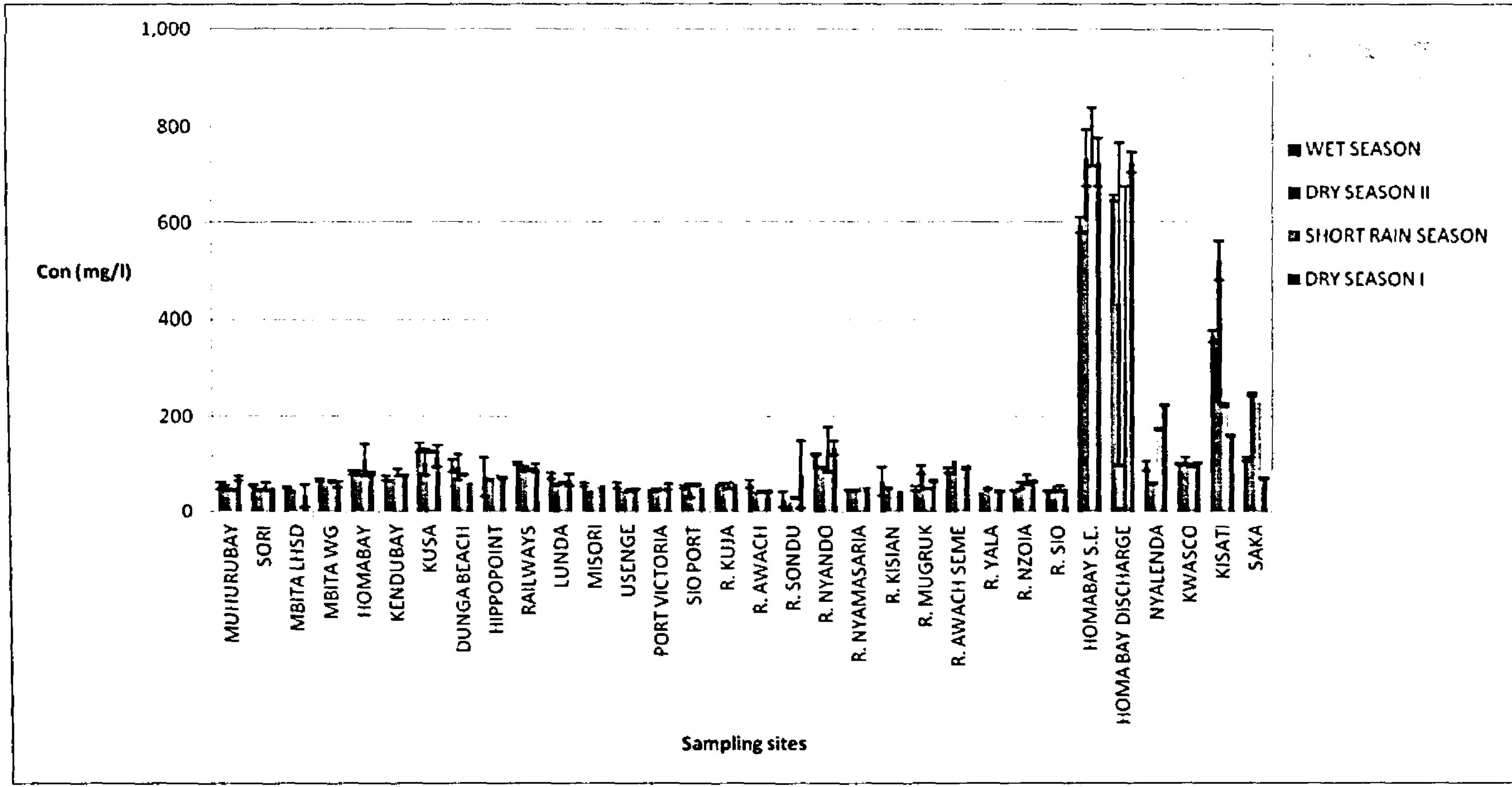

Figure 4.1.2: Total dissolved solids in Lake Victoria Basin water

Strong correlation was observed between TDS measured in adjacent seasons compared to the alternating seasons. For example Pearson correlation of 0.92 ($p< 0.01$) was observed between the wet and dry season II compared to 0.84 ($p < 0.01$) observed between the wet and short rain seasons. Consequently, TDS levels between consecutive seasons were attributed to carry over effects, whereas the levels measured among the alternating seasons were attributed to fresh inputs.

4.1.1.3 Water pH of Lake Victoria Basin water

The pH of an aquatic ecosystem is related to biological productivity and hence its measurement is of significance. It is based on the fact that a small number of water (H_2O) molecules dissociate and form proton (H^+) and hydroxyl (OH^-) ions. The relative proportion of the proton ions compared to the hydroxyl ions determines the acidity or basity of water [US EPA, 1997; Friedl *et al.*, 2004]. The tolerance of individual species varies with the nature of water. However, pH ranging between 6.5 and 8.5 is generally considered as an indicator of good water quality. Figure 4.1.3 below and Annex Table 4.1.3A show that the pH levels of all water samples were within the recommended levels of between 6.5 and 8.5 hence suitable for drinking [WHO, 2004].

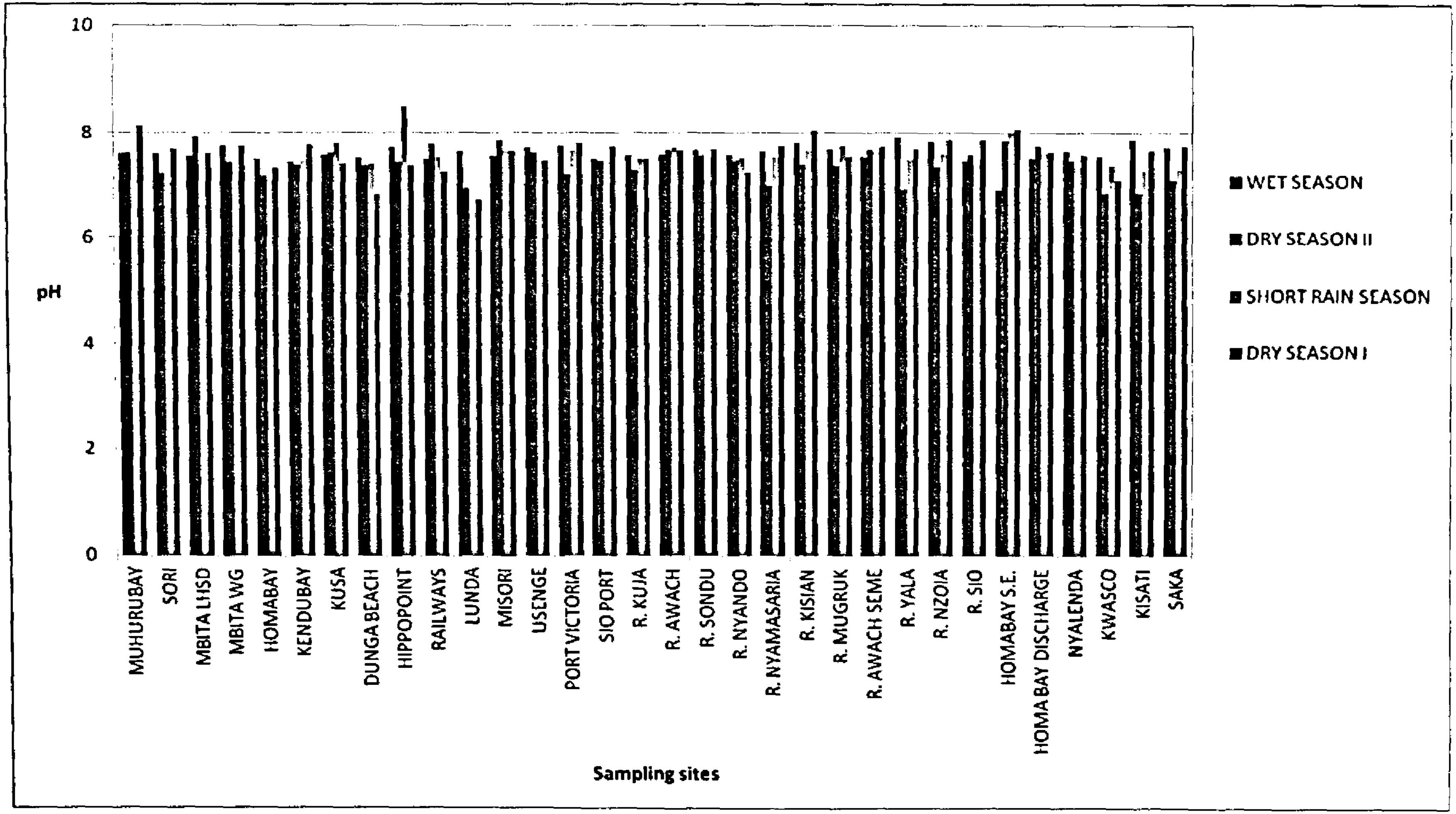

Figure 4.1.3: pH of water from Lake Victoria Basin

Based on the hydrological cycle, natural acidity in rainwater is caused by the dissolution of atmospheric carbon dioxide (CO_2) and other gases like sulphur dioxide (SO_2). The hydrogen ions entering a drainage basin in rainwater are neutralized by carbonate and silicate minerals as water percolates through soils. This neutralization capacity in soils determines whether or not acid precipitation will cause water quality impacts in receiving water bodies. But the ability of rocks and soils in any given drainage basin to buffer the acidity of rainwater is related to the residence time of water in the soil as well as the levels of calcium carbonate, bicarbonate and silicate minerals [Friedl *et al.*, 2004; Wetzel and Likens, 2000].

Evaluation of seasonal variation in water pH showed no significant difference in levels across all the seasons implying limited influence of human activities on water pH recorded in the basin.

4.1.1.4 Water discharge/stream flow

Figure 4.1.4 below and Annex Table 4.1.4A summaris the discharge rates measured for different rivers under this study. The highest discharge rates were measured in Rivers Nzoia, Kuja, Nyando and Sondu, whereas the lowest were Mugruk, Awach, Kisiani, Awach Seme and Saka. The discharge rate for Nzoia could not be measured during the wet seasons due to extremely fast and dangerous velocities and increased depth that rendered the application of the tools impossible.

The discharge data showed higher rates between July and September compared to the period between October and December, with strong influence not only from seasonal changes, but also the local environment especially for direct discharges such as Saka.

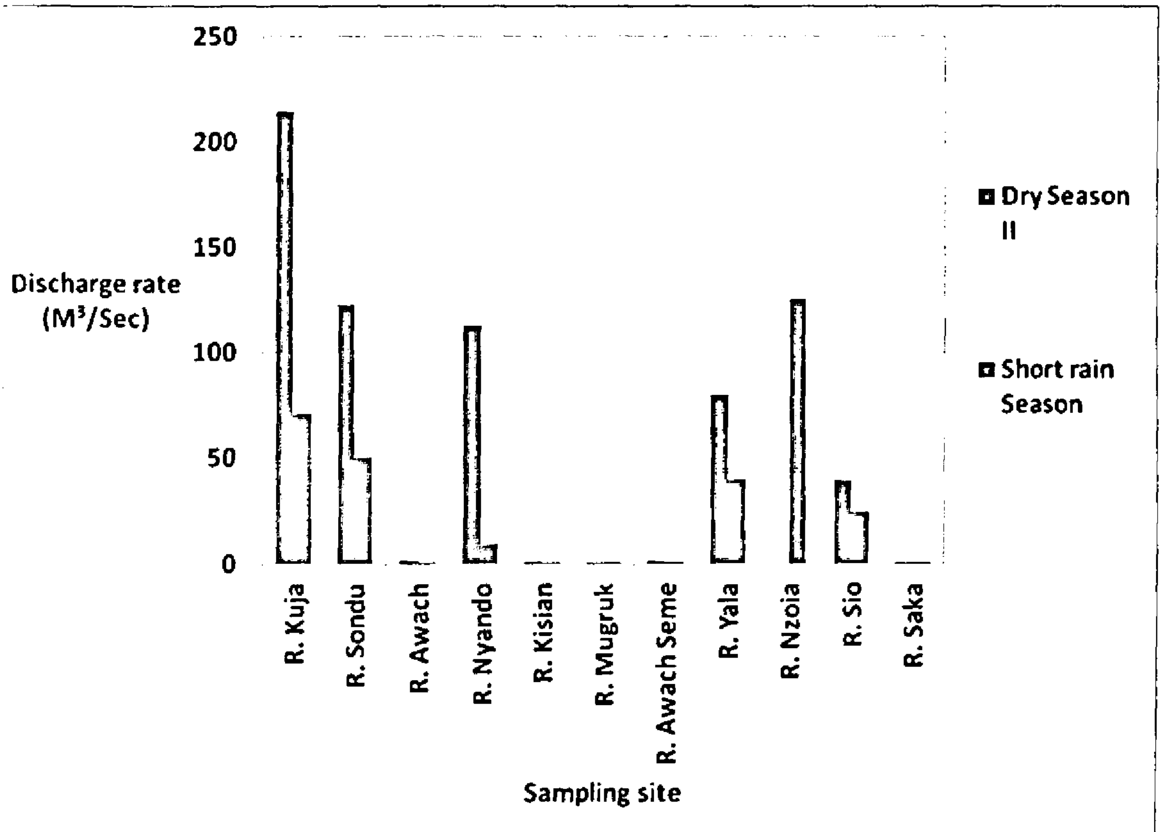

Figure 4.1.4: Discharge rates of the Rivers in the Kenyan Catchment of Lake Victoria

The results showed that the discharge rates of the rivers in the catchment are strongly affected by seasonal variations, increasing during rainstorms and decreasing during dry periods. As a consequence, the increase in the stream velocity would influence the kinds of organisms and habitats that can be found in the entire- or a particular section of the stream, as well as the chemical composition of a riverine environment. For instance, some organisms prefer fast moving streams whereas others prefer slow moving waters. Stream velocity also affects the amount of silt and sediment carried by the stream, whereby sediments in slow-flowing streams settle to the stream bottom, whereas in the fast-moving waters, they will remain suspended in the water column, and eventually settle in lakes, reservoirs or the near shore environments. Further, the flow can also influence fluctuations in stream water temperature, because temperature is more heavily influenced by atmospheric conditions during periods of low flow.

As a consequence, discharge rates influence the susceptibility of a stream to pollution. In most of the cases, large, swiftly flowing rivers can receive pollution discharges and, through dilution, be little affected, whereas small, slow-flowing streams have a reduced capacity to attenuate and degrade wastes.

4.1.2 Characteristics of Lake Victoria basin soil

4.1.2.1 Texture characteristics for Lake Victoria basin soil

Analysis of the texture of the soils revealed high levels of sand in most of the sites, followed by clay and silt. The high composition of sand implies low levels of organic matter hence low ability to retain organic contaminants such as pesticides. This has a strong effect on the influx of agrochemicals into the lake contributing to pollution, especially through the storm water. The composition of sand, clay and silt was nearly equal in the soil collected from Dunga Beach. Figure 4.1.5 summarises the composition of sand, clay and silt in soils from different sites.

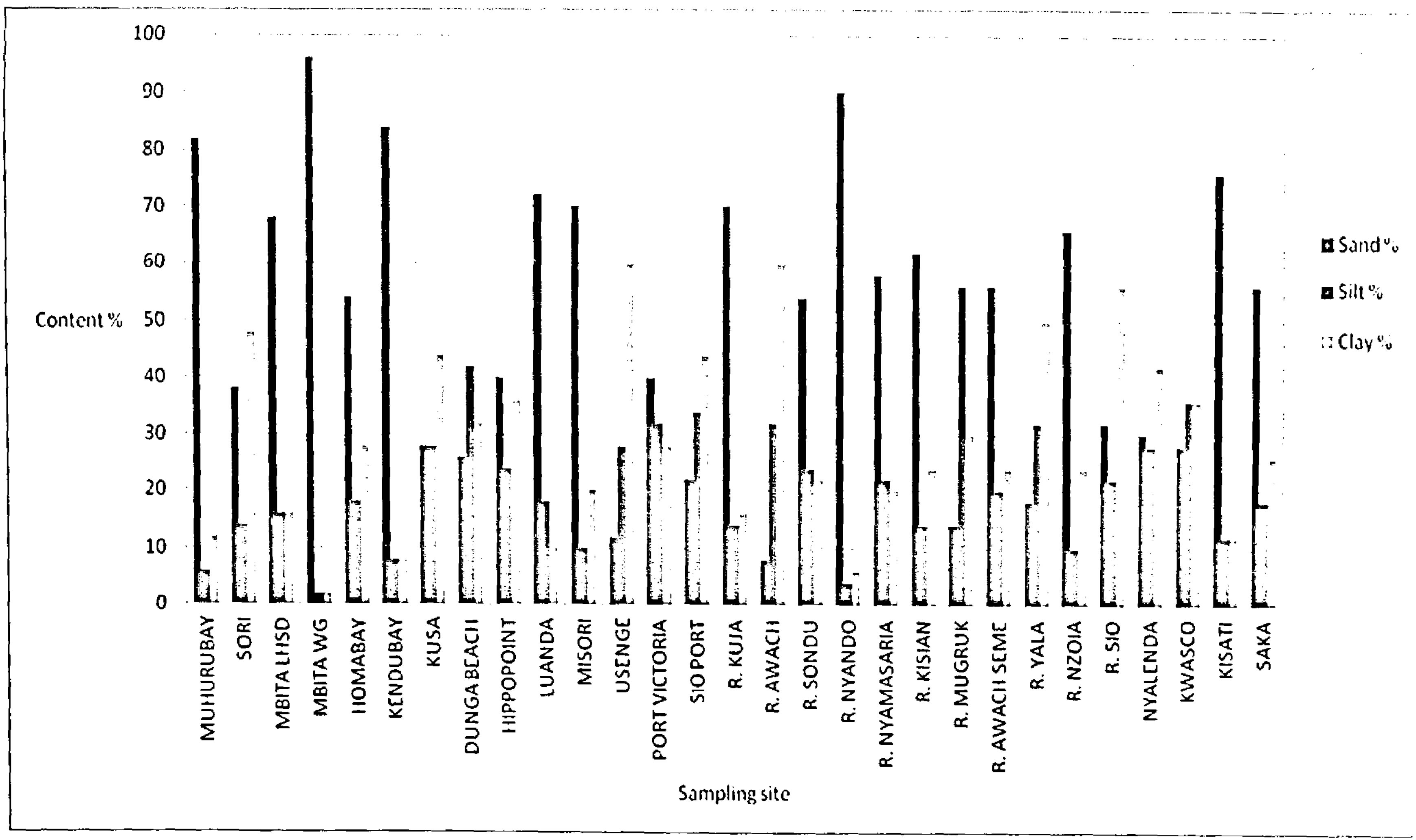

Figure 4.1.5: Composition of sand, silt and clay in Lake Victoria basin soil

This variation in composition of sand, clay and silt in Dunga soil compared to other sites could be attributed to its close proximity to the lake, and also the possibility that most of the dry land around this site formally constituted part of the lake, before the lake levels started to shrink.

4.1.2.2 Characteristics of Lake Victoria basin soil

Table 4.1.1 below shows the composition of different soil properties in Lake Victoria Basin. Soil pH ranged between 4.07 and 7.79 with the highest and lowest values measured at Sio Port and Usenge, respectively. The majority of the soils had pH ranging between 5 and 7. High levels of phosphorus were measured in all the soils compared to nitrogen, with P:N ratio ranging from 60 to 1,517 measured at Railways and Dunga Beach, respectively. Soil acidity had major effect on phosphorus chemistry, since low pH causes P to form insoluble compounds with aluminium and iron, but increasing pH dissolves these insoluble compounds and allows P to be more available for plant uptake. However, pH beyond 7.0 causes P to form complexes with Ca or Mg [Ian, 2007], hence soil pH between 5.5 and 6.8 is recommended to avoid formation of complexes that would limit available phosphorus concentration to plants.

The levels of calcium and magnesium were comparable for most of the sites, whereas organic carbon content ranged between 0.21 and 2.25 %. Among the metals, iron constituted the highest concentration followed by zinc.

Clay content was highest in soils from River Sio, Nyalenda, Nzoia, Yala, Awach, Sio Port, Kusa and Sori, whereas silt constituted the highest texture composition at Dunga, Mugruk and KWASCO. High silt content was attributed to runoff from the surrounding areas.

Table 4.1.1 : Lake Victoria Basin soil properties

	pH	N%	OC%	P%	K e%	Ca e%	Mg e %	Mn e%	Cu ppm	Fe ppm	Zn ppm	Na e %
MUHURUBAY	7.45	0.12	1.07	8	0.27	8.3	1.67	0.66	6.08	25.4	12.9	0.28
SORI	7.53	0.11	1.01	10	0.59	27.7	5.82	0.31	4.54	10	6.61	1.87
MBITA LHSD	7.57	0.11	0.98	11	0.53	6.6	3.01	0.24	1.58	4.51	13.6	0.56
MBITA WG	7.75	0.01	0.04	9	0.87	9.7	2.57	0.36	5.26	7.88	18.5	1.47
HOMABAY	7.25	0.21	1.96	82	0.29	12.5	5.26	0.56	5.9	6.51	27.1	0.18
KENDUBAY	7.34	0.18	1.72	8	1.13	13.1	1	0.71	6.68	310	12.4	1.17
KUSA	5.45	0.22	2.25	68	0.82	7.7	5.06	0.87	2	181	12.2	0.54
DUNGA BEACH	5.91	0.17	1.59	258	0.69	5.6	3.2	0.7	2.12	330	23.5	0.4
HIPPOPOINT	5.37	0.19	2.04	90	1.13	11.7	5.12	1.44	3.2	186	17.8	0.89
RAILWAYS	7.04	0.2	1.94	12	0.49	9.7	1	1.66	76.8	564	113	1.03
LUANDA	7.76	0.03	0.21	7	0.87	24.5	4.63	0.29	3.62	1.22	3.69	0.16
MISORI	7.62	0.11	0.99	25	1.11	17.6	4.78	0.39	6.3	19.2	20	0.96
USENGE	7.79	0.03	0.17	22	0.59	7.7	1.58	0.43	9.13	3.5	6.99	0.14
PORT VICTORIA	5.53	0.09	0.79	165	0.49	3.6	3.04	0.73	6.97	430	14.4	0.16
SIO PORT	4.07	0.14	1.23	59	0.79	6.6	3.59	0.51	7.49	1027	28.4	0.62
R. KUJA	7.06	0.04	0.29	62	0.83	8.7	4.74	0.81	5.66	73.1	14.2	2.05
R. AWACH	6.01	0.17	1.62	31	0.81	7.7	5.04	1.18	6.37	146	30.9	0.6
R. SONDU	5.8	0.11	1.04	24	0.55	4.4	2.64	0.9	4.57	491	17.2	1.17
R. NYANDO	6.2	0.1	0.89	66	1.19	19.1	5.28	1.16	10	1963	12.4	0.32
R. NYAMASARIA	6.04	0.06	0.54	40	0.71	3.6	3.75	0.56	5.33	301	8.54	2.05
R. KISIAN	5.86	0.08	0.65	30	0.83	5.6	2.49	0.77	6.65	71.8	6.81	1.13
R. MUGRUK	7.38	0.07	0.59	7	0.14	3.5	2.15	0.2	1.01	152	6.18	0.32
R. AWACH SEME	6.09	0.07	0.61	42	0.71	1.8	3.09	0.99	6.57	121	6.68	0.22
R. YALA	6.37	0.04	0.26	35	1.01	16.5	3.99	1.05	5.82	93.1	10.6	1.65
R. NZOIA	6.55	0.09	0.79	41	0.41	6.8	4.71	1.08	9.42	669	10	0.06
R. SIO	5.71	0.12	1.14	18	0.35	5.6	2.85	0.62	9.89	72.2	5.92	0.58
NYALENDA	5.49	0.16	1.48	33	0.49	7.7	3	1.92	8.81	476	20.2	0.87
KWASCO	7.4	0.11	1.01	2	0.33	16.7	3.42	0.79	5.33	475	14.1	0.36
KISATI	6.38	0.12	1.11	50	0.69	7.7	0.75	1.05	2.49	82.4	8.36	0.73
SAKA	6.07	0.07	0.44	20	0.25	4	2.22	0.64	4	107	11.1	0.06

e = equivalent; ppm = parts per million

4.1.3 Characteristics of Lake Victoria Basin Sediments

4.1.3.1 Texture characteristics of Lake Victoria Basin sediments

Most of the sediments had high sand content followed by silt and clay. Except for Dunga, the rest of the sites had sand constituting over 50% of the total composition (Figure 4.1.6).

High levels of sand and silt in the sediments could be attributed to the strong influence of soil erosion by the surface runoff and the rivers in the catchment. Dunga had considerably high levels of organic matter due to the huge mass of water hyacinth that contribute large amount of organic matter during decomposition process.

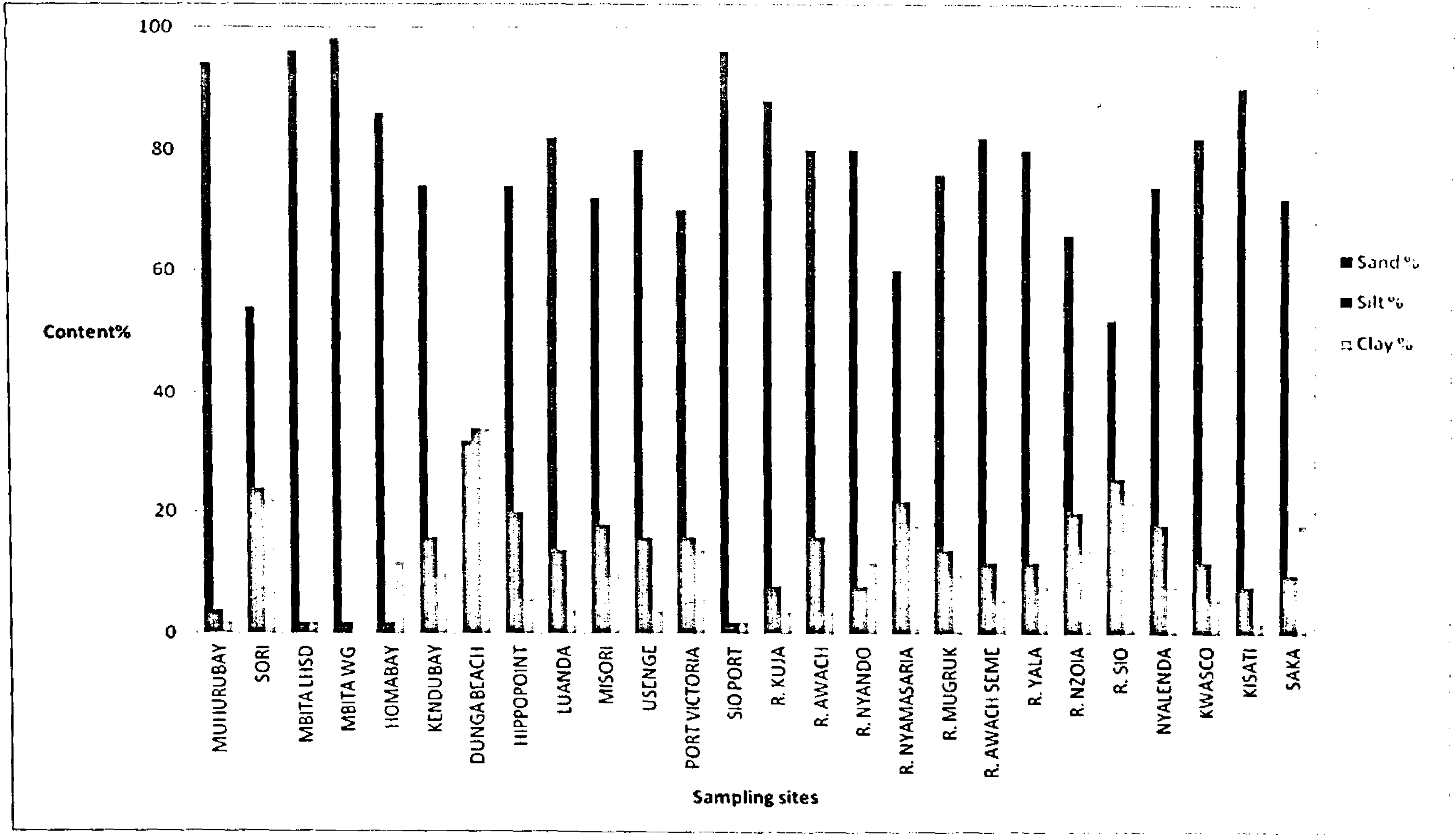

Figure 4.1.6: Texture classification of Lake Victoria Basin sediments

4.1.3.2 Lake Victoria Basin sediment properties

The highest pH (8.25) was measured at Kisiani, whereas the lowest (6.65) was determined at KWASCO. The ratio of P:N varied from 20 to 12,100 signifying accumulation of phosphorus in the sedimenmts. Like in the case of soils, the levels of iron was the highest (2,486 mg/kg) among the metals analysed followed by zinc which had a maximum concentration of 79.2 mg/kg (Table 4.1.2). Organic carbon in sediments ranged between 0.01 and 1.71 % measured at Port Victoria and Kusa, respectively.

4.1.4 Correlation analysis of physico-chemical parameters

Pearson Correlation showed weak correlation between soil and sediment physico-chemical properties indicating minimal influence between the two media. This implied that soils around the lake shores did not play a major role in the chemistry of the sediments. Results of the analysis are summarised in Annex Table 4.1.5-6A. The implication of the findings is that activities in the upstream play a significant role in impacting the chemistry of the sediments in the lake. The texture composition of soils and sediments in Lake Victoria basin is highly diversified and influenced by environmental conditions. Most of the sites had soils and sediments with high composition of sand which has a significant effect on the fate and transport dynamics of agrochemicals in the catchment. Sediments contained higher clay content compared to the soils, a factor attributed to organic matter decomposition in the lake and river systems. In general, water pH>sediment pH>soil pH in the catchment.

Table 4.1.2 : Lake Victoria Basin sediment properties

	pH	N%	OC%	P%	K%	Ca%	Mg %	Mn%	Cu ppm	Fe ppm	Zn ppm	Na %
MUHURUBAY	7.38	0.07	0.59	7	0.14	3.5	2.15	0.2	1.01	152	6.18	0.32
SORI	7.42	0.04	0.34	14	1.33	14.5	5.3	0.81	4.53	59.3	15.3	1.73
MBITA LHSD	8.03	0.05	0.41	8	0.14	4	2.24	0.45	2.09	204	6.35	0.54
MBITA WG	7.97	0.03	0.17	1	0.16	3.6	1.25	0.27	3.07	118	6.65	0.54
HOMABAY	7.62	0.06	0.51	10	0.49	5.2	5.39	0.94	2.78	9.43	55.4	0.56
KENDUBAY	7.17	0.08	0.68	10	0.49	6.2	2.4	0.99	6.4	12	79.2	0.79
KUSA	6.83	0.18	1.71	47	0.41	7.3	2.79	2.05	20	924	15.4	0.77
DUNGA BEACH	7.49	0.18	1.67	16	0.59	10.9	4.32	1.77	38.1	942	59.2	1.57
HIPPOPOINT	7.87	0.02	0.14	8	0.91	9.3	1.76	1.44	11.4	878	14.7	2.05
RAILWAYS	7.62	0.03	0.16	4	0.69	15.7	1.1	3.32	8.95	2486	63.5	1.81
LUANDA	7.56	0.03	0.17	4	0.25	2.4	2.47	0.75	5.65	369	7.09	0.34
MISORI	7.74	0.06	0.48	18	0.43	7.5	6.8	0.73	6.11	7.16	31.5	1.01
USENGE	7.51	0.03	0.17	13	0.2	2.4	2.5	1.9	5.98	966	6.9	0.34
PORT VICTORIA	7.16	0.01	0.01	12	0.22	3.8	1.83	0.9	9.51	432	37.7	0.52
SIO PORT	7.44	0.05	0.41	1	0.04	2	4	0.08	1.13	201	4.09	0.06
R. KUJA	7.71	0.02	0.15	8	0.55	10.5	3.61	0.45	3.16	5.21	17.2	1.49
R. AWACH	7.88	0.09	0.84	3	0.29	3.2	3.09	2.36	11	510	11.4	0.38
R. SONDU	7.65	0.03	0.15	16	0.27	4.8	4.41	0.47	1.61	8.95	3.18	0.54
R. NYANDO	6.65	0.01	0.02	121	0.49	2.2	2.1	1.09	11.1	925	8.58	2.4
R. NYAMASARIA	7.06	0.05	0.41	11	0.18	1.4	2.79	1.74	4.5	2156	7.95	0.14
R. KISIAN	8.25	0.03	0.15	6	0.69	13.7	4.86	1.1	3.21	387	9.56	1.85
R. MUGRUK	7.13	0.03	0.15	4	0.25	2.6	1.48	1.37	4.05	557	5.8	0.34
R. AWACH SEME	7.88	0.02	0.11	2	0.12	2	6.52	1.04	7.22	22	4.04	0.32
R. YALA	7.86	0.03	0.18	7	0.69	12.5	1.8	2.17	10.7	1127	7.39	1.61

R. NZOIA	6.81	0.02	0.11	87	0.87	8.1	5.36	0.8	7.97	177	6.06	1.01
R. SIO	7.37	0.02	0.09	2	0.18	5.4	4.79	1.2	7.35	1709	4.63	0.93
NYALENDA	6.79	0.04	0.34	63	0.95	10.7	5.3	3.69	6.31	1906	15.5	1.33
KWASCO	7.64	0.03	0.17	2	1.09	30.1	0.85	1.14	2.84	336	9.4	3.78
KISATI	7.5	0.04	0.25	14	1.11	7.5	0.55	3.55	6.88	31.5	16.7	0.77
SAKA	6.69	0.04	0.34	90	0.51	3.6	5.96	2.09	4.68	802	12	0.43

4.2 SPECIATION OF PHOSPHORUS WATER

4.2.1 Speciation of phosphorus in water

The phosphorus analysed in water samples was categorized into total reactive phosphorus (TRP), total hydrolysable phosphorus (THP) and total phosphorus (TP). Data interpretation was based on seasonal variations within the basin namely dry season I (January-March), wet season (April-June), dry season II (July-September) and the short rain season (October-December). Evaluation of the results showed differential variability in phosphorus species where total phosphorus (TP)>total reactive phosphorus (TRP)>total hydrolysable phosphorus (THP).

4.2.1.1 Phosphorus levels in water during wet season

Figure 4.2.1 below shows the concentrations of different forms of phosphorus measured in water during the wet season. Phosphorus levels in most sites were considerably higher than the recommended guideline for aquatic life. Total phosphorus was highest in water from Homa Bay sewage effluent with concentration of 17.04 mg/l, followed by Kisati wastewater treatment effluent (5.24 mg/l). Among the rivers, River Awach Seme, Nyando, Sondu Miriu, Awach and Yala were leading in total phosphorus concentrations varying between 2.2 and 1.6 mg/l.

The concentration of phosphorus in shoreline sites was comparable with levels detected in the river samples. The highest concentration of 3.17 mg/l was measured in water from Kusa Beach (Figure 4.2.1) and was mainly attributed to the heavy agricultural activities practised around the site ranging from maize, sugarcane, yams to rice farming. In addition, the site is also in close proximity to the mouth of River Nyando which seems to have a significant influence on levels of phosphorus measured. River Nyando traverses large agricultural farms in the upstream, which comprise of coffee, tea, sugarcane and rice plantations that are characterised by extensive application of fertilizers and pesticides.

Concentrations of hydrolysable phosphates ranged from BDL to 3.38 mg/l, with the highest concentration measured in the effluent from wastewater treatment plant in Homa Bay (3.38 mg/l), followed by Nyalenda effluent (2.27 mg/l) and River Sio at 1.97 mg/l. All the samples from the lakeshores contained hydrolysable phosphorus concentrations below 1 mg/l. Similarly, five out of the eleven rivers sampled had hydrolysable phosphorus below detection limit.

Total phosphorus was the highest in all the samples; a factor which was attributed to the cumulative effect of all other forms of phosphorus in the sample, including the total reactive phosphate, the total hydrolysable phosphorus and the organically bound phosphorus. The concentrations of total phosphorus in the effluents from the wastewater treatment sites ranged between 1.59 and 21.51 mg/l, which were several magnitudes higher than levels detected in the rivers and lake samples with concentrations ranging from 0.45 to 6.51 mg/l for the rivers and from 1.41 to 7.0 mg/l for the lake samples (Annex Table 4.2.1A).

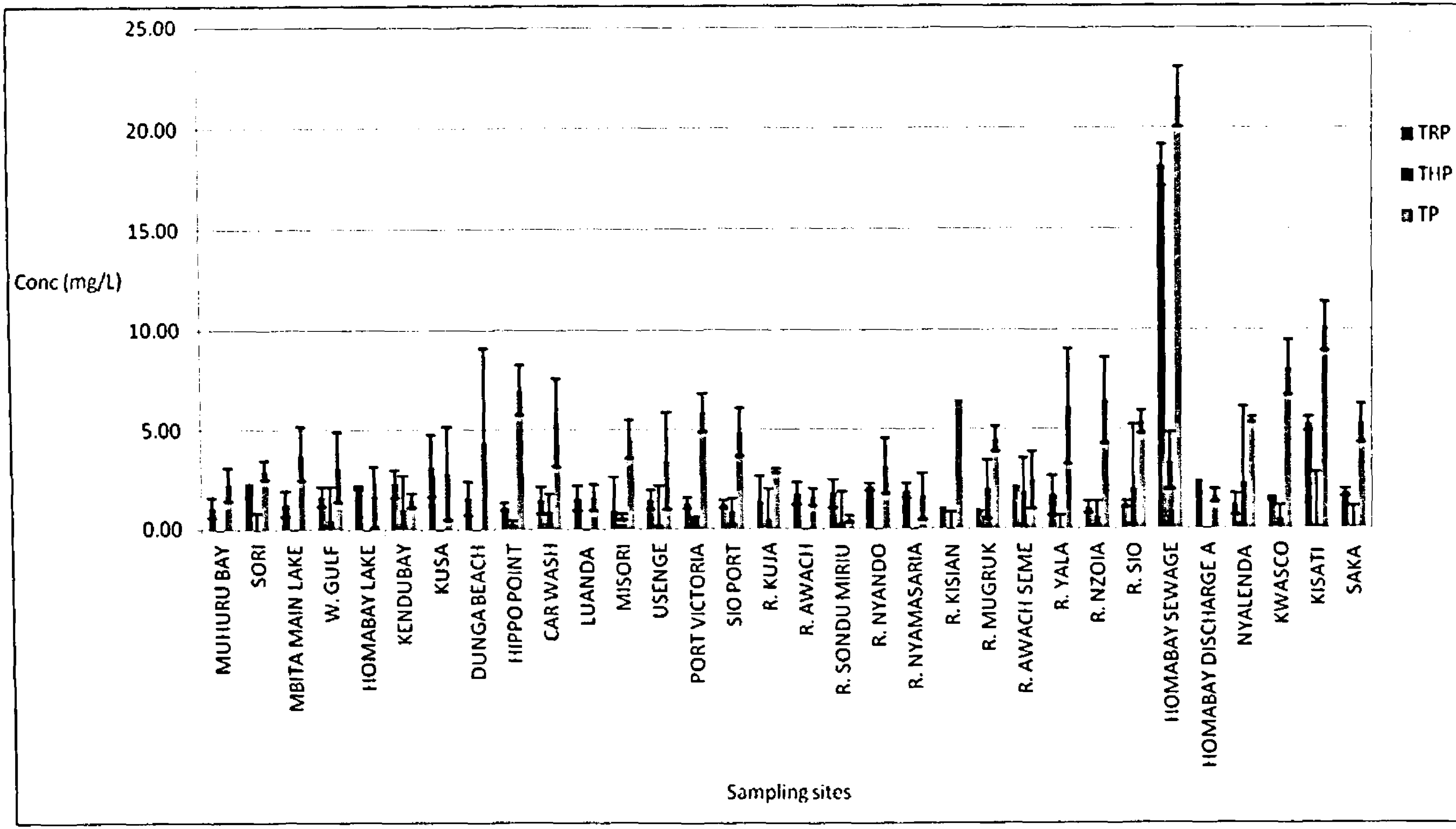

Figure 4.2.1: Concentrations of phosphorus in water during the wet season

4.2.1.2 Phosphorus levels in water during dry season II

The concentrations of phosphorus in the dry season II were lower compared to those measured in the wet season. The highest concentration was recorded in effluents from Homa Bay wastewater treatment plant, Kisati, Saka and Homa Bay discharge from the commercial activities (Figure 4.2.2). The rivers and lakeshore samples had considerably low phosphorus, varying from BDL to 0.8 mg/l.

Hydrolysable phosphorus in the dry season II ranged between BDL and 3.83 mg/l. The effluent from direct discharge and the wastewater treatment plants recorded the highest concentrations (3.83 mg/l in samples from Homa Bay sewage) compared to the rivers and lake samples.

Total phosphorus ranged from 0.78 mg/l to 21.37 mg/l, with the highest measured in Homa Bay wastewater treatment effluents, followed by Kisati (12.41 mg/l). The rivers samples had total phosphorus concentration ranging between 1.89 and 0.78 mg/l detected in samples from River Sondu Miriu and River Nyamasaria respectively. The levels in samples from the lakeshores varied between 1.72 and 0.95 mg/l detected in samples from Kendu Bay and Muhuru Bay, respectively (Annex Table 4.2.2A).

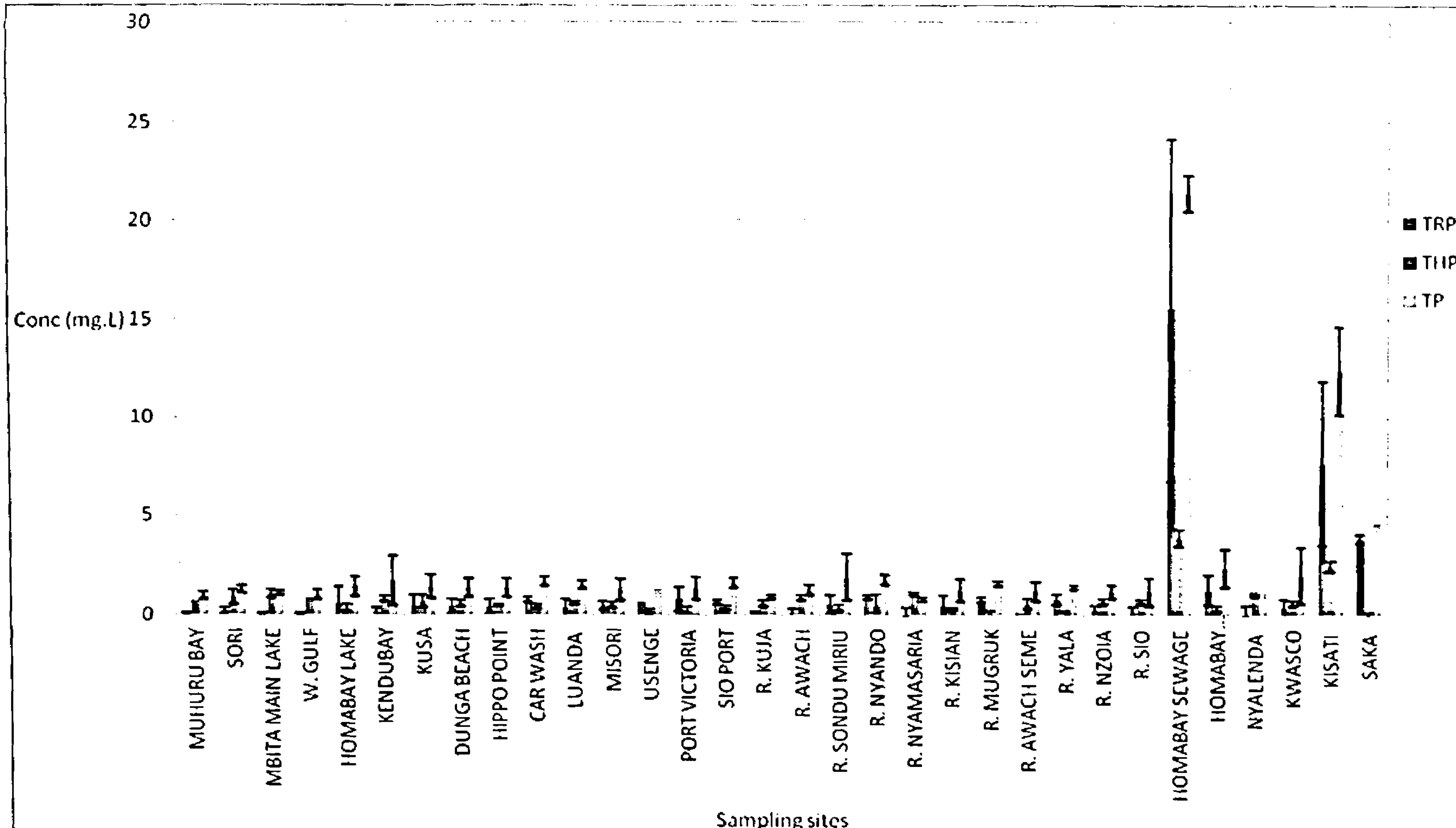

Figure 4.2.2: Phosphorus in water during dry season II

4.2.1.3 Phosphorus levels in water in the short rain season

Total reactive phosphorus ranged between 0.84 and 20.05 mg/l, with the highest amount measured in effluents discharged into the lake through Homa Bay wastewater treatment plant followed by Saka, Kisati, Homa Bay open discharge, Nyalenda and KWASCO. Total reactive phosphorus in the river samples ranged between 0.84 and 2.21 mg/l with the highest concentration measured in samples from Sondu Miriu and Nyando rivers, whereas lake samples had concentrations ranging from 0.94 mg/l and 2.0 mg/l detected in samples from Mbita and Sio Port, respectively (Figure 4.2.3).

High levels of hydrolysable phosphorus were detected in samples from Homa Bay wastewater treatment plant (7.71 mg/l), whereas the rest of the samples analysed for Total Hydrolysable Phosphorus (THP) were much lower with average concentrations varying between BDLand 0.88 mg/l. The lake samples had THP between BDL and 0.63 mg/l, whereas the river water had concentrations between BDL and 0.88 mg/l.

Total phosphorus concentrations in the short rain season were higher than in the wet and dry seasons, with the concentrations in direct discharge sites like Homa Bay wastewater treatment plant effluent characteristically high (33.03 mg/l). Kisati, Saka and Homa Bay open discharge recorded concentrations of 6.28, 5.66 and 3.02 mg/l, respectively.

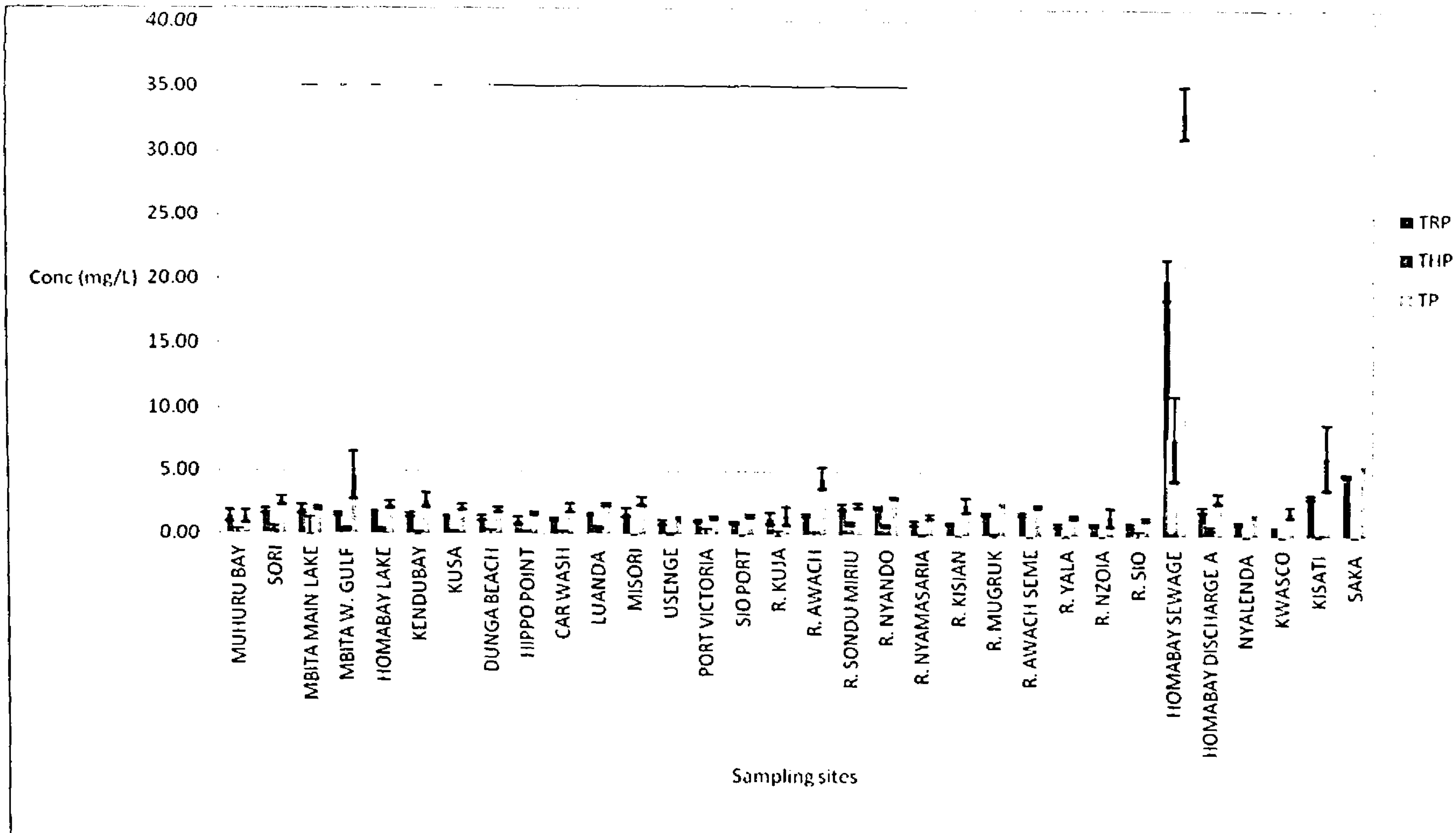

Figure 4.2.3: Phosphorus levels in water during short rain season

The levels measured in the river samples varied between 1.35 and 4.49 mg/l, with the highest concentration recorded in samples from River Awach. This could be attributed to farming activities taking place upriver and drainage of municipal wastes within the river catchment. The lake samples had concentrations between 1.35 and 4.66 mg/l with the highest concentration detected in samples from Mbita Winam Gulf (Figure 4.2.3, Annex Table 4.2.3A). In general the levels of total phosphorus in the lake and river waters were in comparable range.

4.2.1.4 Phosphorus levels in water during dry season I

Total reactive phosphorus (TRP) ranging between 0.71 and 19.62 mg/l mg/l was recorded in the dry season I. In general, samples from effluent discharge points retained the highest concentrations of TRP with Homa Bay wastewater effluent measuring 19.62 mg/l. Other discharge sites had concentration ranging between 0.71 and 1.51 mg/l, whereas the samples from the rivers had TRP between 0.74 mg/l.

River Awach Seme recorded the highest TRP followed by Sondu Miriu, Nyando and Nyamasaria with equal concentrations of 1.07 mg/l. The lake samples had TRP concentrations in the same range as the river samples, with the highest concentration of 1.22 mg/l and the lowest of 0.78 mg/l (Figure 4.2.4 and Annex Table 4.2.4A).

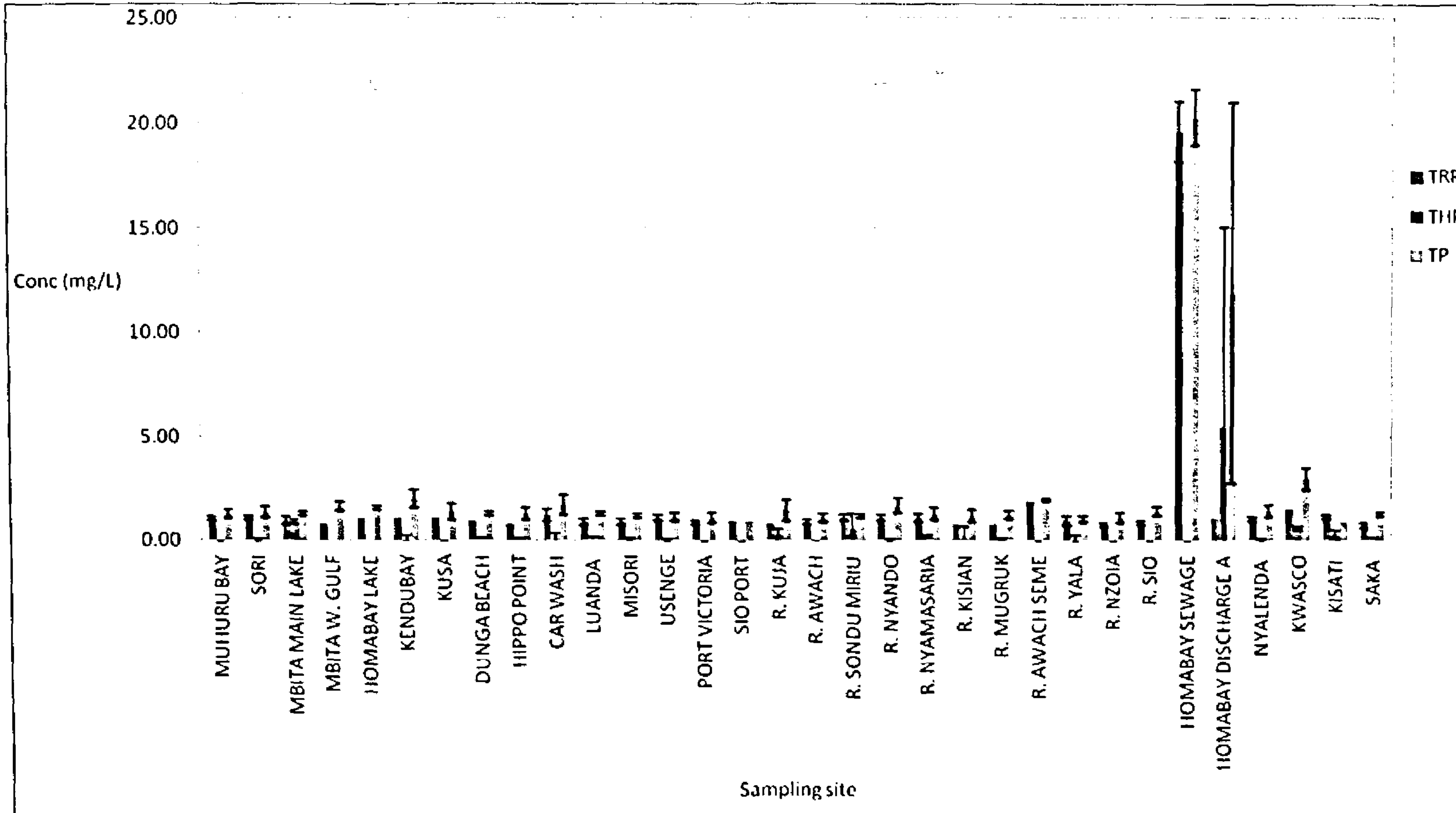

Figure 4.2.4: Phosphorus levels in water during dry season I

THP varied between BDL and 5.58 mg/l, with Homa Bay wastewater treatment effluent recording the highest concentration, followed by Mbita main lake, KWASCO and Sondu Miriu sampling points, with concentrations of 5.48, 0.88, 0.60 and 0.55 mg/l, respectively. In general, THP was the lowest in all the samples except Homa Bay open discharge where it was higher than the reactive phosphorus concentration (Figure 4.2.4). Most of the river water samples and the lake water samples had THP below detection limit.

Total phosphorus (TP) concentration in the dry season I varied between 0.94 and 20.28 mg/l, with the highest detected in effluents from Homa Bay wastewater treatment plant. Samples from effluents discharge sites had characteristically higher TP compared with the samples collected from the rivers and the lake. Homa Bay wastewater treatment plant effluents had the leading concentration of 20.28 mg/l followed by Homa Bay open discharge, KWASCO, Nyalenda, Saka and Kisati (Figure 4.2.4). All samples from the rivers had TP concentration below 2 mg/l with the highest concentration recorded in rivers Awach Seme (1.97), Nyando (1.69 mg/l) and Kuja (1.46 mg/l). The lake samples had concentrations between 0.94 and 2.04 mg/l, with the highest recorded in samples from Kendu Bay, Kisumu Car wash and Mbita Winam Gulf, with mean concentrations of 2.04, 1.74 and 1.65 mg/l, respectively.

4.2.2 Temporal changes in phosphorus in water samples

Analysis of the effects of seasonal variability on the concentration of phosphorus in the basin was carried out based on the four main seasons namely Wet season (April-June), dry season II (July-September), short rain (October-December) and dry season I (January-March).

4.2.2.1 Seasonal variations of total reactive phosphorus

Total reactive phosphorus was highest in the wet and short rain seasons, followed by the dry season I and the dry season II. For both rivers and lake samples, the wet- and the short rain-seasons had the highest concentrations. However, the effect of seasonal variations on the level of total reactive phosphorus was not very distinct in the case of wastewater effluent discharges into the lake. This could be attributed to the fact that most of the wastewater treatment systems in the region are either not properly functioning or that they are overloaded beyond their designed capacity especially during the wet season and short rain season when the runoffs exert more pressure on the performance of the systems. All the rivers and lake samples collected over all the four seasons had total reactive phosphorus below 4 mg/l.

Figure 4.2.5 below shows the temporal changes in the concentrations of total reactive phosphorus in Lake Victoria Basin.

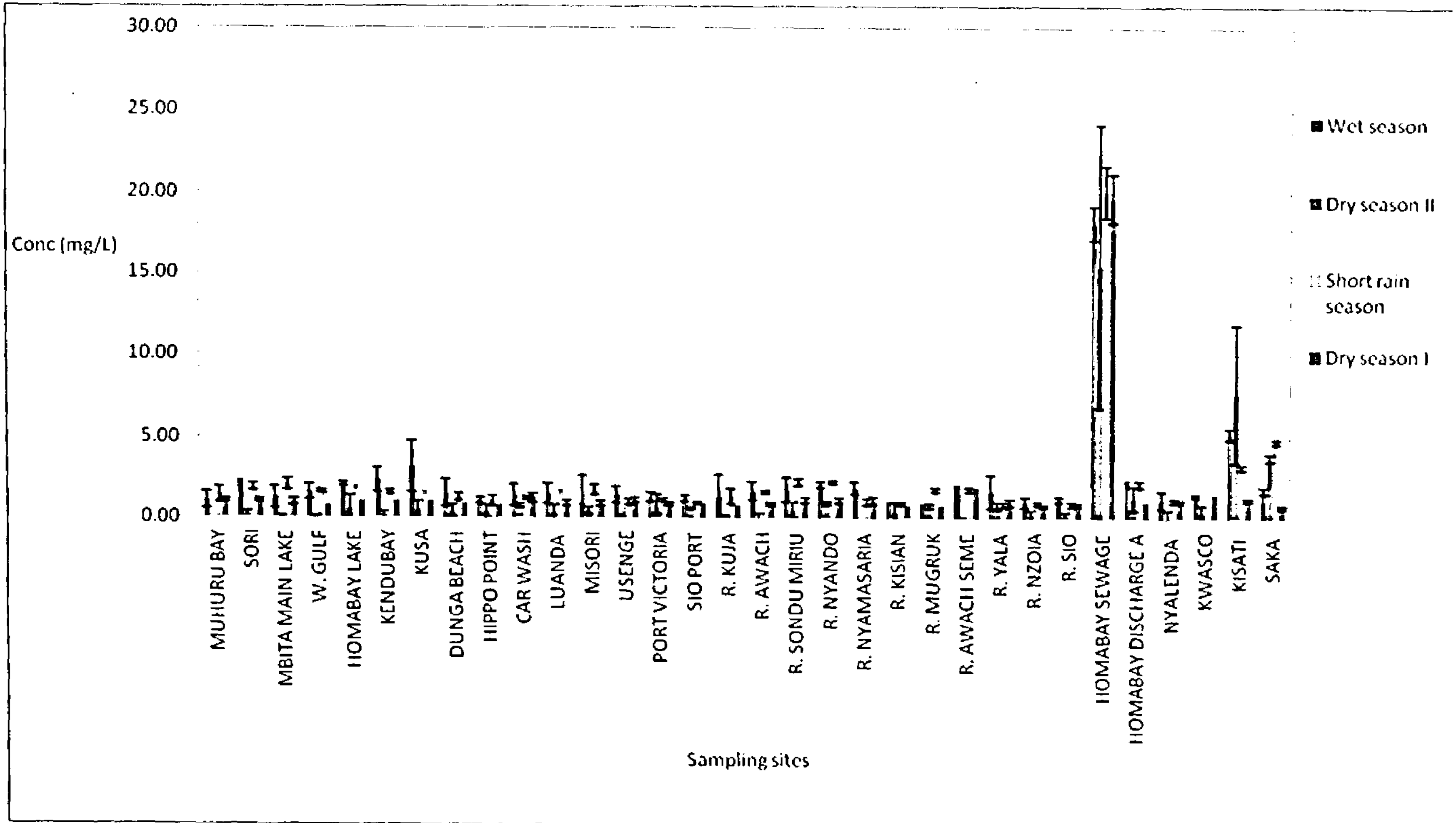

Figure 4.2.5: Temporal changes in total reactive phosphorus in Lake Basin Victoria water

4.2.2.2 Temporal changes in total hydrolysable phosphorus

Total hydrolysable phosphorus was highest in the wet and short rain seasons, followed by the dry season II, although the levels in the lake and river samples were below 2 mg/l. On the other hand, effluent discharge points had THP between BDL and 7.71 mg/l. No distinct trend was observed in the concentrations of THP in the effluents discharged into the lake (Figure 4.2.6).

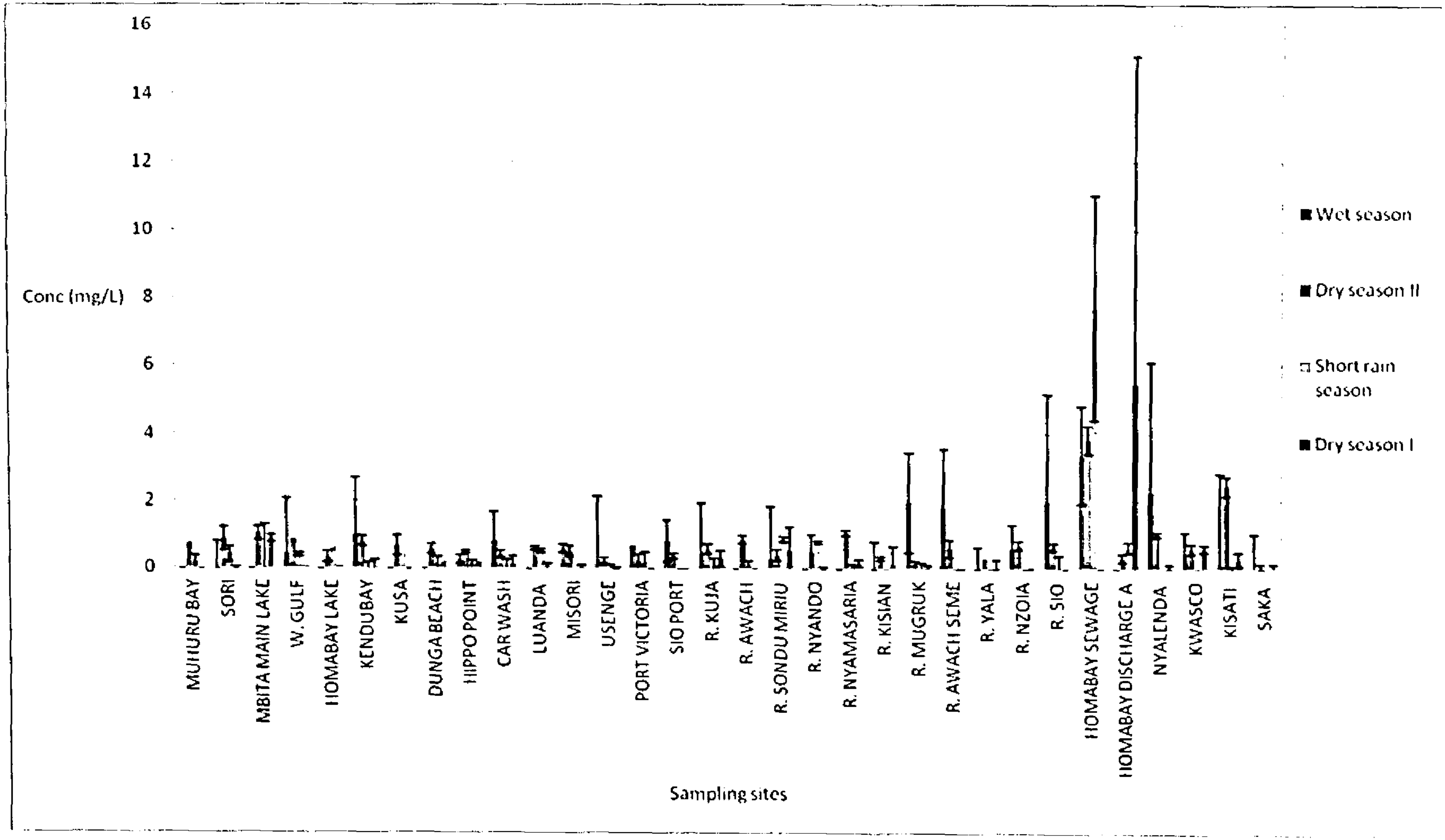

Figure 4.2.6: seasonal variations and the concentrations of hydrolysable phosphates

4.2.2.3 Temporal changes in total phosphorus

The levels of total phosphorus in the lake and river water samples seem to be influenced by the seasonal variations, and the trend in concentration followed wet>short rain>dry season I>dry season II. However, a similar trend was not observed in the case of the samples collected from the effluent discharge sites (Figure 4.2.7), which showed a reverse trend suggesting rainwater dilution effects.

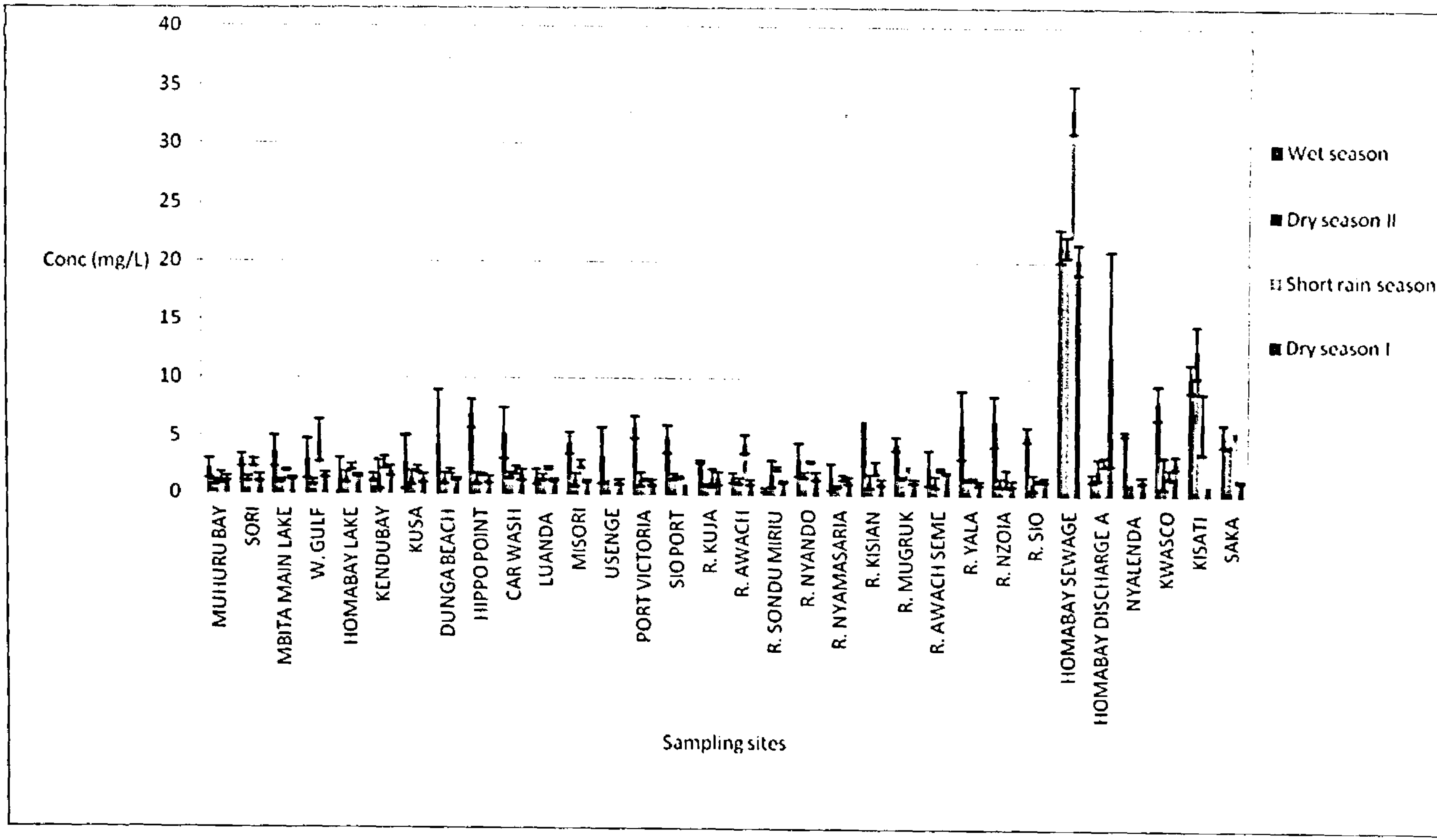

Figure 4.2.7: Correlation analysis of total phosphorus in four different seasons experienced in Lake Victoria

4.2.2.4 Principal component analysis of seasonal phosphorus load

Principal Component Analysis (PCA) was conducted to determine the main seasons influencing phosphorus load into Lake Victoria. The number of the principal components was determined by combination of three techniques: the size of eigenvalues, whereby according to the Kaiser criterion, principal components with eigenvalues greater than 1 are retained; the amount of variance explained, whereby components that cumulatively explain 90% of the variance are retained; and using the scree plot. PCA analysis showed that the wet season was the major contributor of reactive phosphorus influx into lake, and accounted for over 95.5% of the variance in phosphorus concentrations.

4.3 PHOSPHORUS IN SEDIMENTS AND SOILS

This study investigated two forms of phosphorus in sediments: exchangeable phosphorus, which is extractable by magnesium chloride, and the bio-available phosphorus, which is the sodium hydroxide.

4.3.1 Sediment exchangeable phosphorus

The highest levels of sediment exchangeable phosphorus in Lake Victoria drainage basin were detected in samples collected during the dry season I (March 2007) followed by the dry season II (August 2006). There was no clear trend between the levels detected during the wet season and the short rain season since the concentrations were high and low at different sites in both cases (Figure 5.1). The highest amount of sediment exchangeable phosphorus in river samples collected during the dry season I were in samples from River Sio, River Awach, Nzoia and Kuja with concentration of 12.35, 12.24, 9.28 and 9.23 mg/kg, respectively. Among the shorelines, the highest sediment exchangeable P concentrations were detected in samples from Misori, Port Victoria, Muhuru Bay, Luanda and Sio Port with concentrations of 13.60, 11.60, 11.16, 10.94 and 10.92 mg/kg, respectively. Sediment exchangeable concentration in the dry season II (July-September) varied between 8.01 and below detection limit.

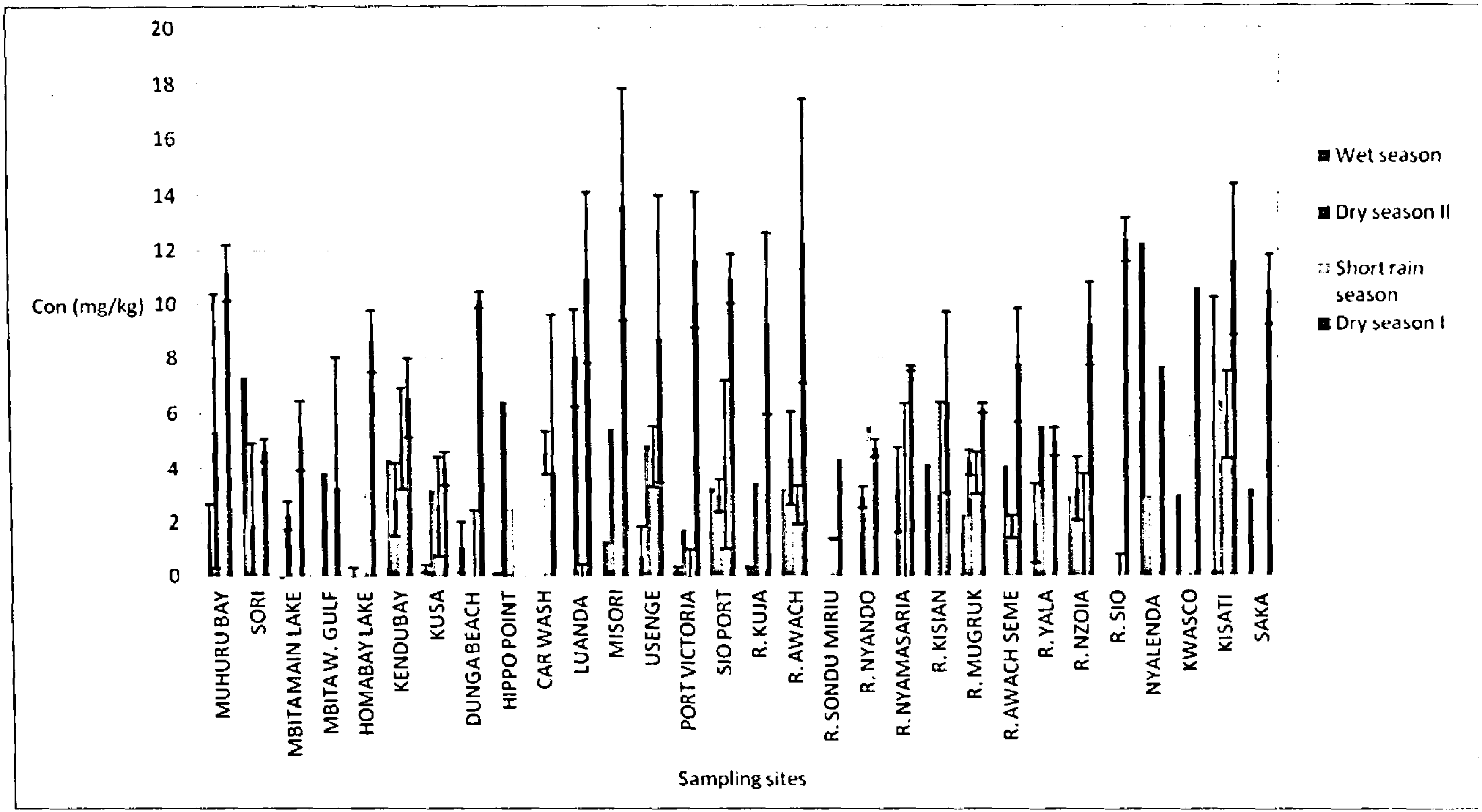

Figure 4.3.1: Seasonal variation in concentration of exchangeable phosphorus in Sediments

The highest concentrations in the river sediments were detected in samples from Rivers Yala, Awach, Mugruk, Awach seme, Kuja and Nzoia with concentrations of 5.51, 4.33, 4.2, 4.08, 3.42, and 3.21 mg/kg, respectively. The levels detected in the lake sediments in the dry season II were slightly higher than those detected in the river sediments. This could be attributed to the fact that these samples were collected after the heavy rain season and most of the sediment in the river samples had been washed into the lake (Figure 4.3.1). The highest levels of sediment exchangeable phosphorus were detected in samples from Luanda, Hippo Point, Misori and Muhuru Bay with concentrations of 8.02, 6.44, 5.44 and 5.35 mg/kg, respectively.

In the wet season, the highest concentrations of exchangeable phosphorus were recorded at the direct discharge sites, with mean levels of 12.23, 3.89 and 2.16 mg/kg in samples from Nyalenda, KWASCO and Saka, respectively. Samples from the river mouths had concentration of phosphorus ranging between BDL and 4.13 mg/l. The samples from the lake sites had concentrations ranging between BDL and 7.29 mg/kg, with the highest concentration recorded in Sori samples (Figure 4.3.1). The short rain season recorded phosphorus concentrations between BDL and 6.4 mg/kg, with the highest levels detected in samples from Kisati, River Nyando, KWASCO and Kendu Bay, at 6.4, 5.52, 5.2 and 5.05 mg/l, respectively.

4.3.2 Sediment bio-available phosphorus

Sediment bio-available phosphorus in the drainage system was higher than exchangeable phosphorus. This was attributed to the fact that bio-available phosphate fraction also contains phosphorus bound to metal ions like iron, aluminium and calcium which is not incorporated in the exchangeable fractions. The highest concentration of bio-available phosphorus was detected in the dry season I. However, there was no consistent trend with respect to seasonal variability, both high and low levels were observed in various samples collected at different times. Bio-available phosphorus in the wet season had average concentration of 23 mg/kg and a seasonal range between BDL and 59.79 mg/kg. The highest levels of bio-available phosphorus in rain season were measured in samples from Nzoia, Yala, Mugruk and Kuja rivers at 28.94, 27.76, 26.69 and 24.43 mg/kg, respectively. Concentration in the lake samples was slightly higher than the rivers, with the highest being 56.61, 52.83, and 24.24 mg/kg detected in the samples from Sio Port, Port Victoria and Usenge, respectively. This could imply that lake sediments are acting as a sink for phosphorus load from the catchments. Therefore, there is possibility of the phosphorus retained in sediments to be recharged to the water column through microbial activity and up-welling processes. This could influence the cycling of the phosphorus load in the lake.

Bio-available phosphorus in effluent discharge systems was highest in samples from Kisati followed by Saka and Nyalenda as shown in Figure 4.3.2 beow. Elevated levels measured in direct discharge sites could be attributed to decomposition of biological wastes associated with wastewater treatment systems. The average concentration of bio-available phosphorus dry season II was 19.74 mg/kg with the highest concentrations of 51.42, 33.83 and 31.08 mg/kg detected in samples from Usenge, Sio Port and Hippo Point, respectively. The mean in the short rain season was 14.25 mg/kg, with the highest concentration of 27.92 mg/kg recored in samples from Sio Port followed by Port Victoria (27.70 mg/kg). The average concentration of bio-available phosphorus in the dry season I was 24.45 mg/kg, with the highest (82.6 mg/kg) detected in samples from Port Victoria (Figure 4.3.2).

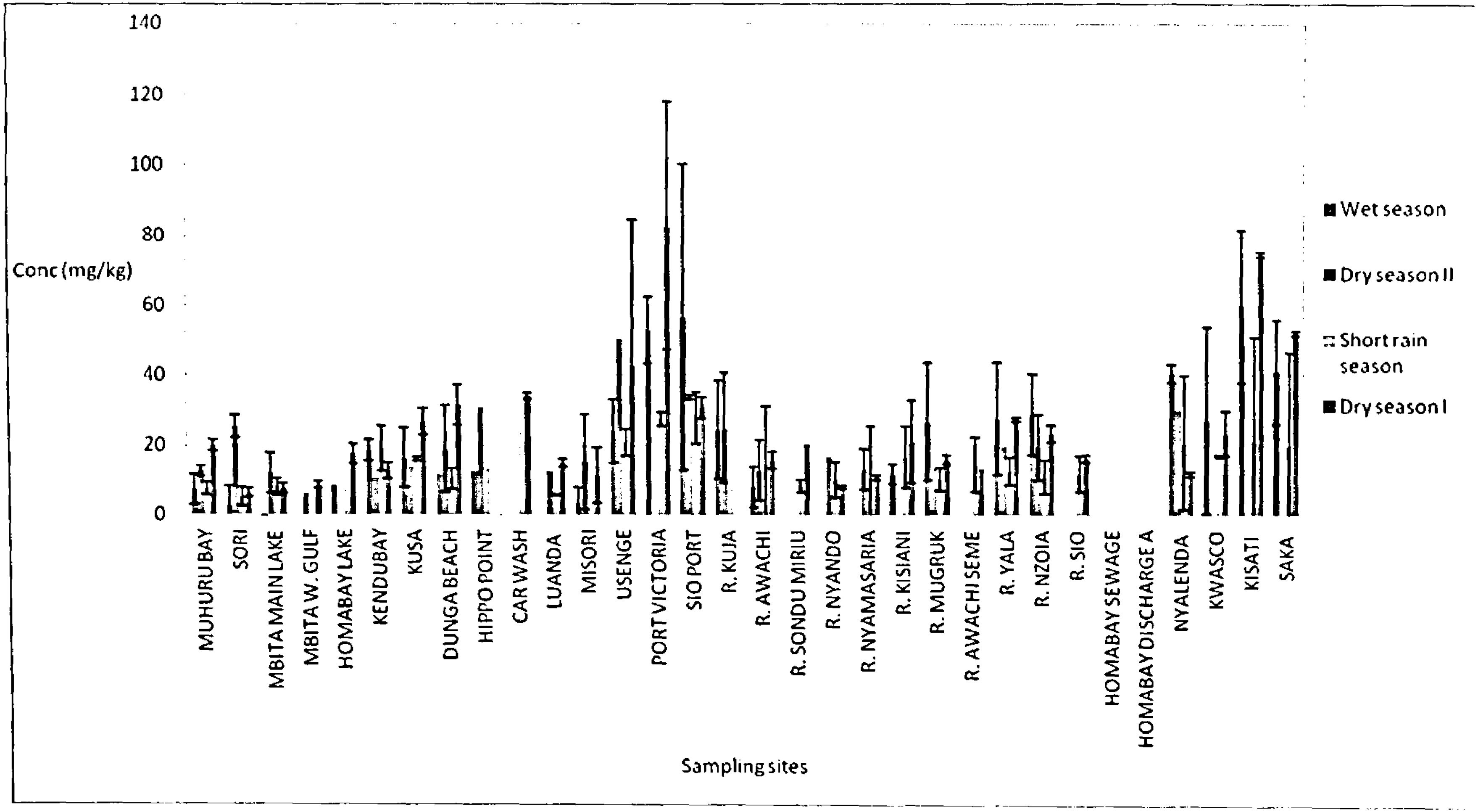

Figure 4.3.2 Seasonal variation in concentration of bio-available phosphorus in sediments

The levels in the lake varied between 82.6 and 5.1 mg/kg with high levels recorded in Port Victoria, Usenge, Kisumu Railways (Car wash), Sio Port, Dunga Beach, Kusa and Muhuru Bay samples having mean concentrations of 82.60, 42.31, 34.12, 31.56, 30.96, 26.92 and 20.14 mg/kg, respectively.

Bio-available phosphorus in the rivers ranged between 8.03 and 27.71 mg/kg with the highest concentration measured in samples from rivers Yala, Nzoia, Kisian and Sondu Miriu. It was noted that sites along the effluent discharge had higher concentration between 11.95 and 74.71 mg/kg with the highest recorded in Kisati, Saka and KWASCO. These places were also characterized by informal settlements and grazing of livestock such as cows and goats that could contribute to loading of phosphorus.

4.3.3 Soil available phosphorus in Lake Victoria drainage basin

Soil available phosphorus (SAP) was highest in the dry season II (5,232 mg/kg) followed by the short rain (2,853 mg/kg) and the dry season I (2,643 mg/kg). The average SAP was 566 mg/kg in the dry season II with the overall concentrations ranging from 76.9 to 2,643 mg/kg (Figure 4.3.3). Soils from the settlement areas around the lakeshore contained higher SAP compared to soils around the river mouths and effluent discharge points.

Misori, Sori and Mbita soils recored the highest SAP in the dry season II among the lakeshore sites. On the other hand, soils from areas close to the river mouths had mean SAP between 93 and 265 mg/kg with the highest concentration detected in the samples around rivers Nzoia and

Yala, whereas the highest concentration in soils from effluents discharge areas was recorded in Kisati samples (233 mg/kg).

The mean SAP in the short rain season I was 639 mg/kg, whereas the highest contration was 2,853 mg/kg, recorded in samples from Mbita main lake. The concentration of SAP in the lakeshore sites varied between 128 and 2,853 mg/kg, whereas levels in the river mouths ranged from 106 to 338 mg/kg.

The mean concentration of SAP in the dry season II was 1,076 mg/kg, with the highest concentration recorded in Homa Bay (5,232 mg/kg) followed by Misori, Sori and Kusa at 4,885, 3,415 and 3,267 mg/kg, respectively (Figure 5.3). The concentration of phosphorus in soils from the river mouths ranged from 76 mg/kg and 538 mg/kg, which was approximately ten to one hundred times lower than the levels measured in soils from the lake shore sites. River Nyando recorded the highest SAP (538 mg/kg) among the river samples. Low SAP levels were also observed in sites around direct discharges compared to the shorelines and ranged between 531 and 199 mg/kg.

A positive Pearson correlation was observed between phosphorus levels in the four seasons with r values between 0.873 and 0.97. This indicated the likelihood of accumulation of phosphorus in the Lake Victoria drainage basin. Therefore, there is a need for the regulatory systems to discourage unsustainable land use practices leading to soil erosion, discharge of poorly treated industrial and municipal effluents and release of agrochemicals and solid wastes into the catchment drainage system.

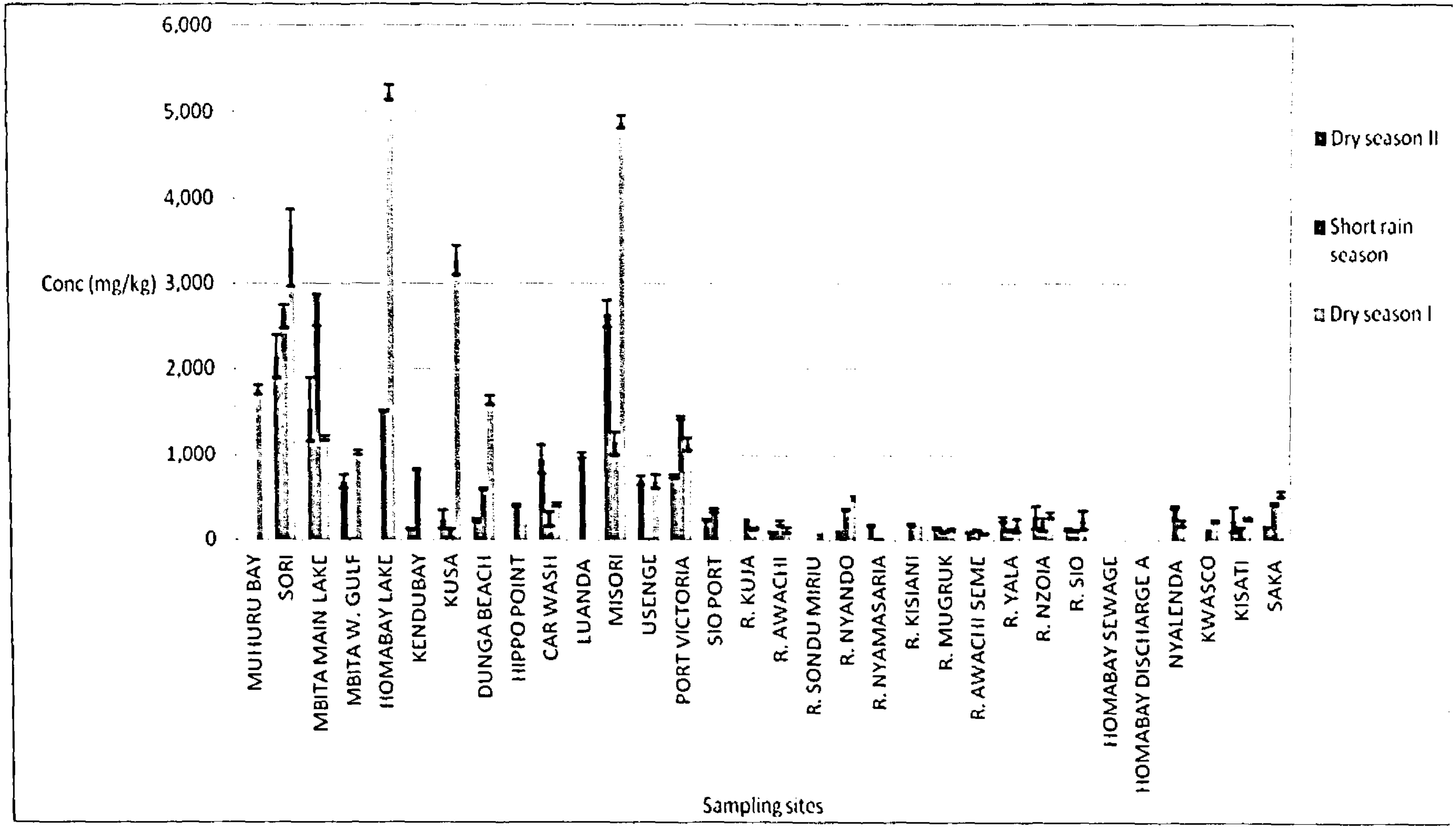

Figure 4.3.3: Seasonal variation in concentration of available phosphorus in soils

Phosphorus in soil occurs in either inorganic or organic phosphorus and each form is a continuum of many P compounds, existing in equilibrium with each other and ranging from solution P to very stable or unavailable compounds. Inorganic P is usually associated with aluminium (Al), iron (Fe), and calcium (Ca) compounds of varying solubility and availability [Rhue and Harris, 1999; Axt and Walbridge, 1999]. The rate of phosphorus fixation depends on soil chemistry parameters such as pH and mineral composition in terms of Al, Fe, and Ca content [Moore and Reddy, 1994]. Conversion of unavailable to available forms of P usually takes place too slowly but also determines the extent of phosphorus transport from soil to aquatic systems [Dunne *et al.*, 2005].

In sediments, the main processes that control phosphorus binding are: 1) transport of dissolved phosphate between the particulate components, 2) adsorption – desorption mechanisms, 3) chemical binding, and 4) uptake, accumulation and turnover in organisms [Jacobsen, 1978]. Usually, chemical bindings are perceived to be independent of the surrounding dissolved forms, while physical adsorption on the surface of particles is in constant equilibrium with the dissolved concentrations. Both processes may comprise of a number of different substances and compounds, of which, the most important are iron, calcium, aluminium, manganese, clay particles and organic matter [Dunne *et al.*, 2005].

4.4 PHOSPHORUS ADSORPTION KINETICS IN SOIL

4.4.1 Phosphorus Adsorption on non-amended soils

In the methodology, phosphorus sorption studies incorporated amended and un-amended soils from Lake Victoria Basin. Interpretation of the P concentration in the solution was done based on the standard multilevel calibration curve developed using KH_2PO_4 standard solutions as shown in Figure 4.4.1 below.

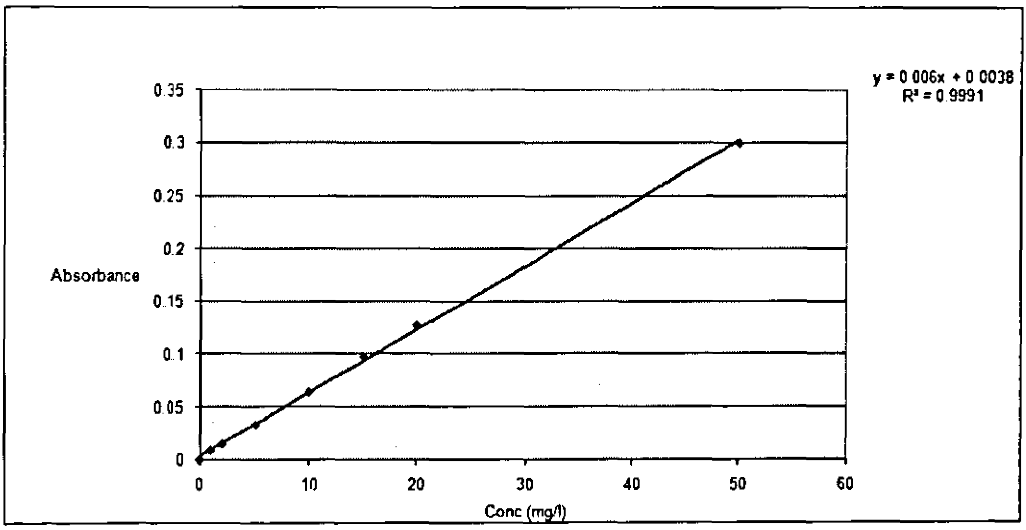

Figure 4.4.1: Phosphorus multilevel calibration curve

Langmuir, Freundlich and Temkin isotherms obtained are listed in Annex 6 (Annex Figures 4.3.1A-4.3.6A). Calculation of soil adsorption capacity using Langmuir adsorption equation showed that River Nyando had the highest phosphorus adsorption (b = 96.15) followed by

River Nzoia soil (b = 81.96) and Prot Victoria and Homa Bay soils with b values of 78.75 and 77.52, respectively (Table 4.4.1). The Langmuir sorption capacity compared well with Freundlich adsorption coefficient K, although the values of β were higher than the calculated values of K in all the samples. The r^2 varied between 0.72 and 0.97 for Langmuir isotherm and between 0.62 and 0.98 for Freundlich isotherm.

Results of soil phosphorus buffer capacities based on Temkin adsorption equation showed that the Nyando soil had the highest adsorption capacity (b = 80), followed by Homa Bay soil (b = 53), Sori soil (b = 43) and Misori soil (b = 40).

Table 4.4.1: Calculated Langmuir, Freundlich and Tehmkin adsorption constants for non amended soil

	Langmuir adsorption isotherm				Freundlich adsorption isotherm				Temkin adsorption isotherm			
	Equation	R^2	b	K	Equation	R^2	K	B	Equation	R^2	k	B
River Nyando soil	y = 0.014x-0.009	0.81	96.2	-1.16	y = 0.539x+1.857	0.72	71.9	0.54	y = 79.977x+45.401	0.90	45.4	79.98
River Nzoia soil	y = 0.012x-0.019	0.79	82.0	0.65	y = 0.138x+2.068	0.94	116.6	0.14	y = 18.63x +118.59	0.92	118	18.63
River Kuja soil	y = 0.013x-0.009	0.84	72.46	-1.37	y = 0.161x+2.043	1.00	110.4	0.16	y =18.89x +111.9	0.99	112	18.89
Muhuru Bay soil	y = 0.055x+0.033	0.95	18.18	1.68	y = 0.808x+0.971	0.97	9.34	0.81	y =18.267x+14.042	0.90	14.0	18.27
Sori	y = 0.019x-0.015	0.97	50.51	-1.33	y = 1.018x+0.832	0.92	6.79	1.02	y = 42.706x-28.141	0.96	28.1	42.71
Homa Bay	y = 0.013x+0.011	0.83	77.52	1.23	y = 0.844x+1.261	0.91	18.24	0.84	y = 53.02x-6.645	0.77	6.67	53.02
Port Victoria	y = 0.013x+0.051	0.98	78.74	0.25	y = 0.591x+1.166	0.98	14.64	0.59	y =16.779x +16.36	0.95	16.4	16.78
Misori	y = 0.06x4+0.366	0.72	15.72	-0.17	y = 1.171x+0.364	0.62	0.40	1.17	y =40.014x- 87.301	0.99	87.3	40.01

4.4.2 Phosphorus Adsorption on compost amended soils

Adsorption of phosphorus on soils treated with compost was conducted to determine the effect of soil composting on transport of phosphorus in the catchment. Soils were treated with 10,000 ppm compost and equilibrated for the same period as non-amended soils. The results revealed that composting of soil increases phosphorus retention, although the extent varied from one soil type to the other. Table 4.4.2 summarises the calculated values for phosphorus adsorption capacity, phosphorus affinity and distribution coefficients using Langmuir, Freundrich and Temkin adsorption equations.

Addition of compost was observed to increase phosphorus adsorption in 100% of the soils studied. The degree of adsorption varied from one site to another, depending on soil properties. For instance, soil amendment increased Langmuir phosphorus adsorption maximum "b" to 181, and to 333 for River Kuja soil. A similar trend was observed in the case of Freundlich distribution coefficient "K" and Temkin buffer capacity factor "B". The greatest effect of composting was observed in River Kuja soil with b = 333, k = 156 and B = 57. The results show that proper application of land use practices such as soil composting would reduce phosphorus influx into the aquatic systems within the basin.

Comparison between phosphorus adsorption capacity, adsorption coefficient and buffer capacity using Pearson correlation coefficient (r) revealed a negative correlation between the Langmuir phosphorus affinity factor (k) and the Freundlich adsorption coefficient (K) with r = -0.925 ($P<0.05$). No significant correlation was observed between the Langmuir adsorption capacity and the Freundlinch sorption coefficient, r = 0.6 at $p>0.1$.

Table 4.4.2: Calculated Langmuir, Freundlich and Tehmkin adsorption constants for soils amended with compost

	Langmuir adsorption isotherm				Freundlich adsorption isotherm				Temkin adsorption isotherm			
	Equation	R^2	B	K	Equation	R^2	K	B	Equation	R^2	K	B
River Nyando soil	*y = 006x=0.0032*	0.86	181.82	1.72	*y =0.202x+2.048*	0.73	111.61	0.20	*y =46.86x8+100.86*	0.99	100.86	46.87
River Nzoia soil	*y =0.007+0.004*	0.73	144.93	1.86	*y =1.202+1.504*	0.98	31.9	1.20	*y =96.331x+19.52*	0.94	19.52	96.33
River Kuja soil	*y =0.003+0.0036*	0.83	333.33	0.83	*y =0.771+2.195*	0.95	156.64	0.77	*y =56.696x+152.52*	0.94	152.52	56.70
Muhuru Bay soil	*y =0.013+0.179*	0.99	76.34	0.07	*y =0.927+0.701*	0.98	5.02	0.93	*y =21.59x-4.964*	0.91	-4.96	21.59
Sori	*y =0.010+0.015*	0.96	99.06	0.64	*y =0.411+1.554*	0.86	35.81	0.41	*y =18.705x+43.05*	0.91	43.05	18.71
Homa Bay	*y = 0.003+0.017*	0.96	232.58	0.18	*y =0.987+1.595*	0.94	39.38	0.99	*y = 63.37x+51.27*	0.99	51.27	63.37
Port Victoria	*y =0.009+0.008*	0.88	111.11	1.17	*y =0.356+1.684*	0.87	48.35	0.36	*y =30.302x+40.614*	0.91	40.61	30.30
Misori	*y =0.008+0.008*	0.91	125	0.99	*y =0.478+1.673*	0.87	47.04	0.48	*y =25.346x+60.007*	0.83	60.01	25.35

A high correlation was observed between the Langmuir adsorption capacity (b) and the Freundlich adsorption coefficient (K) with $r = 0.815$, $p < 0.05$, signifying effect of compost in enhancing phosphorus adsorption on the soil (Annex Tables 4.3.1A-4.3.2A). However, no significant correlation was observed between the Langmuir adsorption capacity and the Temkin buffer capacity ($r = 0.481$, $P > 0.2$) and between the Temkin buffer capacity and the Freundlich adsorption coefficient. Therefore, sorption in the Lake soil was better described by the Langmuir and Fruendlich adsorption models compared to the Temkin model. The findings of this study are in agreement with Reddy and co-workers [1980], who also reported increase in P adsorption when animal manure was applied to the soil, hence reducing runoff and increase infiltration.

4.5 PESTICIDE RESIDUES IN LAKE VICTORIA BASIN

This study investigated the occurrence, spatial and temporal variation of 17 organochlorine pesticides in water, sediments and soil samples in four different seasons experienced in Lake Victoria Basin. Limit of Detection (LOD) was calculated based on three times the ratio of signal of the noise and that of lowest concentration standard, multiplied by the lowest standard concentration. The instrument detection limits of the compounds studied are summarised in Table 4.5.1 below.

Table 4.5.1: Instrument Limit of Detection (LOD) and retention times

Pesticide Name	ng/ml	Retention time (minutes)
α-HCH	0.037	23.591
γ -HCH	0.009	25.516
β -HCH	0.209	25.809
δ-HCH	0.004	27.124
Heptachlor	0.040	27.784
Aldrin	0.022	34.122
Heptachlor epoxide	0.001	37.483
Endosulphan I	0.007	40.409
p,p'-DDE	0.008	42.558
Dieldrin	0.001	42.615
Endrin	0.014	44.292
p,p'-DDD	0.090	45.145
Endosulphan II	0.068	46.285
Endrin aldehyde	0.012	46.752
p,p'-DDT	0.165	50.332
Endosuphan sulphate	0.010	51.532
Methoxychlor	0.271	52.316

4.5.1 Concentration of pesticide residues in water from Lake Victoria Basin

Data on pesticide residues in water was evaluated on compound basis across the four seasons: Dry season I (January-March), Wet season (April-June), Dry seasons II (July-September) and Short rain (October-December).

4.5.1.1 Concentration of aldrin and Dieldrin in water

Aldrin concentrations varied from BDL to 194 ng/l across the four seasons. The highest concentration was measured in the dry season I (194 ng/l) in samples from Sori, followed by Nyalenda effluent (170 ng/l). The levels measured in the wet season were generally lower, compared to the dry season, with a mean concentration of 3.5 ng/l and highest concentration of 41 ng/l. The dry season II experienced an elevated concentration of aldrin in water with highest of 170 ng/l and an average of 6.34 ng/l. In the short rain season, the mean concentration reduced to 3.4 ng/l and a maximum of 15.57 ng/l measured in samples from KWASCO effluent discharge.

The total aldrin in the samples revealed the highest concentration in the dry season I> dry season II> wet season> short rain season. The higher concentrations recorded during the dry season compared to the two wet seasons could be attributed to dilution experienced during the wet seasons (Figure 4.5.1).

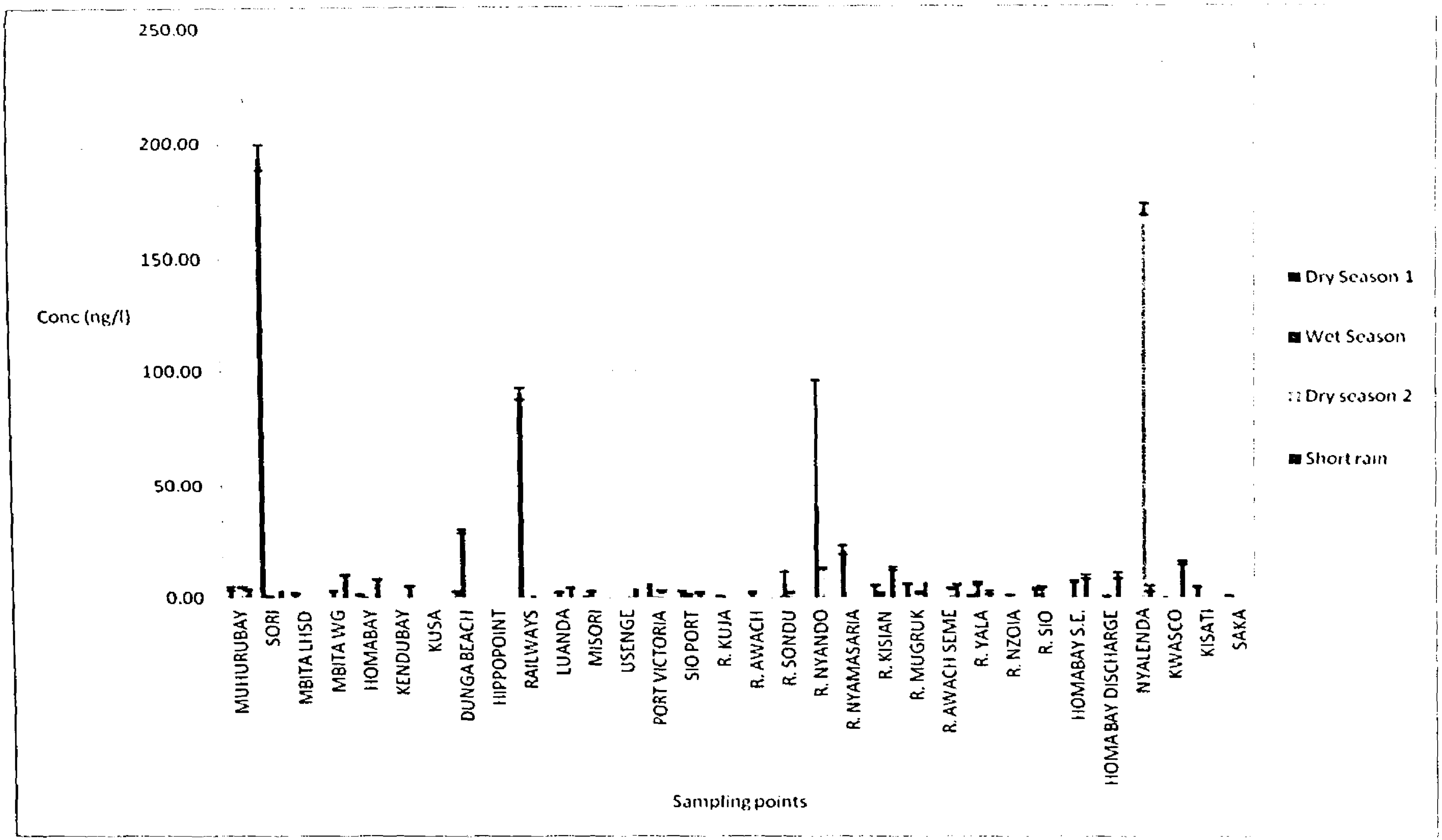

Figure 4.5.1: Concentration of Aldrin in water

Analysis of aldrin frequency in the water samples showed 71.8% in the dry season I, 59.4% in the wet season, 31.3% in dry season II and 53.1% in the short rain season (Annex Table 4.4.1 A).

Dieldrin concentration in the samples varied from BDL to 5.59 ng/l in the dry season I, 2.38 to 17.2 ng/l in the wet season, 2.05 to 5.87 ng/l in the dry season II and 1.1 to 7.65 ng/l in the short rain season. Sites that recorded high concentrations were Hippo Point (17.2 ng/l), Kendu Bay (13.92 ng/l) and Homa Bay waste water treatment effluent (12.57 ng/l). The median concentrations increased from 3 ng/l measured in the dry Season I to 5.19 ng/l in the wet season then decreased to 3.5 and 2.9 measured in the dry Season II and short rain season, respectively (Figure 4.5.2).

The wet season registered the highest levels of sum dieldrin (201 ng/l) compared to the other seasons, dry season II (120 ng/l), short rain (107 ng/l) and the dry season I (98 ng/l). Percentage occurrence of dieldrin in the catchment varied from one season to the other with the dry season I recording 96.9%, whereas the wet, dry season I and short rain recorded 100% occurrence in all the samples (Annex Table 4.4.1 A).

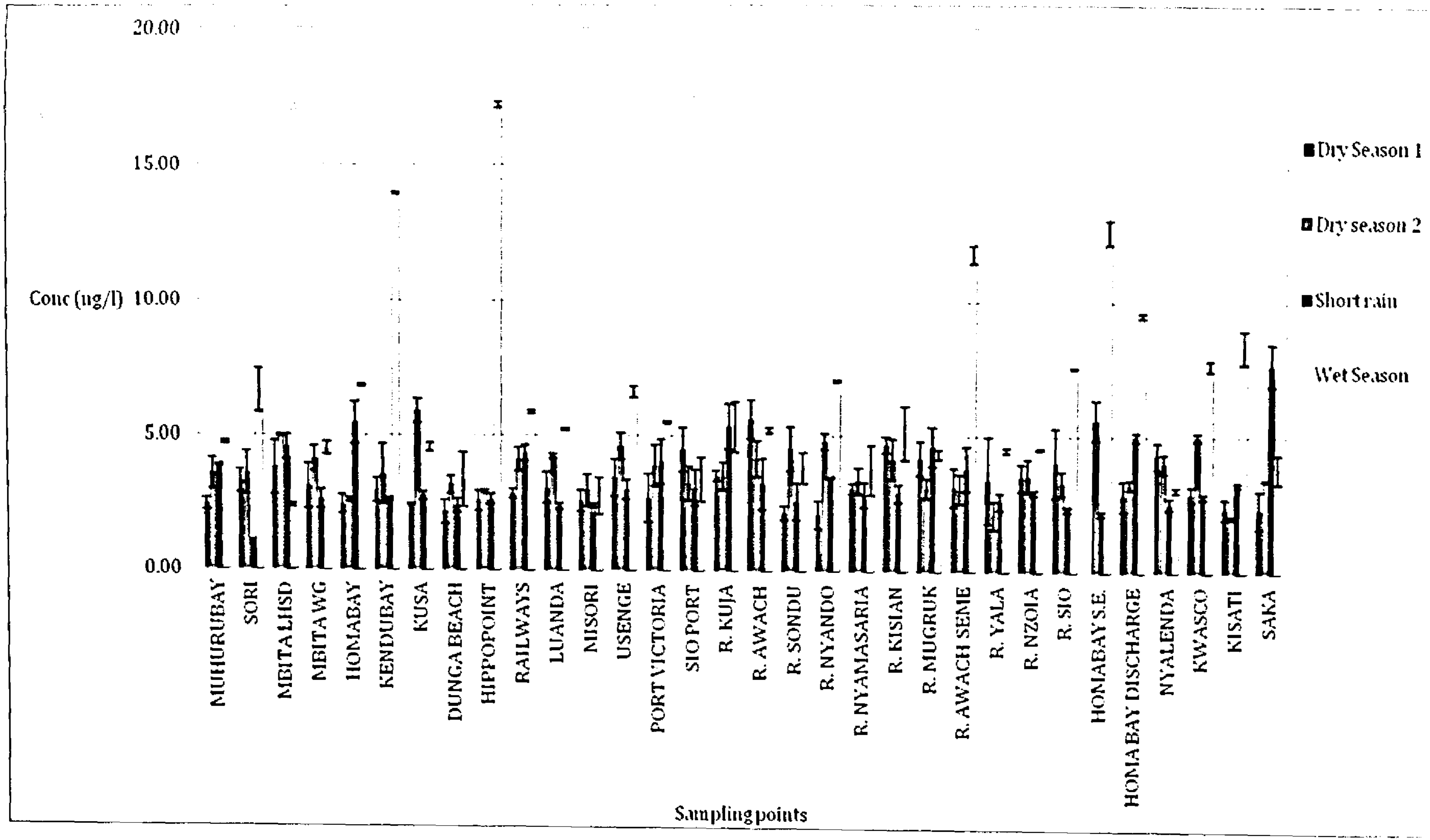

Figure 4.5.2 Concentration of Dieldrin in water

Both aldrin ((1R,4S,4aS,5S,8R,8aR)-1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-,4:5,8-dimethanonaphthalene) and dieldrin ((1R,4S,4aS,5R,6R,7S,8S,8aR)-1,2,3,4,10,10-Hexachloro-1,4,4a,5,6,7,8,8aoctahydro-6,7-epoxy-1,4:5,8-dimethanonaphthalene) have been used in the past as insecticides for soil-dwelling pests and for the protection of wooden structures against termites. But dieldrin was also used as an insecticide against insects of public health concern. The use of the two compounds has been banned in Kenya and many other countries due to their deleterious effects on human health and environment.

In the environment, aldrin breaks down slowly by oxidation to dieldrin. But the metabolite, dieldrin, has equally slow degradation rate with an estimated half-life of 5 years in temperate regions. In the tropics, both oxidation and dissipation rates of dieldrin are faster, whereby volatilisation alone is reported to contribute to over 90% disappearance of the compound within 1 month [WHO, 1989].

4.5.1.2 DDT and metabolites in water

Dichlorodiphenyltrichloroethane (DDT) and metabolites analysed in this study included *p,p'*-DDT, *p,p'*-DDE and *p,p"*-DDD. DDT was formerly worldly used in agriculture for the control of insect pests on cotton, potatoes and fruits and in public health to control malaria, typhus, body lice and other disease vectors. But its agricultural and other uses were banned in most countries in 1970s and 80s due to its toxicological effects on human health and environment. Currently, its application is limited to indoor spraying for malaria control.

The mean concentration of *p,p'*-DDT varied from BDL to 9.64 ng/l in the dry season I, BDL to 244 ng/l in the wet season, BDL to 7.76 ng/l in the dry season II and BDL to 308 ng/l in the short rain. The highest levels were observed in the wet season (244 ng/l) and the short rain season (308 ng/l) compared to the two dry seasons. Percentage occurrence of *p,p'-DDT* varied from one season to the other with the highest frequency detected in the dry Season I (78.1%) followed by the wet season (37.5%), short rain (25%) and the dry season II (6.3%). The sum *p,p'*-DDT across the four seasons was highest in the wet season (Σ*p,p'*-DDT = 380 ng/l) followed by the short rain season (Σ*p,p'*-DDT= 361 ng/l), the dry season I (Σ*p,p'*-DDT= 19.3 ng/l) and finally the dry season II (Σ*p,p'*-DDT = 11.85 ng/l) season (Annex Table 4.4.1 A). Figure 4.5.3 shows the variations in concentration of *p,p'*-DDT in the samples across the four seasons season.

The highest concentrations were measured at KWASCO water treatment effluent discharge during both wet and short rain seasons. The levels could be attributed to runoff from the environment and human activities around the site.

Compared to WHO guidelines, *p,p'*-DDT levels in water were below the maximum permissible levels in all the samples signifying low risks to the end users. However, other matrices with higher bio-accumulation factor may contain elevated residue levels of these compounds and hence raise the concern.

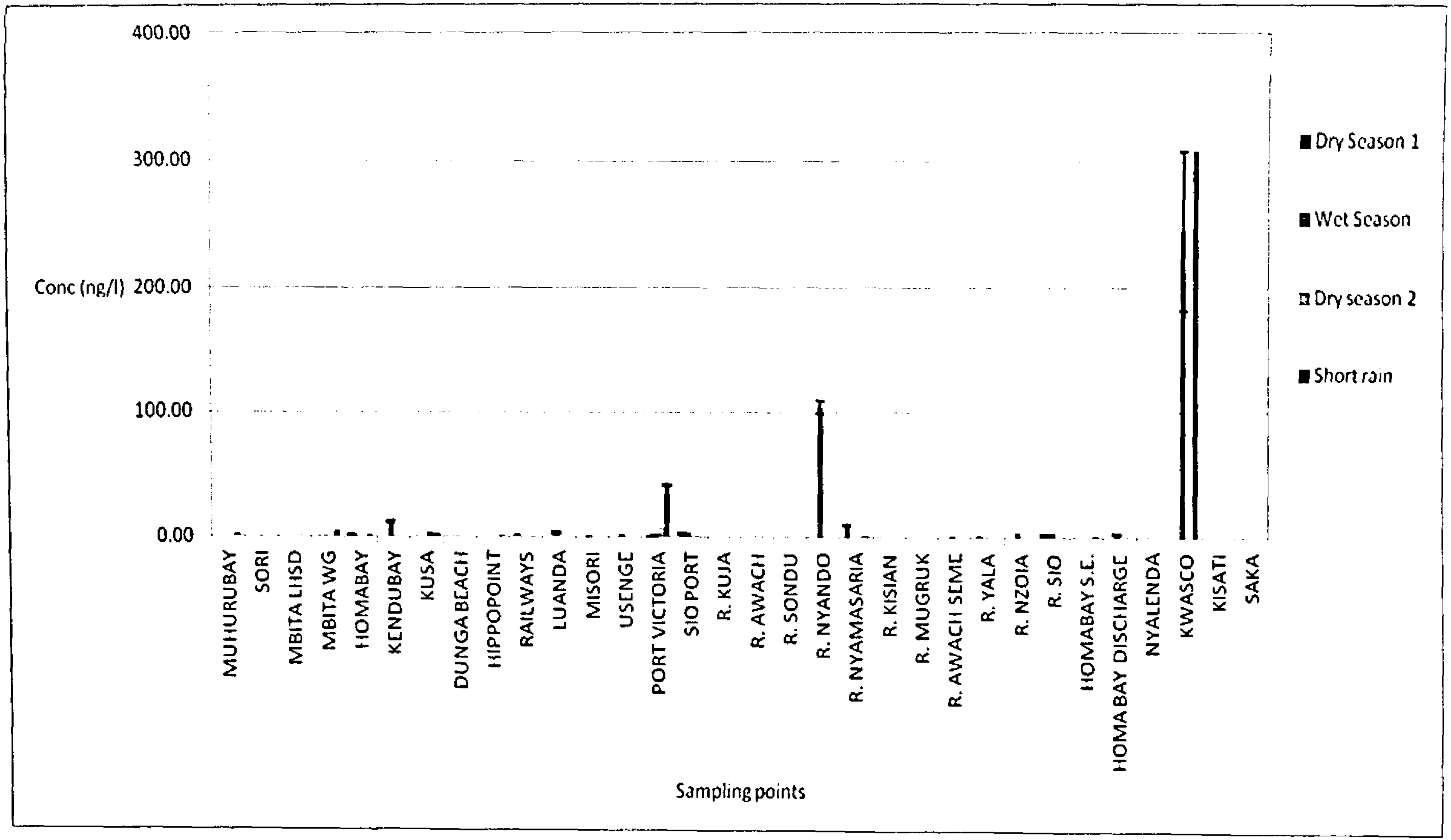

Figure 4.5.3: Concentration of p,p'-DDT in water

The highest levels of dichlorodiphenyldichloroethene (*p,p'*-DDE) were observed in dry season I and the wet season with concentrations of 63.34 ng/l and 18.64 ng/l, respectively. Luanda Kotieno with concentration of 63.36 ng/l was the leading in the dry season I followed by Homa Bay wastewater treatment effluent (11.61 ng/l). The highest concentration in the Wet season, dry season II and the Short rain season was measured in samples from Homa Bay wastewater treatment effluent with concentrations of 13. 33 ng/l, 15.32 ng/l and 4.94 ng/l, respectively, as shown in Figure 4.5.4 and season and Annex Table 4.4.1 A. Although *p,p'*-DDE had more cases compared to *p,p'*-DDT, several sites had below detection limit concentrations. In the dry season I the concentration ranged between BDL and 63.36 ng/l. Similarly, concentrations between BDL and 18.64 ng/l were observed in the wet season, between BDL and 15.32 ng/l in the dry season II and between BDL and 6.61 ng/l in the short rain season.

Percentage occurrence was highest in the dry season I (81.3%) followed by the dry season II (68.8%), the short rain (65.6%) and the wet season (28.1%). Calculation of sum *p,p'*-DDE revealed the highest concentration (Σ*p,p'*-DDE = 166.65 ng/l) in the dry season I followed by the Short rain (Σ*p,p'*-DDE = 58.74 ng/l), the dry season II (Σ*p,p'*-DDE = 53.94 ng/l) and the wet season (Σ*p,p'*-DDE = 49.55 ng/l).

Comparison of the ratio of Σ*p,p'*-DDE and Σ*p,p'*-DDT across the four seasons showed values with varying trends. In the dry seaon I, the calculated value of Σ*p,p'*-DDE/ Σ*p,p'*-DDT was 3.45, whereas the values of Σ*p,p'*-DDE/Σ*p,p'*-DDT for the wet season, dry season II and the short rain season were 0.13, 4.55 and 0.16, respectively. The Σ*p,p'*-DDE/ Σ*p,p'*-DDT >1 signify previous input of these compounds, and could be attributed to degradation pathways. Like in the case of *p,p'*-DDT, all levels of *p,p'*-DDE were below the WHO maximum residue level of 2 μg/l (Annex Table 4.4.1 A).

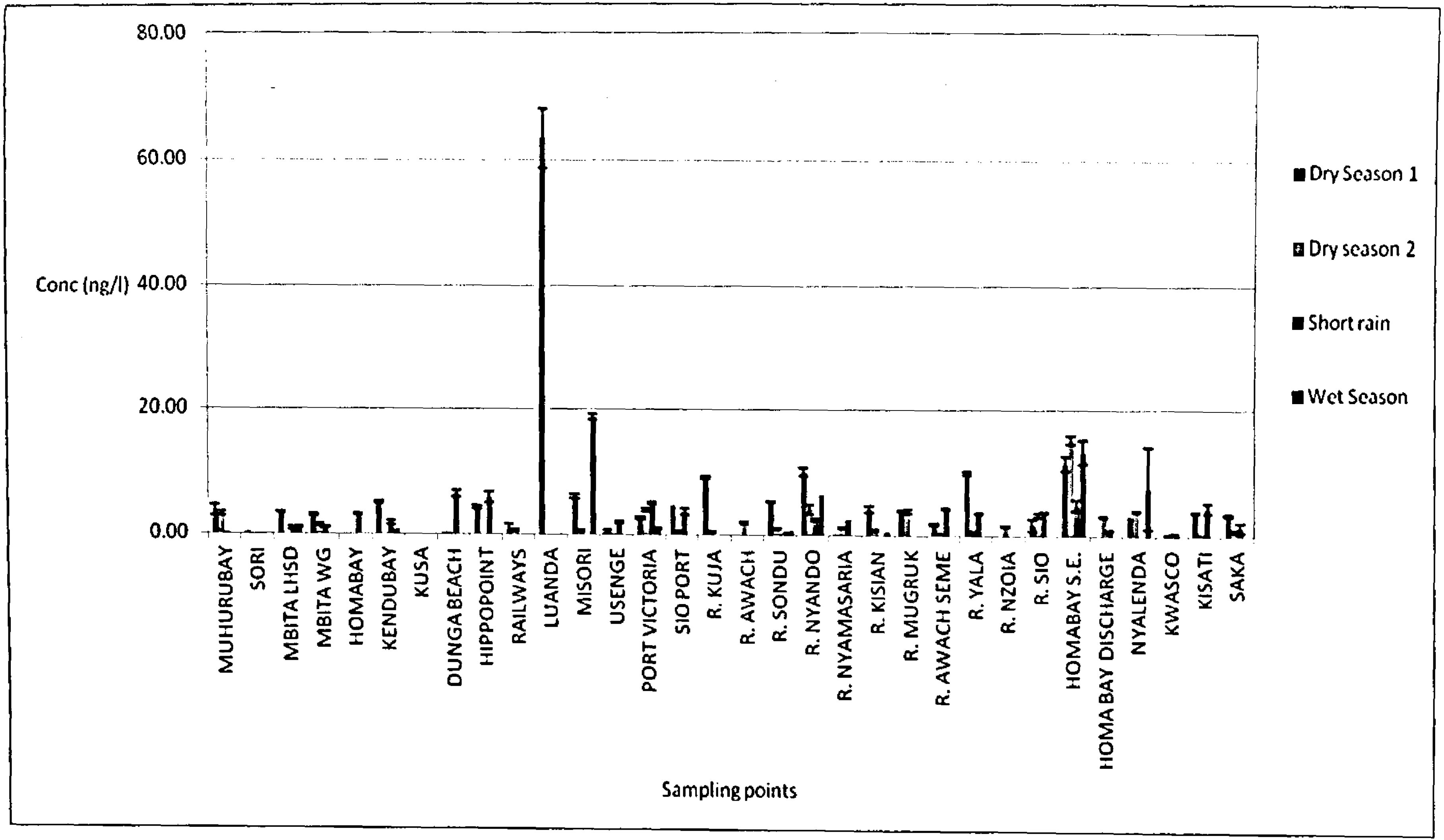

Figure 4.5.4: Concentration of p,p'-DDE in water

Dichlorodiphenyldichloroethane (*p,p'*-DDD) concentrations in the dry season I ranged between BDL and 13.77 ng/l, whereas the levels between BDL and 15.25 ng/l were measured in the wet season, BDL-17.42 ng/l in the dry season II and BDL-27.31 ng/l in the short rain season. The highest concentration was observed in the Short rain season (25.98 ng/l), followed by the dry season II (17.42 ng/l), wet season (15.25 ng/l) and the dry season I (13.77 ng/l). The median concentration ranged between 3.32 ng/l in the dry season I and BDL in the wet season, dry season II and short rain season. Sites with the highest concentrations included River Kuja (27.31 ng/l), KWASCO (17.42 ng/l) and River Nyando (15.25 ng/l) (Figure 4.5.5 and Annex Table 4.4.1 A).

The sum *p,p'*-DDD was highest in the dry season I (Σ*p,p'*-DDD = 128.24 ng/l) followed by the short rain season (Σ*p,p'*-DDD = 83 ng/l), wet season (Σ*p,p'*-DDD = 34.55 ng/l) and the dry season II (Σ*p,p'*-DDD = 22.06 ng/l). Percentage occurrence followed almost the same trend except for the shift between the wet season and the dry season II, with the highest incidences measured in the dry season I (68.8%) followed by the short rain season (46.9%), the dry season II (40.6%) and the least incidences in the wet season with 21.9% (Annex Table 4.4.1 A).

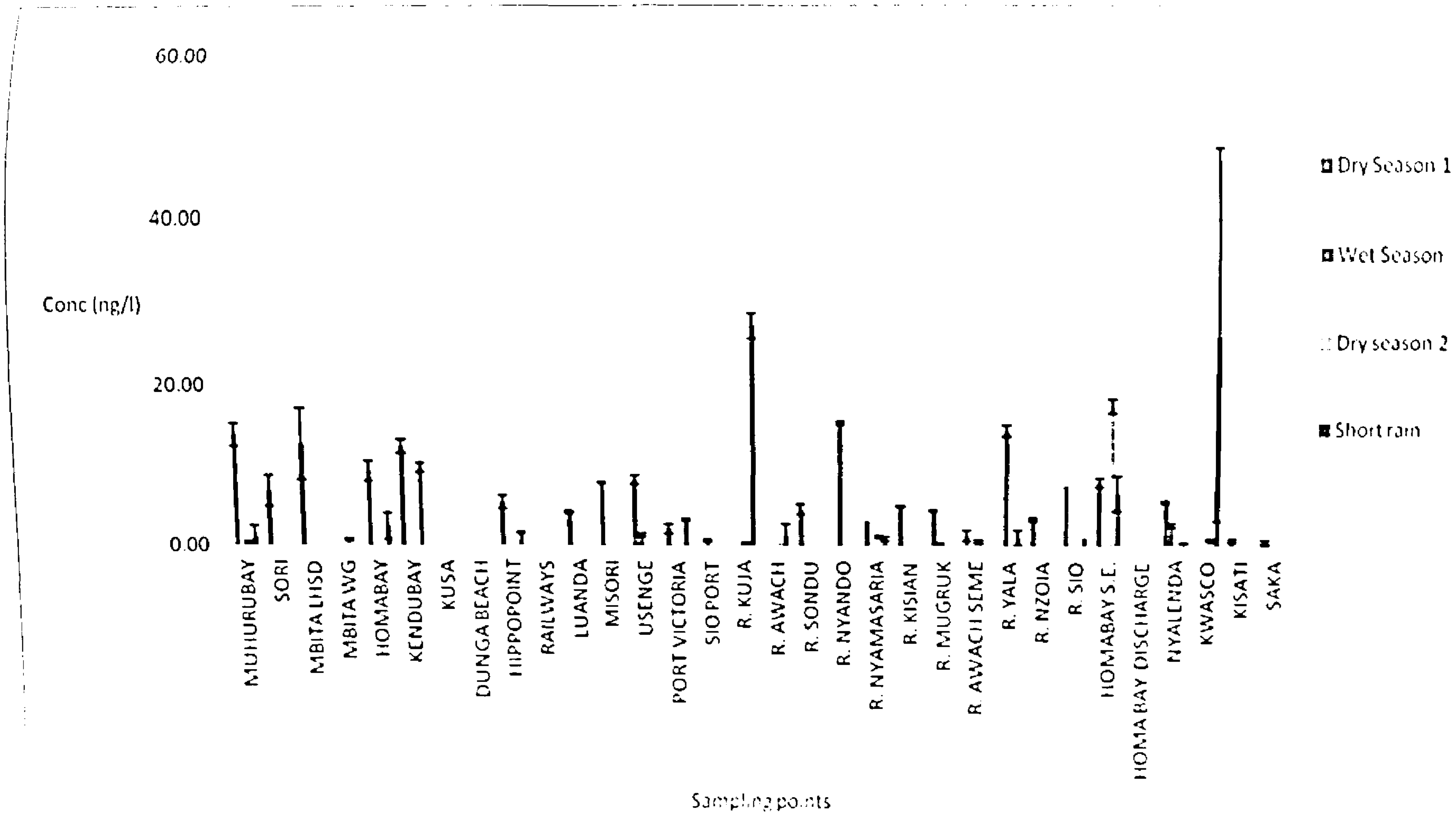

Figure 4.5.5: Concentration of p,p'-DDD in water

4.5.1.3 Endosulphan levels in water

Endosulphan (6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-enzodio-xathiepin-3-oxide) is an organochlorine insecticide belonging to the cyclodiene group. It is commonly used as insecticide to control pests on vegetables, cotton and fruits [Jalili *et al.*, 2007]. Technical grade endosulphan is a 2:1 to 7:3 mixture of α- and β-isomers. Both α-and β-endosulphan isomers can be oxidized to endosulphan sulphate through abiotic metabolism. Endsulphan sulphate is two to three times more persistent but comparably toxic like the parent compounds. Further degradation of the three compounds leads to formation of endosulphan diol which is more hydrophilic but less toxic.

The levels of endosulphan I ranged between 0.83 and 9.87 ng/l in the dry season I, BDL and 6.11 ng/l in the wet season, 0.8 and 2.21 ng/l and between BDL and 15.46 ng/l in the dry season II and the short rain seasons respectively. The highest concentrations in the dry season I were measured in samples from River Yala (9.87 ng/l), Homa Bay wastewater effluent (7.5 ng/l) and Kendu Bay (5.54 ng/l), whereas in the wet season the leading concentrations were measured in samples from River Awach (6.11 ng/l), Homa Bay wastewater effluent (5.89 ng/l) and Kisati (5.64 ng/l). The dry season II and the short rain season had highest concentrations measured in samples from KWASCO and Homa Bay wastewater effluent, respectively. The median concentration in all seasons was less than 2 ng/l, with the highest recorded in the dry season II (1.44 ng/l), followed by the dry season I (1.29 ng/l), short rain season (1.28 ng/l) and lastly, the wet season with 1.2 ng/l (Figure 4.5.6 and Annex Table 4.4.1 A).

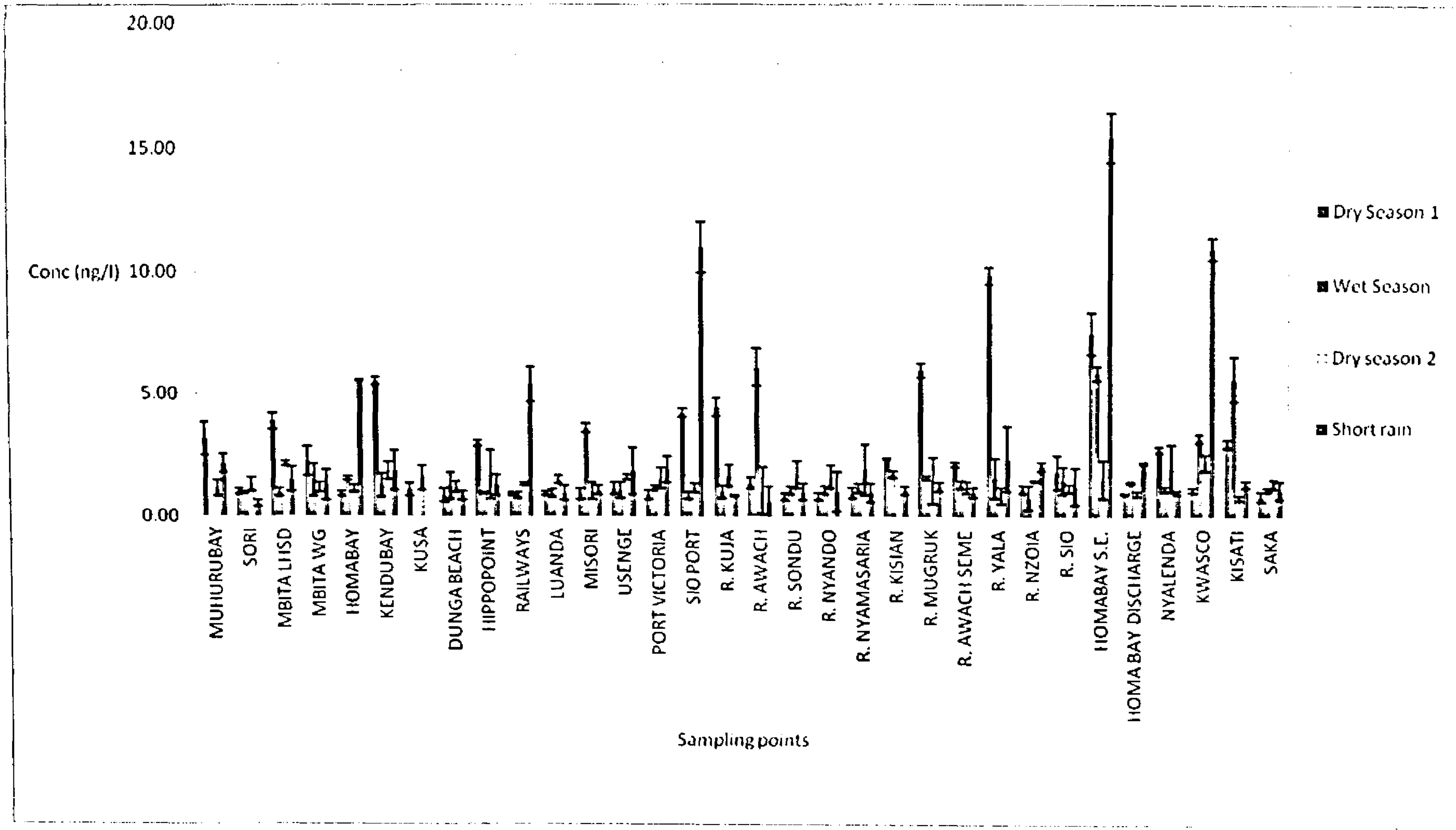

Figure 4.5.6: Concentration of Endosulphan I in water

The sum endosulphan I in the samples was highest in the short rain season (Σendosulphan I = 83.18 ng/l), followed by dry season I (Σendosulphan I = 79.06 ng/l), wet season (Σendosulphan I = 54.71) and the dry season II (46.21 ng/l). A similar trend was observed in frequency with the dry season I and II recording 100%, whereas the short rain and the wet seasons recorded 96.87% and 93.75%, respectively (Annex Table 4.4.1 A).

The average concentration of endosulphan II was highest in the dry season II (8.09 ng/l) followed by the wet season (7.97 ng/l), the short rain season (5.43 ng/l) and the dry season I (3.71 ng/l). The sites with the highest concentrations of endosulphan II during the dry season I were Kendu Bay (13 ng/l), followed by Muhuru Bay (11.69 ng/l) and Homa Bay wastewater effluent (12.98 ng/l) (Figure 4.5.7).

Concentration range per season varied between BDL and 13 ng/l in the dry season I, BDL-86 ng/l in the wet season, BDL-173 ng/l in the dry season II and from BDL to 37.83 ng/l in the short rain season. The wet season and the dry season II had median concentrations BDL whereas the median from dry season I was 2.36 ng/l, whereas the short rain season had a median of 0.56 ng/l.

The occurrence of endosulphan II was highest during the dry season I (71.9%) followed by the short rain season (53.1%), the wet season (46.9%) and least in the dry season II (28.1%). Further, the sum concentration was highest in dry season II (Σendosulphan II = 258.9%), followed by the wet season (Σendosulphan II = 254.9%), then the short rain (Σendosulphan II = 173.9 ng/l) and the dry season I (Σendosulphan II = 118.7%) (Annex Table 4.4.1 A).

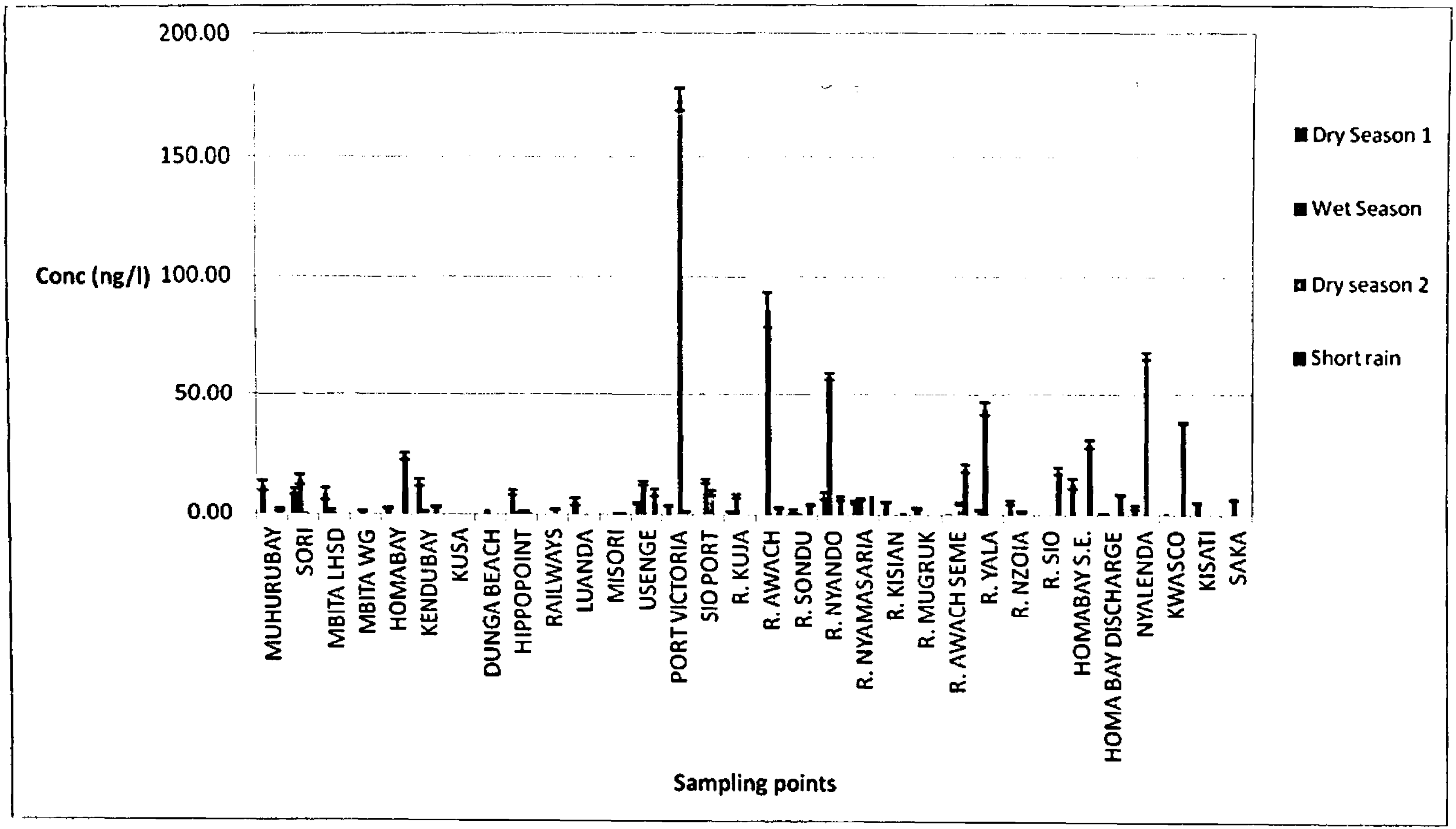

Figure 4.5.7: Concentration of Endosulphan II in water

Endosulphan sulphate registered higher occurrence in the water compared to the parent compounds endosulphan I and endosulphan II. The highest concentration (14.87 ng/l was recorded in samples from Saka drainage canal during the short rain season, followed by the wet season (13.26 ng/l), dry season I (12.9 ng/l) and the dry season II (12.27 ng/l). The dry season I recorded the highest mean concentration (4.57 ng/l), followed by the wet season (4.56 ng/l), the dry season II (3.97 ng/l) and the short rain season (3.81 ng/l) (Figure 4.5.8). Throughout the four seasons, the median concentration was between 3 and 5 ng/l with the dry season I recording a median of 4.37 ng/l, and 4.23 ng/l for the wet season, whereas the short rain and dry season II recorded 3.81 ng/l and 3.58 ng/l, respectively.

Percentage occurrence of endosulphan sulphate was 100% for the dry season I and II, whereas the wet season and short rain season recorded the percentage occurrence of 90.6% and 96.9%, respectively. The sum endosulphan sulphate was highest in the dry season I (Σendosulphan sulphate = 146 ng/l), followed by the wet season (Σendosulphan sulphate = 145 ng/l), dry season II (Σ126 ng/l) and the short rain season (Σendosulphan sulphate = 121 ng/l) (Annex Table 4.4.1 A).

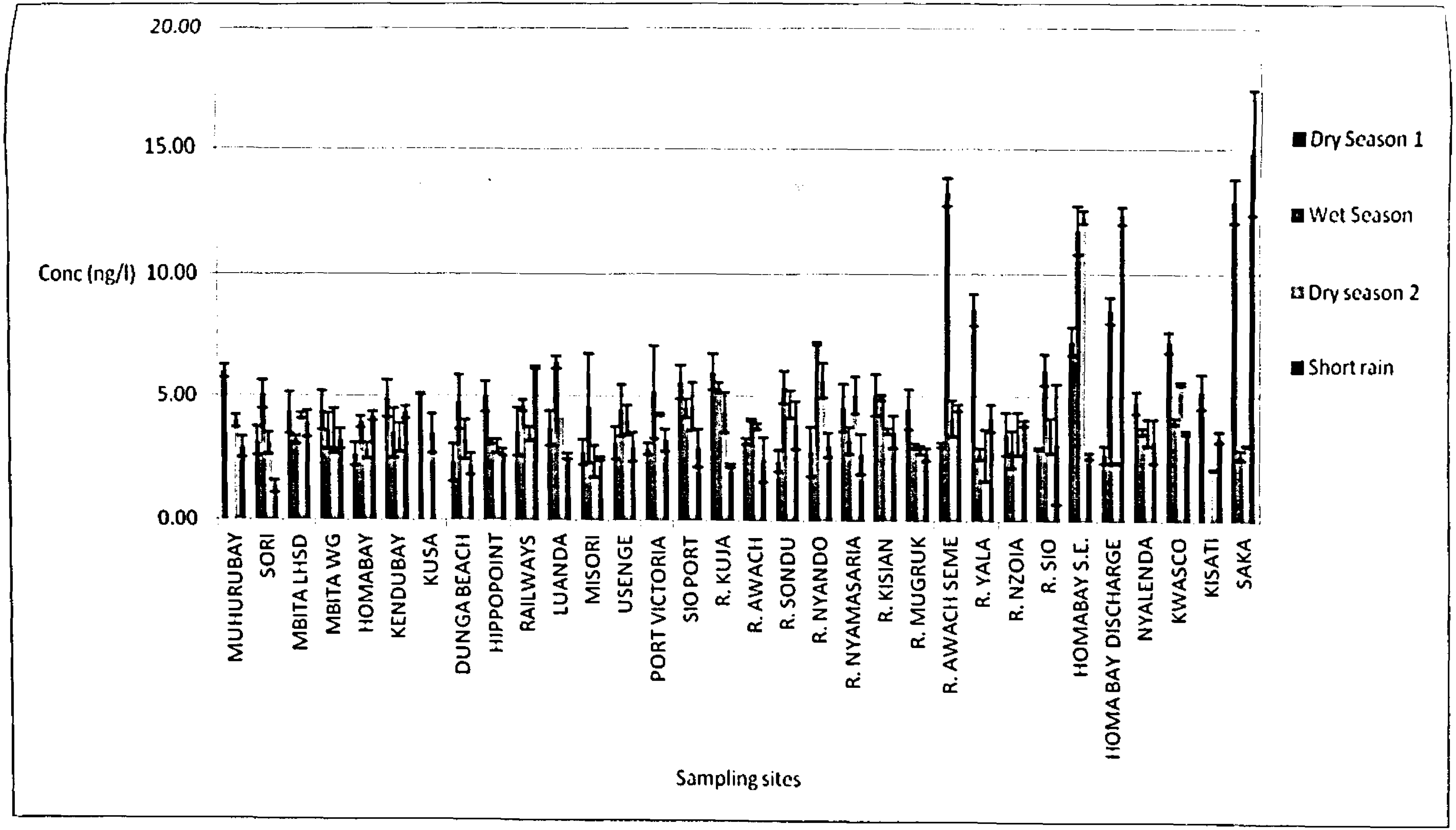

Figure 4.5.8: Concentration of Endosulphan sulphate in water

4.5.1.4 Endrin and Endrin aldehyde in water

Endrin (1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8aoctahydro-1,4-*endo,endo*-5,8-dimethanonaphthalene) is a broad-spectrum foliar insecticide that acts against a wide range of agricultural pests, but also used as a rodenticide. When released into surface water, endrin transforms into endrin ketone and endrin aldehyde. The mean concentration of endrin in the catchment varied from BDL to 7.34 ng/l in the dry season I, from BDL to 16.01 ng/l in the wet season, from BDL to 5.76 ng/l in the dry season II and from BDL to 40.72 ng/l in the short rain season.

The highest concentration in the short rain season was registered at sites: Sio Port (40.72 ng/l), followed by KWASCO (9.5 ng/l) and River Awach Seme (4.05 ng/l). The wet season recorded the second highest seasonal concentrations with the leading levels at Misori (16.01 ng/l), followed by River Nyando (11.82 ng/l) and River Sio (4.04 ng/l). The highest levels in the dry season I and II were 7 ng/l and 5 ng/l recorded in samples from Sori and Nyalenda drainage discharge, respectively (Figure 4.5.9).

The percentage frequency of endrin in the samples was highest in the dry season I (81.3%), followed by the short rain season (65.6%), the wet season (53.1%) and the dry season II (18.8%). But sum endrin was highest in the short rain season (Σendrin = 80.4 ng/l), followed by the dry season I (58.7 ng/l), the wet season (53.95 ng/l) and the dry season II (7.26 ng/l) (Annex Table 4.4.1 A).

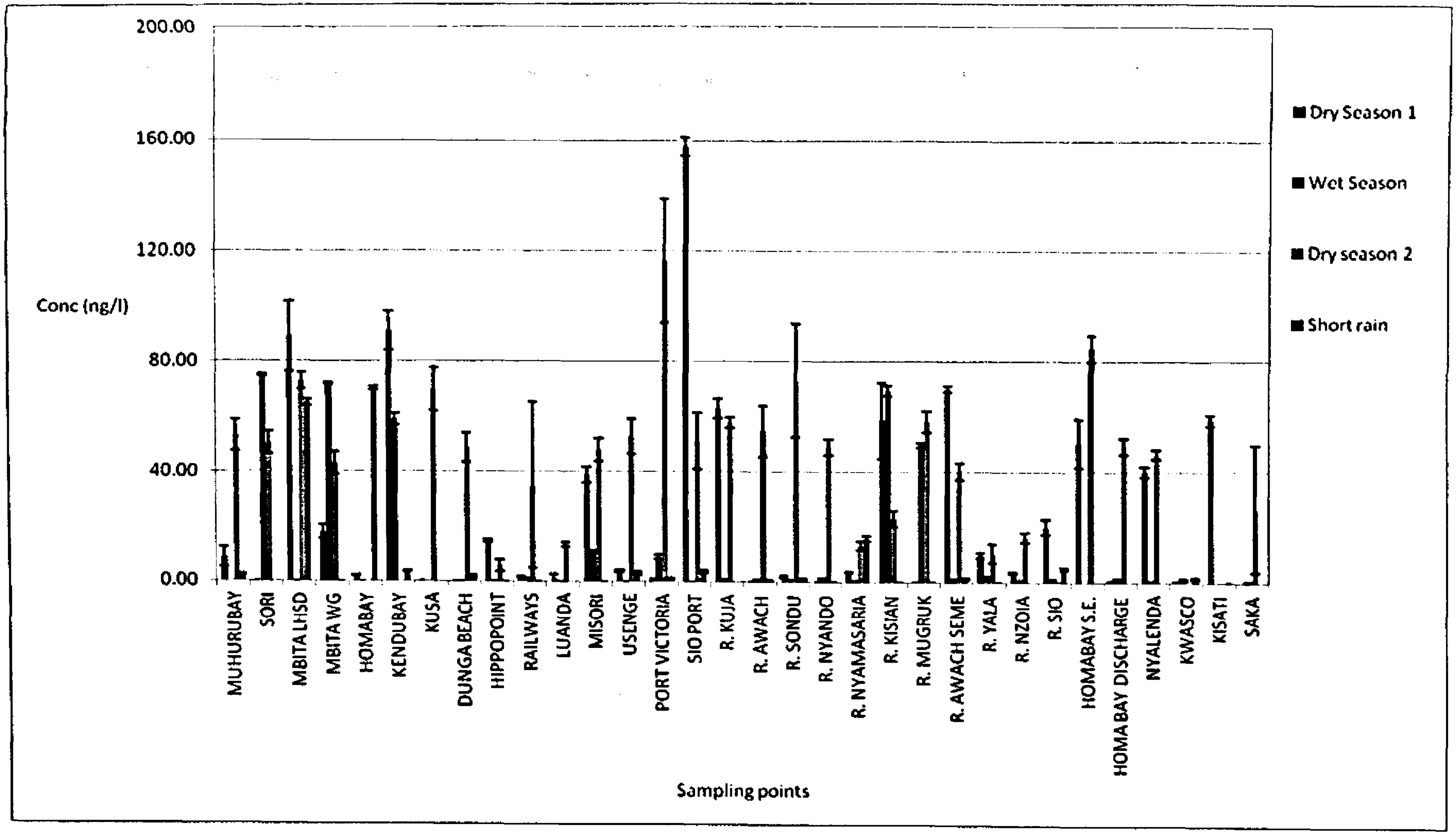

Figure 4.5.9: Concentration of Endrin in water

Endrinaldehyde levels in the water varied from BDL to 157 ng/l in the dry season I, from BDL to 75 ng/l in the wet season, from BDL to 116 ng/l in the dry season II, and from BDL and 70 ng/l in the short rain season. The dry season I recorded the highest levels with a mean concentration of 157 ng/l measured in samples from Sio Port, followed by Kendu Bay (91 ng/l) and Mbita main lake (89 ng/l). A reduction in concentration was observed during the wet season with the highest concentration (74 ng/l) measured in samples from Sori, followed by Mbita Winam Gulf (72 ng/l) and River Kisiani (69 ng/l). However, the concentration increased in the dry season II to the highest of 116 ng/l detected in samples from Port Victoria, followed by Homa Bay wastewater treatment effluent (84 ng/l) and River Sondu (73 ng/l). The short rain season record the lowest concentration compared to the other three seasons, with the highest (70 ng/l) measured in samples from Homa Bay, followed by Mbita main lake (65 ng/l) and Saka drainage system (23 ng/l) (Figure 4.5.10 and Annex Table 4.4.1 A).

Occurrence of endrinaldehyde was highest in the dry season I (96.9%), followed by the wet season and dry season II which had 87.5% occurrence each, whereas the short rain season recorded the least frequency (71.9%). The highest sum endrinaldehyde was recorded in the dry season II (Σendrinaldehyde = 1,259 ng/l) followed by the dry season I (Σendrinaldehyde = 808 ng/l), wet season (Σendrinaldehyde = 356 ng/l) and the short rain season (Σendrinaldehyde = 175 ng/l).

The ratio of sum endrin aldehyde/sum endrin was greater than 1 signifying effect of previous application of the endrin in the environment rather than current use. The dry season II recorded the highest Σendrin adehyde/Σendrin (17.3) followed by the dry season I (Σendrin adehyde/Σendrin = 13.8), the wet season (Σendrin adehyde/Σendrin = 6.6) and lowest in the short rain season (Σendrin adehyde/Σendrin = 2.2 ng/l).

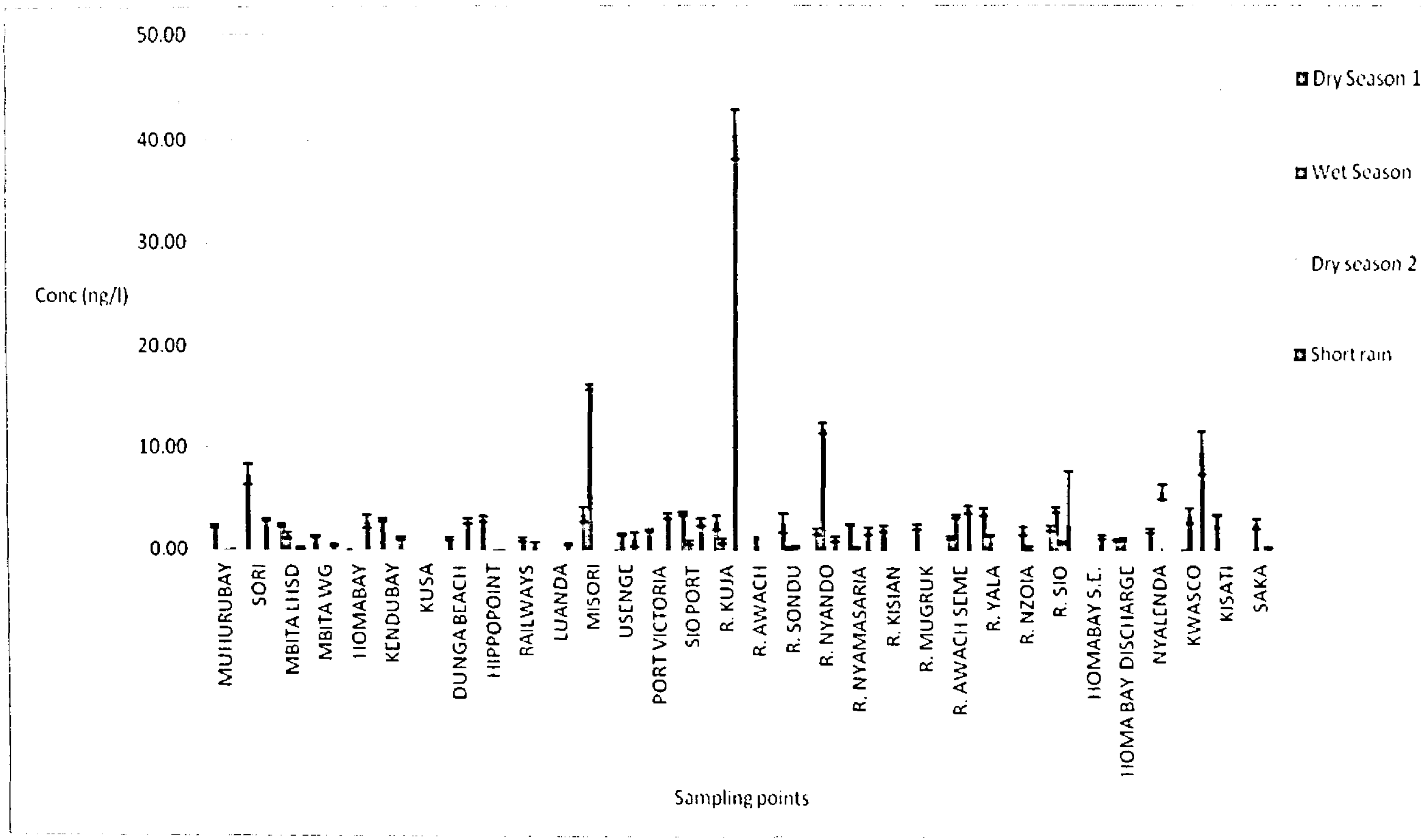

Figure 4.5.10: Concentration of endrinaldehyde in water

4.5.1.5 Hexachlorocyclohexane (HCH) isomers in water

Hexachlorocyclohexane (HCH) also called benzenehexachloride (BHC) is an organochlorine insecticide and fumigant used against a wide range of insects in treatment of seeds, on crops, in warehouses, on domestic and agricultural animals as well as public health vector control of scabies and head lice. It occurs in two formulations - technical grade HCH and lindane - whereby technical grade HCH is a mixture of different isomers: α-HCH (65-70%), β-HCH (7-10%), γ-HCH (14-15%) and δ-HCH (7 %), whereas lindane is the formulation of HCH containing very high percentage of γ-isomer (>99% pure). Most of the uses of HCH, except in public health control of head lice, have been banned under the Stockholm Convention due to their toxicity effects on human and wildlife. Prior to the ban, lindane had been widely used in agriculture.

The study recorded the highest concentration of α-HCH in the short rain season (72.14 ng/l), followed by the wet season (15.03 ng/l), the dry season I (11.04 ng/l) and the dry season II (10.22 ng/l). The median concentration was highest in the dry season II (3.75 ng/l), followed by the short rain season (3.36 ng/l), the wet season (3.3 ng/l) and the dry season I (3.06 ng/l) (Figure 4.5.11).

Occurrence of α-HCH was one of the leading in the basin with the dry season I and II recording 100% frequency, whereas the wet season and the short rain season recorded 90.6% and 96.9%, respectively. The sum concentrations of α-HCH was highest in the short rain season (Σα-HCH = 229 ng/l) followed by the dry season I (Σα-HCH = 130 ng/l), the dry season II (Σα-HCH = 117 ng/l) and the wet season (Σα-HCH = 115 ng/l) (Annex Table 4.4.1 A).

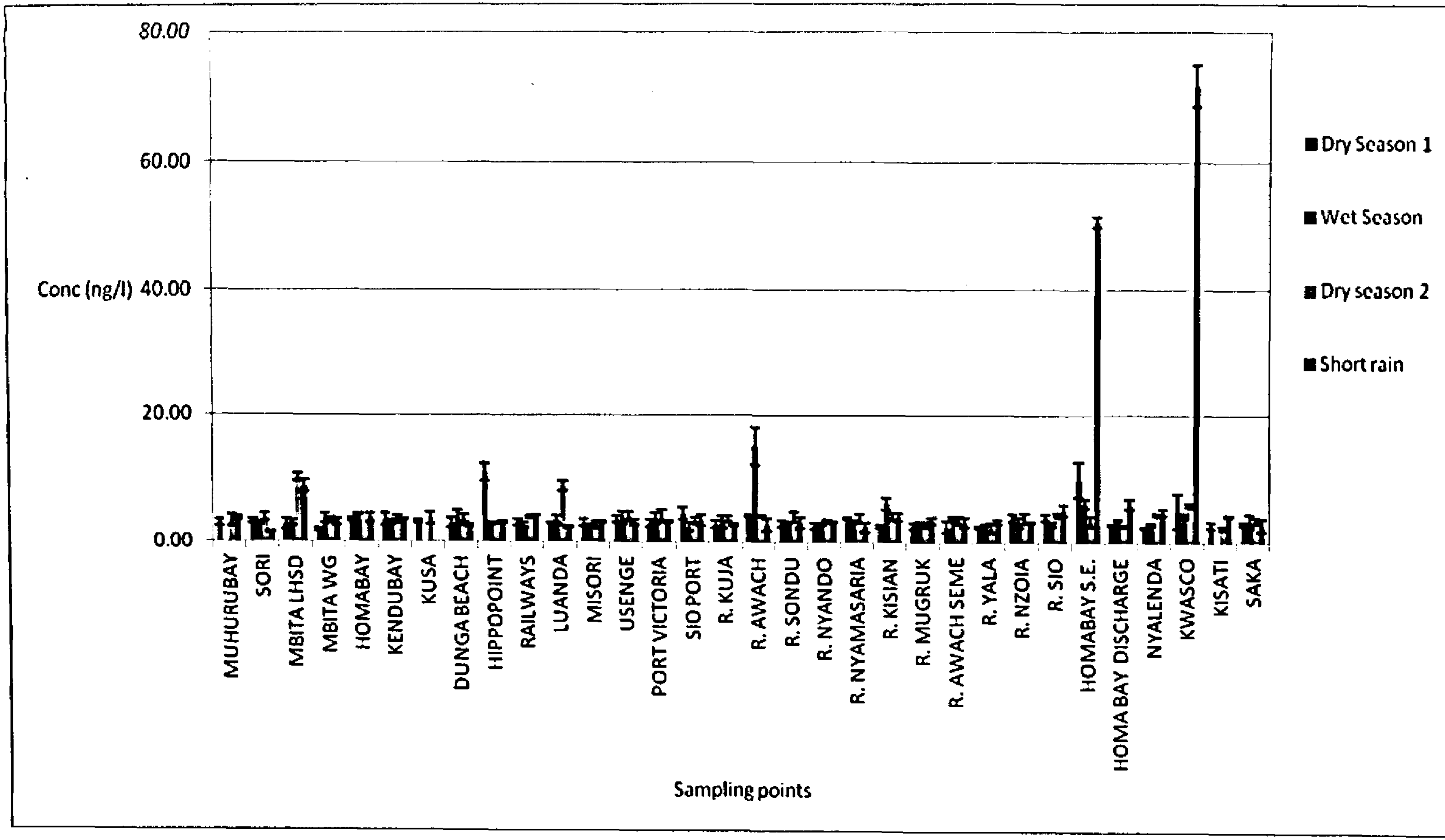

Figure 4.5.11: Concentration of a-HCH in water

The levels of β-HCH varied from 1.01 to 16.84 ng/l in the dry season I, from BDL to 11.97 ng/l in the wet season, from 1.48 to 16.07 ng/l in the dry season II, and from BDL to 80.67 ng/l in the short rain season. The highest concentration in the dry season I was measured in the samples from Kisati (16.84 ng/l), followed by Dunga Beach (15.95 ng/l) and Saka (11.67 ng/l). For the wet season, the sites with the highest concentrations of β-HCH were Mbita Winam Gulf (11.97 ng/l), followed by Homa Bay wastewater treatment effluent (11.63 ng/l) and River Awach (10.81 ng/l). The highest concentration in the dry season II was measured in samples from River Sondu (16.07 ng/l), followed by River Nyamasaria (15.16 ng/l) and KWASCO (13.08 ng/l), whereas for the short rain season, the highest concentration was measured in Kisati (80.67 ng/l), followed by Homa Bay wastewater treatment effluent (18.74 ng/l) and River Nyando (17.86 ng/l) (Figure 4.5.12 and Annex Table 4.4.1 A). The median concentration a cross the seasons ranged between 2 and 5.5 ng/l.

The percentage frequency of β-HCH resembled that of α-HCH, with the highest frequency recorded in the dry season I and II (100%), whereas the wet and the short rain seasons recorded less than 100%. The occurrence of β-HCH in the wet season was 93.8%, whereas that for the short rain was 96.9%. The sum β-HCH was highest in the short rain season (Σβ-HCH = 275 ng/l), followed by the dry season I (Σβ-HCH = 172.8 ng/l), the dry season II (Σβ-HCH = 161.8 ng/l) and the wet season (Σβ-HCH = 125.5 ng/l).

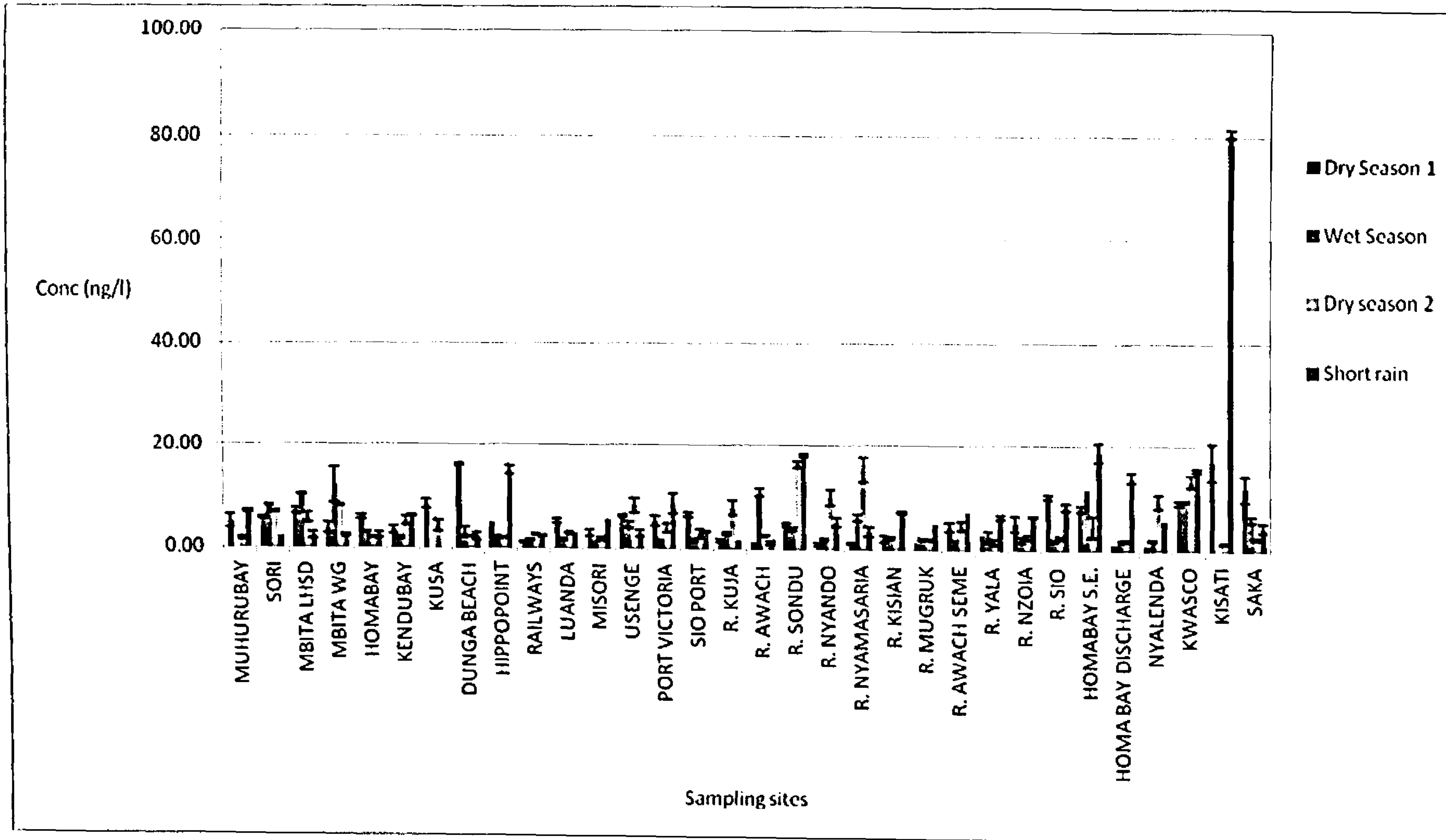

Figure 4.5.12: Concentration of β-HCH in water

Lindane (γ-HCH) concentration across the four seasons varied from BDL to 124.39 ng/l in the dry season I, from 1.96 to 49.84 ng/l in the wet season, from BDL to 19.23 ng/l in the dry season II, and between BDL and 13.75 ng/l in the short rain season.

The mean concentrations per season were 6.55 ng/l) for the dry season whereas the wet, dry season II and the wet seasons recorded 12.48 ng/l, 4.2 ng/l and 26.65 ng/l, respectively (Figure 4.5.13 and Annex Table 4.4.1 A). The median concentration for the dry season I was 6.55 ng/l, whereas 7.35, 3.23 and 11.12 ng/l were recorded for the wet, dry season II and short rain season, respectively.

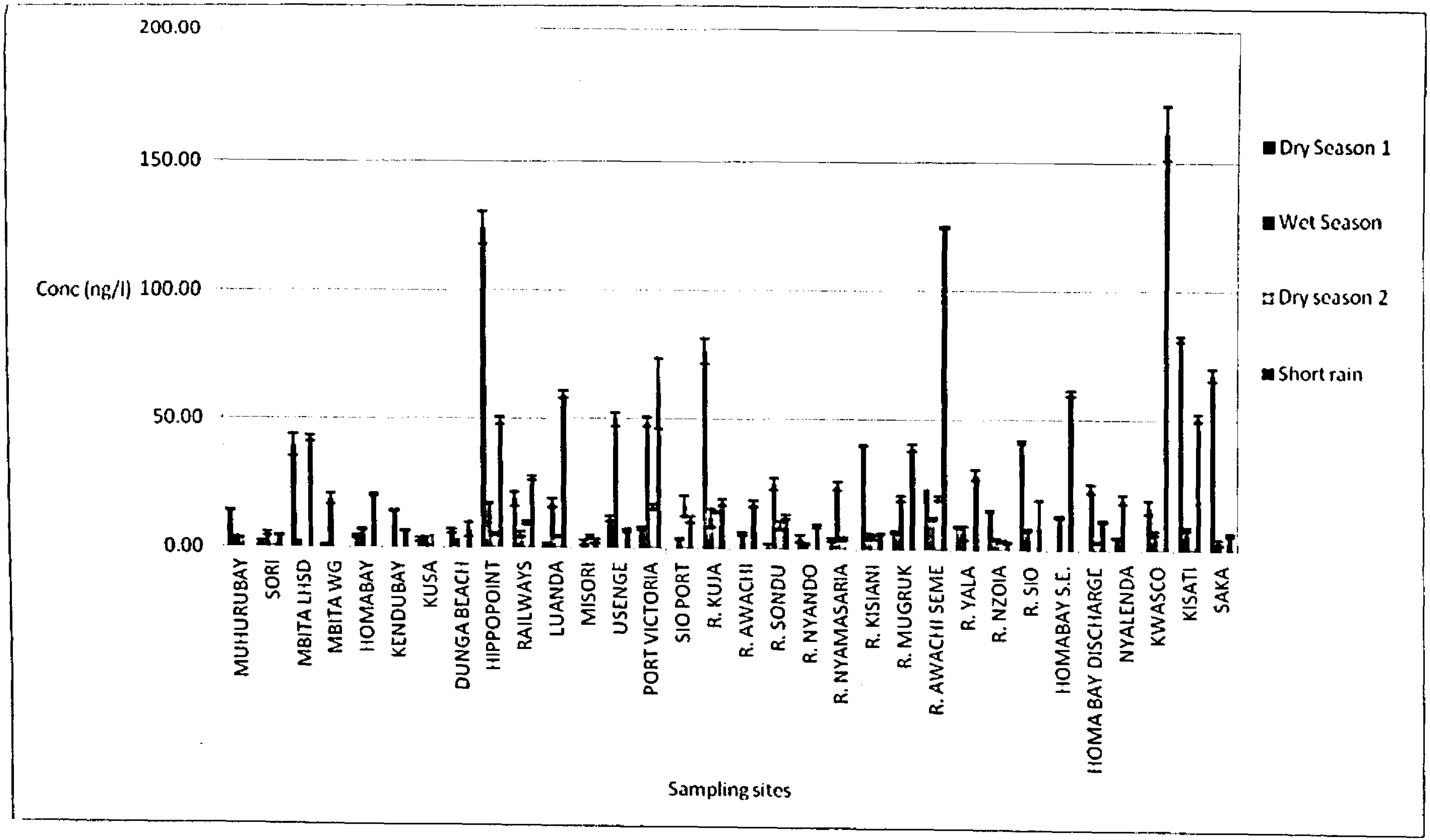

Figure 4.5.13: Concentration of γ-HCH in water from Lake Victoria Catchment

Delta HCH levels varied from BDL to 4.56 ng/l in the dry season I, from BDL to 15.34 ng/l in the wet season , from 0.56 to 4.97 ng/l in the dry season II, and from BDL to 12.35 ng/l in the short rain season. The mean concentrations were highest in the wet season (4.24 ng/l), followed by the short rain season (2.62 ng/l), the dry season I (1.42 ng/l) and the dry season II (1.22 ng/l). The sites with the highest concentrations in the dry season I were Dunga Beach (.456 ng/l) followed by River Awach (3 ng/l), KWASCO (2.9 ng/l) and Homa Bay with concentration of 2.87. Rivers Sio and Nzoia had the leading concentrations during the wet season with means of 15.34 ng/l and 10.32 ng/l respectively, whereas the leading sites in the dry season II were River Awach Seme (4.97 ng/l) and Kusa (2.06 ng/l). The short rain season recorded highest concentrations at Homa Bay (12.35 ng/l) and Hippo Point (6.71 ng/l) (Figure 4.5.14).

The occurrence of δ-HCH was highest in the dry season II (100%), followed by the dry season I and the short rain season each recording 96.9%, whereas the wet season recorded 87.5%. The sum δ-HCH were highest in the wet season (Σδ-HCH = 135 ng/l) followed by the short rain season (Σδ-HCH = 83.8 ng/l), the dry season II (Σδ-HCH = 45.6 ng/l) and the dry season II (38.9 ng/l) (Annex Table 4.4.1 A).

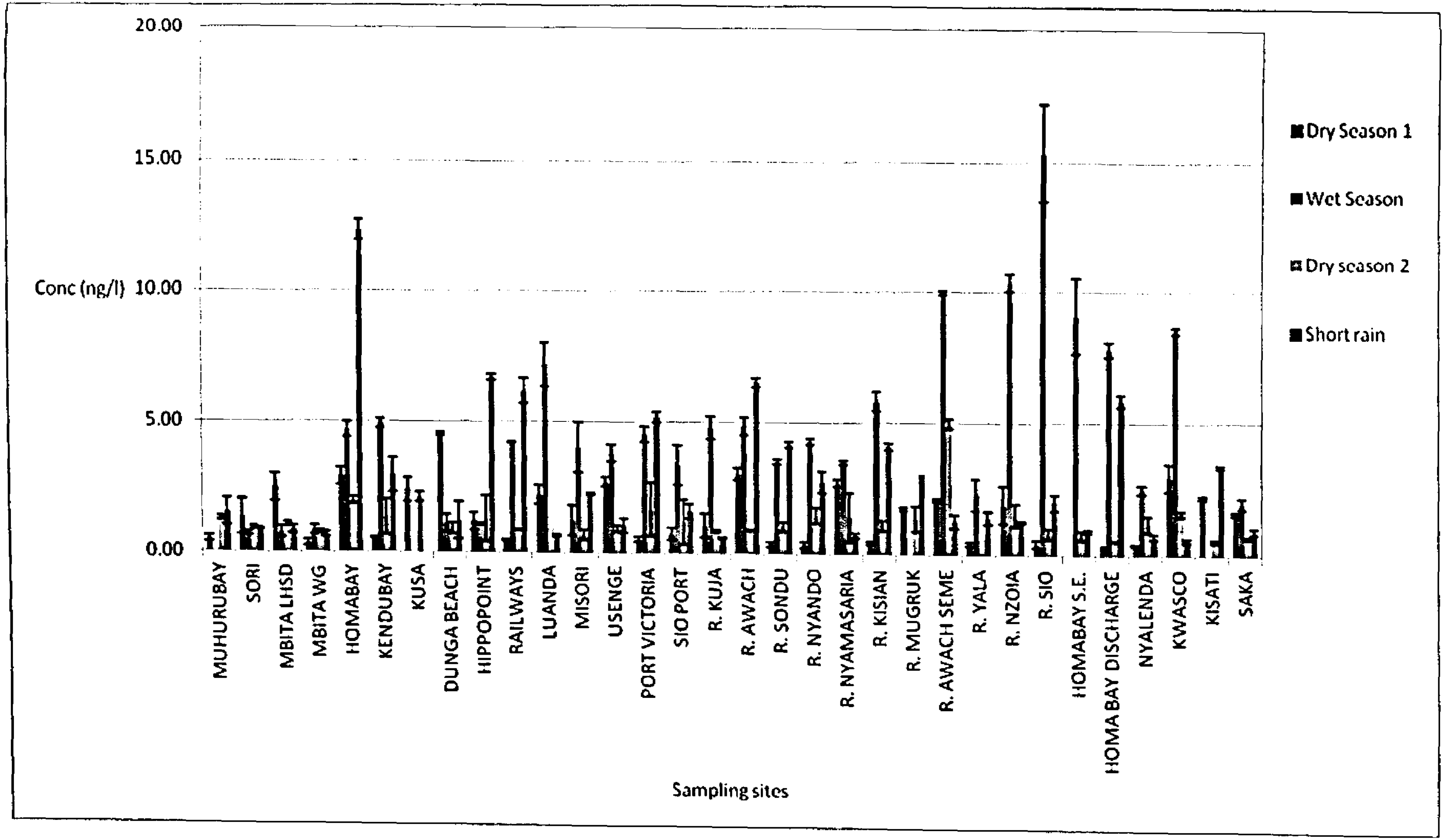

Figure 4.5.14: Concentration of δ-HCH in water

4.5.1.6 Heptachlor and heptachlor epoxide in water

Heptachlor (1,4,5,6,7,8,8-heptachloro-3a 4,7,7a - tetrahydro-4,7-methano-l *H*-indene) is a contact organochlorine pesticide used in the control of soil insects and termites. The technical grade heptachlor consists of 70% heptachlor, 22% trans-chlordane and 5% nonachlor [Deichmann, 1981]. Global production and use of heptachlor has been banned under the Stockholm Convention due to environmental persistence and potential toxicological effects on human and wildlife. Once introduced into environment, heptachlor undergoes transformation into heptachlor epoxide which is more persistent than the parent compound.

Heptachlor concentration in the samples was highest in the dry season (29.37 ng/l), followed by the wet season (26.85 ng/l), the short rain season (21.74 ng/l) and the dry season II (20 ng/l). The concentration range in the dry season I varied from 6.2 to 29.37 ng/l, while the median concentration was 10.91 ng/l. The wet season ranged from BDL to 26.85 ng/l, whereas the median concentration was 10.90 ng/l. The dry season II and the short rain seasons had concentrations from 7.63 to 20 ng/l, and from BDL to 21.74 ng/l and medians of 12.34 ng/l and 12.51 ng/l, respectively (Figure 4.5.15).

The occurrence of heptachlor was highest in the dry season I and II (100%) followed by the short rain season (96.9%) and the wet season (90.6%). The dry season I had the leading sum heptachlor (Σheptachlor = 397 ng/l) followed by the dry season II (Σheptachlor = 395 ng/l), the short rain season (Σheptachlor = 393 ng/l) and the wet season (Σheptachlor = 391 ng/l) (Annex Table 4.4.1 A).

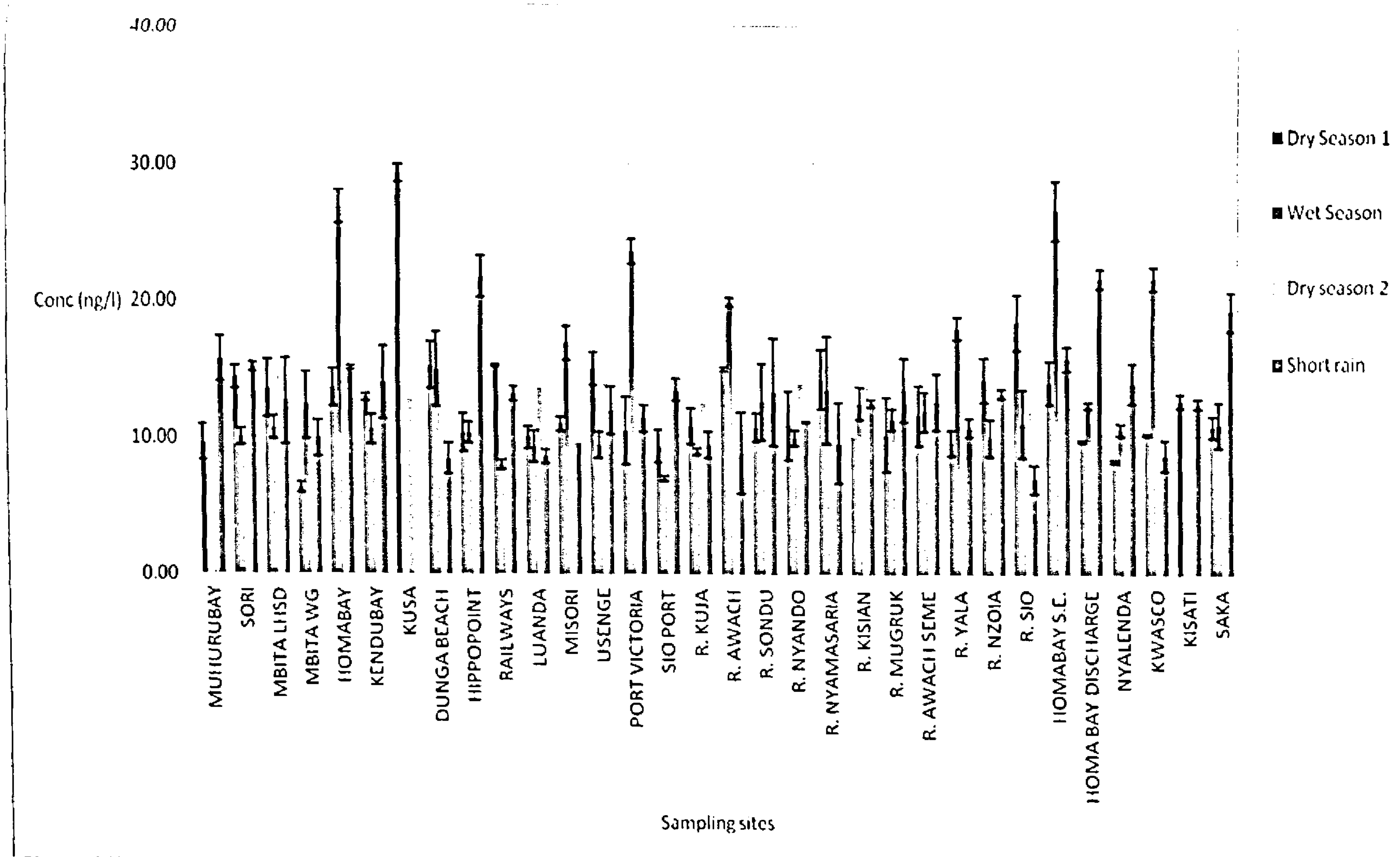

Figure 4.5.15 Concentration of heptachlor in water

Heptachlor epoxide concentrations varied from BDL to 45.28 ng/l in the dry season I, from BDL to 10.37 ng/l in the wet season, from BDL to 39.97 ng/l in the dry season II and from BDL to 130 ng/l in the short rain season. The highest mean concentration was recorded in the short rain season (21.24 ng/l), followed by the dry season I (10.21 ng/l), the dry season II (5.62 ng/l) and the wet season (0.87 ng/l). The highest concentration in the dry season I were measured in samples from Sio Port (45.28 ng/l), followed by R. Kisian (40.37 ng/l) and Misori (41.15 ng/l). Sori recorded the highest concentration in the wet season (10.37 ng/l), followed by Homa Bay wastewater treatment effluent (6.73 ng/l), whereas Port Victoria measured the leading concentration in the dry season II (39.97 ng/l). The highest concentrations in the short rain season were measured at Homa Bay (129.98 ng/l), followed by R. Awach Seme (114.32 ng/l) and Luanda (81.08 ng/l) (Figure 4.5.16).

The occurrence of heptachlor epoxide was highest in the short rain season (81.3%), followed by the dry season II (75%), the dry season I (71.9%) and the wet season (43.8%). The sum concentrations of heptachlor epoxide were highest in the short rain season (Σheptachlor epoxide = 680 ng/l), followed by the dry season I (Σheptachlor epoxide = 327 ng/l), the dry season II (Σheptachlor epoxide = 180 ng/l) and the wet season (Σheptachlor epoxide = 27.71 ng/l) (Annex Table 4.4.1 A).

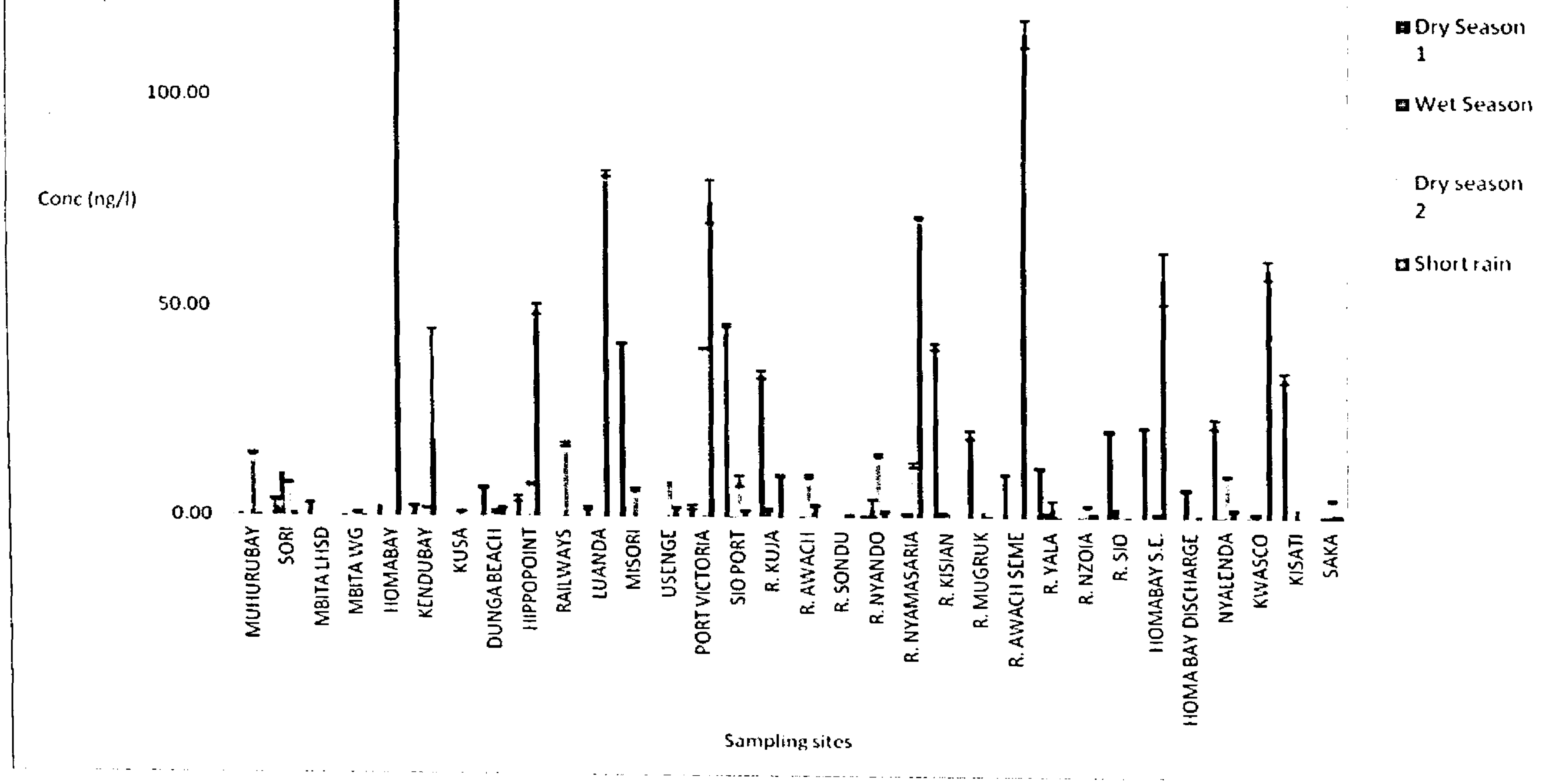

Figure 4.5.16 Concentration of heptachlor epoxide in water

4.5.1.7 Methoxychlor in water

Concentration of methoxychlor varied from BDL to 5.7 ng/l in the dry season I, from BDL to 87.04 ng/l in the wet season, from BDL to 43.48 ng/l in the dry season II, and from BDL to 130.93 ng/l in the short rain season (Figure 4.5.17). The highest concentrations in the dry season I were measured in samples from KWASCO (5.7 ng/l), Mbita Winam Gulf (5.57 ng/l) and River Nyando (3.95 ng/l). Sites with the highest concentrations in the wet season were Mugruk (87.04 ng/l), Mbita Winam Gulf (86.17 ng/l) and River Sio (19.27 ng/l) (Annex Table 4.4.1 A).

Methoxychlor is an organochlorine insecticide used for the control of livestock parasites and a variety of pests on ornamentals, fruits and vegetables. Due to persistence in environment, the use of methoxychlor in Kenya was banned in 1984 [PCPB, 2011].

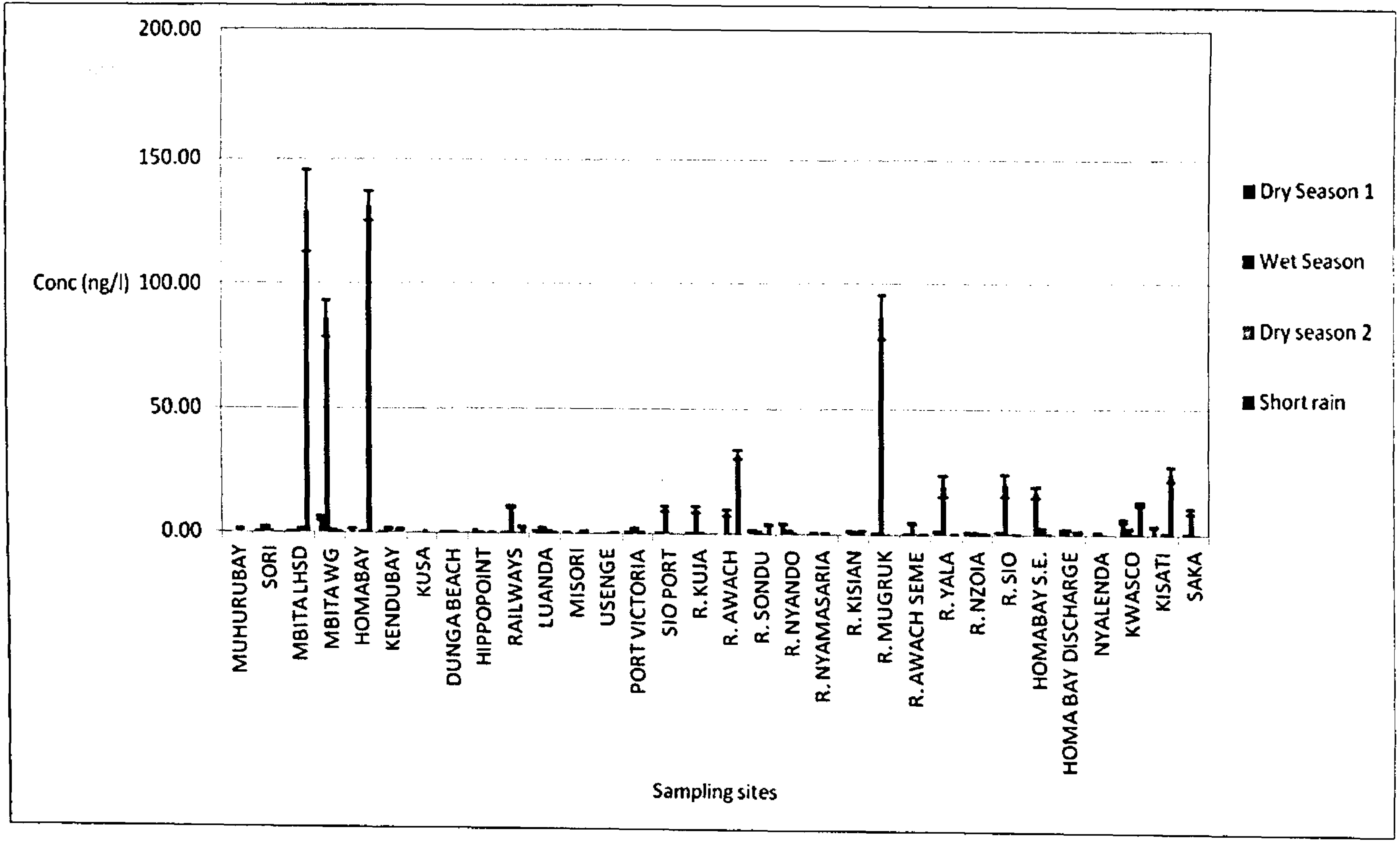

Figure 4.5.17: Concentration of Methoxychlor in water

The results have reaved varying concentrations of organochlorine pesticides water whic could be be attributed to previous use in agriculture, however, there presences poses concern due to their harmful effects on human and environment [Lemaire *et al.,* 2004]. Most of these compounds have been banned from use, but their residues are still detectable in environment due to persistence and bio-accumulative effects. The rates of degradation and dissipation vary greatly depending on the type of pesticide and the prevailing environmental condition such as temperature, wind, humidity, soil type and biotic factors. Consequently, the concentration, spatial and temporal trends in levels vary from one compound to the other. Organochlorine pesticides have been detected in water, soil and sediment samples around the world [Hasan *et al.*, 2010] including Kenya [Wandiga *et al.*, 2002b], but comparison with the prevous reports data shows that the levels are decreasing in water.

4.5.2 Pesticide residues in Sediments

4.5.2.1 Aldrin and dieldrin in sediments

Aldrin levels in sediments ranged between BDL and 3,953 ng/kg in the dry season I, between BDL and 19,501 ng/kg in the wet season, between BDL and 21,815 ng/kg in the dry season II, and between BDL and 3,248 ng/kg in the short rain season.

The sum aldrin in sediments was highest in the dry season II (Σaldrin = 59,899 ng/kg), followed by the wet season (Σaldrin = 28,067 ng/kg), dry season I (Σaldrin = 16,794 ng/kg) and the short rain season (Σaldrin = 10,219 ng/kg) (Figure 4.518).

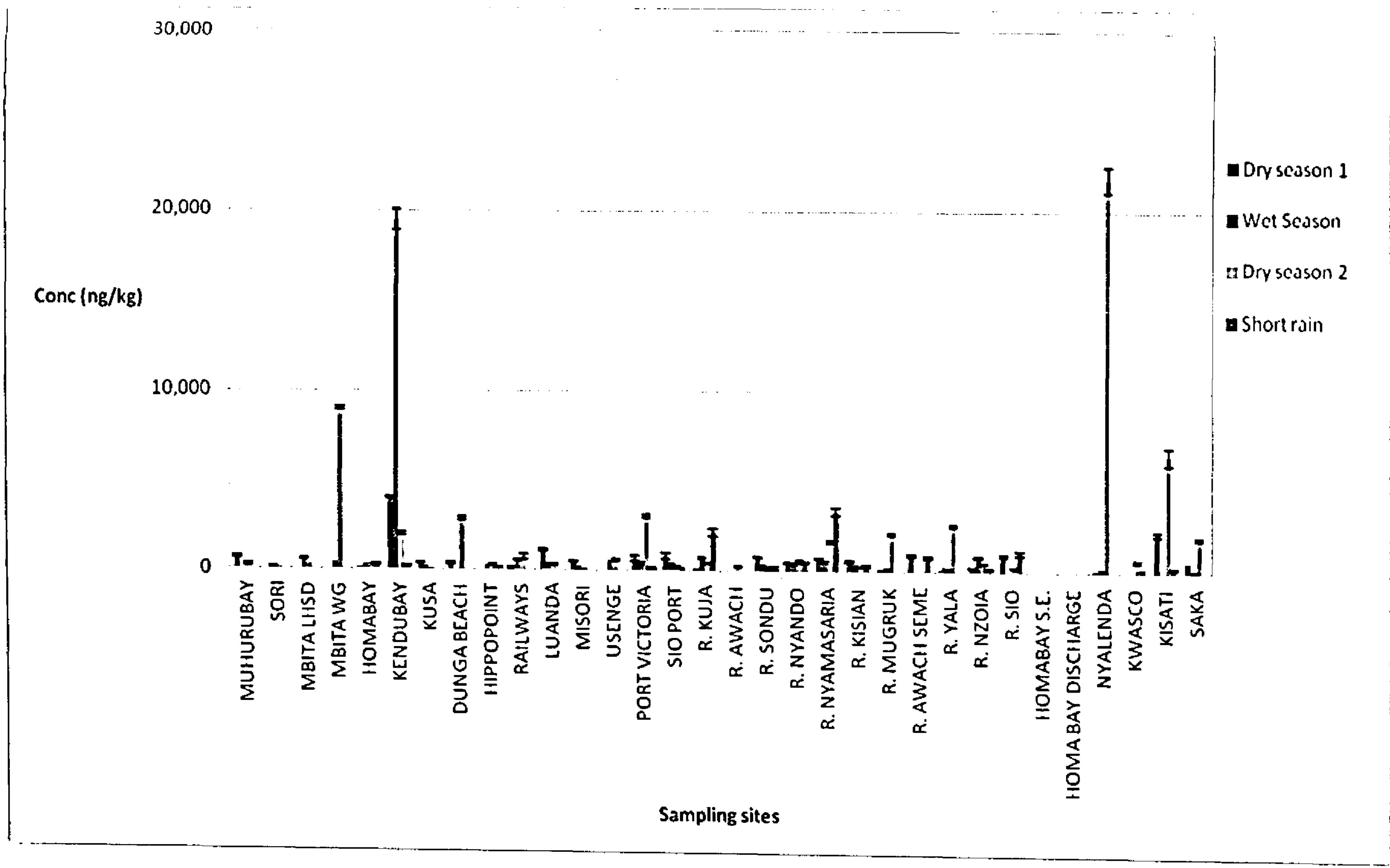

Figure 4.518: Concentration of aldrin in sediments

The dry season II recorded the highest frequency of detection (100%), followed by the wet season (93.3%), the dry season I (76.7%) and the short rain season (63.3%).

The average concentration of dieldrin was highest in the dry season II (4,815 ng/kg), followed by the dry season II (3,850 ng/kg), the wet season (568 ng/kg) and the short rain season (542 ng/kg). However, the highest concentration was recorded in the dry season I (from BDL to 60,150 ng/kg), followed by the dry season II (from BDL to 50,731 ng/kg), the short rain season (from BDL to 7,723 ng/kg) and the wet season (from BDL to 3,433 ng/kg).

The dry season II recorded the highest sum dieldrin (Σdieldrin = 144,462 ng/kg), followed by the dry season I (Σdieldrin = 115,523 ng/kg), the wet season (Σdieldrin = 17,064 ng/kg) and the short rain season (Σdieldrin = 16,283 ng/kg). But percentage frequency was highest in the dry season II (86.7%), then the wet season (60%), the dry season I (56.7%) and the short rain season (40%) (Figure 4.5.19 and Annex Table 4.4.2A).

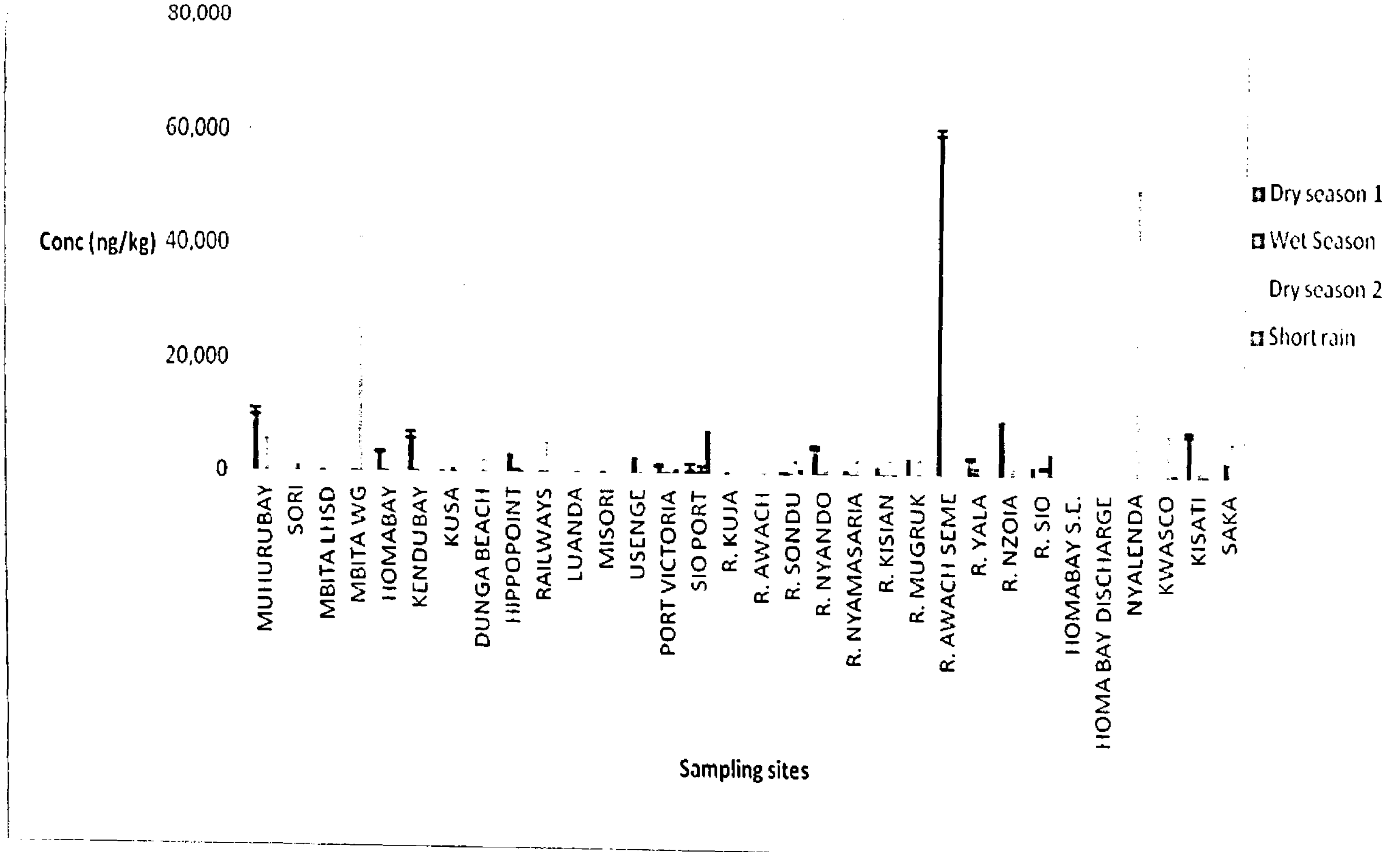

Figure 4.5.19: Concentration of dieldrin in sediments

4.5.2.2 DDT and metabolites in sediments

The mean concentration for *p,p'*-DDT was highest in the dry season I (58,520 ng/kg)>dry season II (24,728 ng/kg)>wet season (8,411ng/kg)>short rain season (7,185 ng/kg). The intra-seasonal concentrations ranged from BDL to 420,409 ng/kg in the dry season I, from BDL to 43,446 ng/kg in the wet season, from BDL to 126,381 ng/kg in the dry season II, and from BDL to 71,800 ng/kg in the short rain season (Figure 4.5.20 and Annex Table 4.4.2A).

The dry season I recorded the highest sum *p,p'*-DDT (Σ*p,p'*-DDT = 1,755,611 ng/kg), followed by the dry season II (Σ*p,p'*-DDT = 741,843 ng/kg), the wet season (Σ*p,p'*-DDT = 252,339 ng/kg) and the short rain season (Σ*p,p'*-DDT = 215,565 ng/kg). But the highest detection frequency was recorded in the dry season II (90%), followed by the wet season (63.3%), the dry season I (60%) and the short rain season (40%).

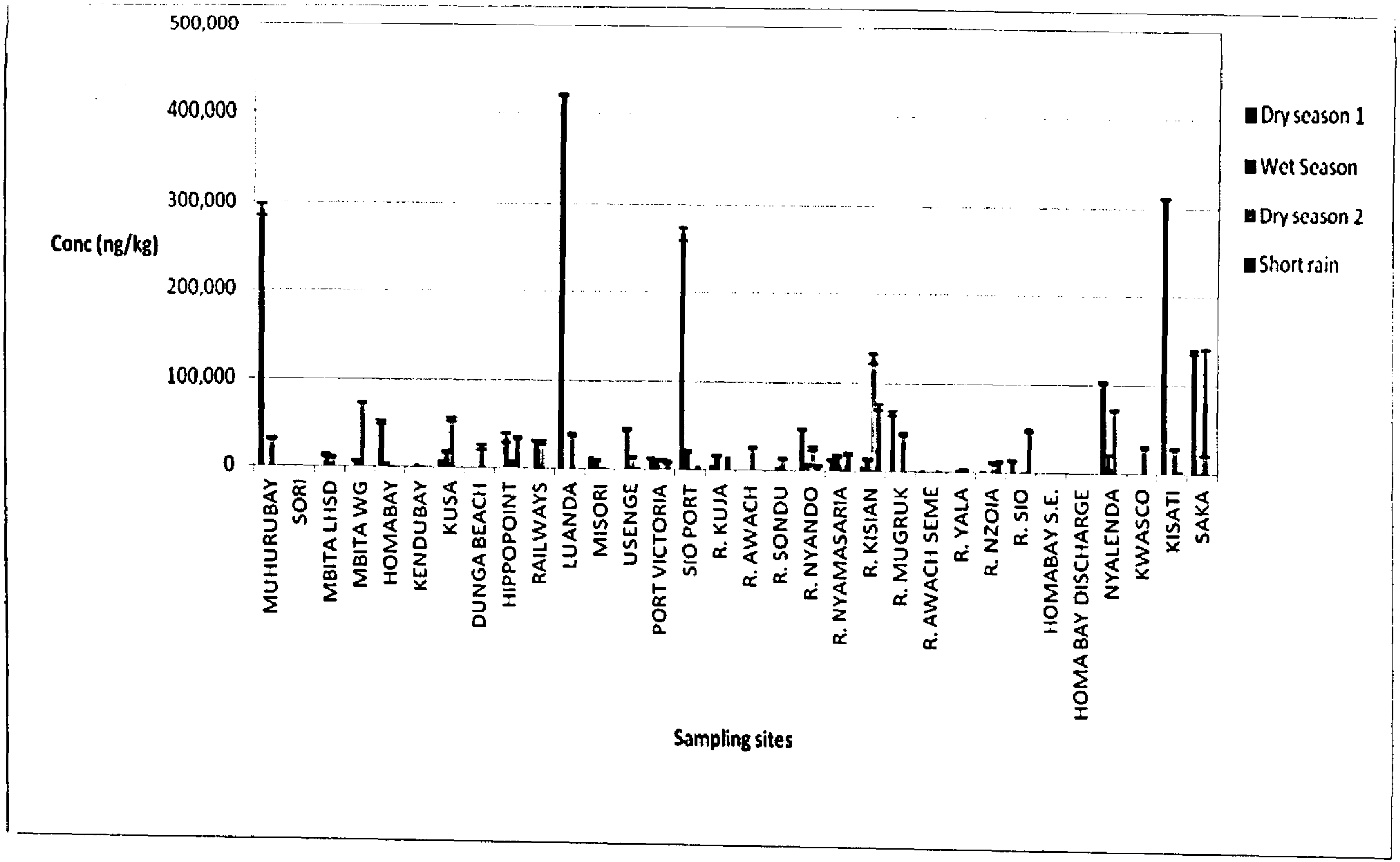

Figure 4.5.20: Concentration of p,p'-DDT in sediments

The concentration of *p,p'*-DDE ranged between BDL and 5,766 ng/kg in the dry season I, between BDL and 5,939 ng/kg in the wet season, between BDL and 25,962 ng/kg in the dry season II, and from BDL to 2,960 ng/kg in the short rain season (Figure 4.5.21).

The sum *p,p'*-DDE was highest in the dry season II (Σ*p,p'*-DDE = 51,906 ng/kg), followed by the dry season I (Σ*p,p'*-DDE = 26,883 ng/kg), the wet season (Σ*p,p'*-DDE = 26,277 ng/kg) and the short rain season (Σ*p,p'*-DDE = 6,964 ng/kg). On the other hand, the wet season recorded the highest frequency of *p,p'*-DDE in the samples (90%), followed by the dry season II (83.3%), the dry season I (76.7%) and the short rain (46.7%).

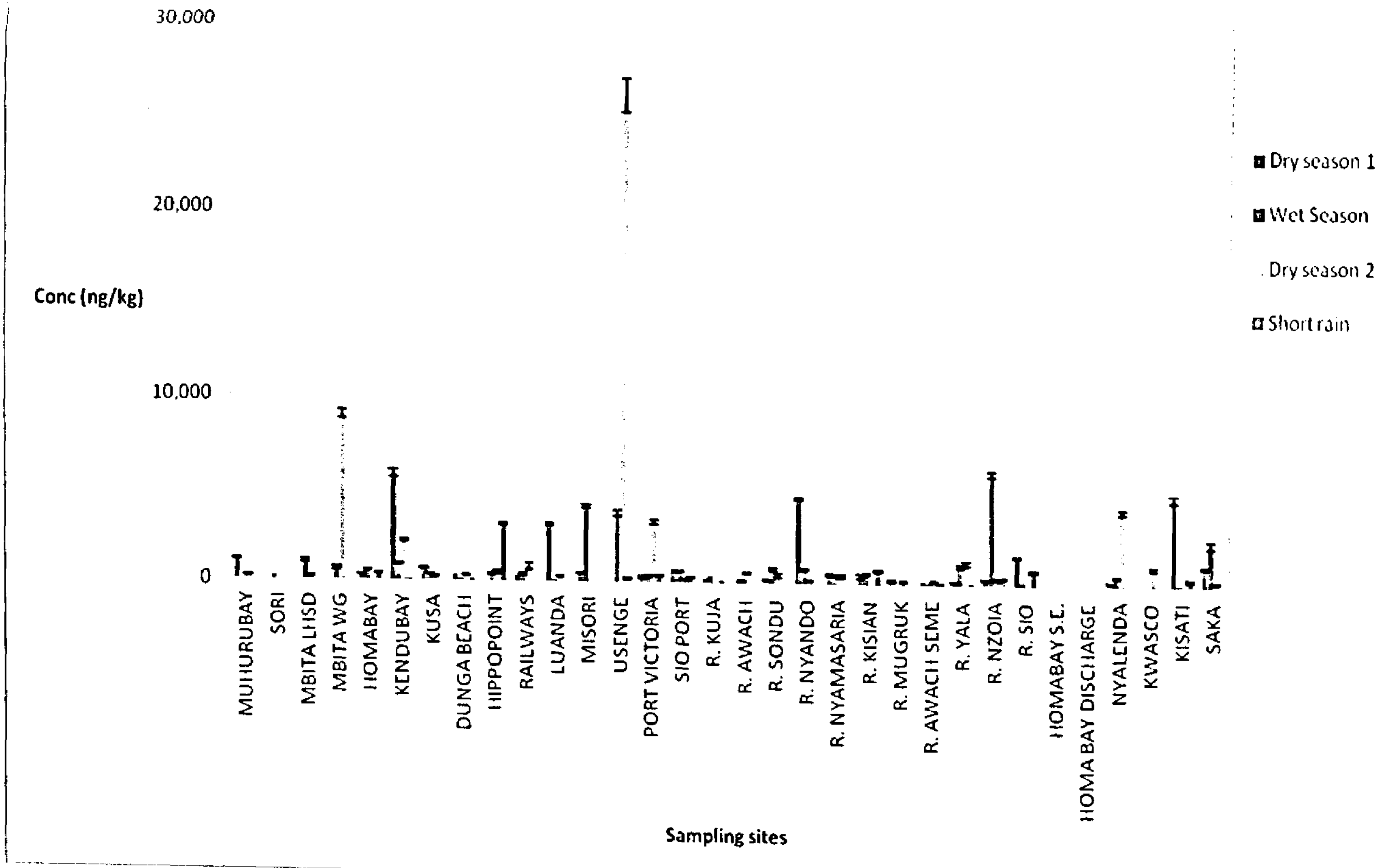

Figure 4.5.21: Concentration of p,p'-DDE in sediments

The levels of *p,p'*-DDD ranged between BDL and 11,330 ng/kg in the dry season I, from BDL to 8,654 ng/kg in the wet season, from 99 to 28,708 ng/kg in the dry season II, and BDL and 5,964 ng/kg in the short rain season (Figure 4.5.22 and Annex Table 4.4.2A).

The sum *p,p'*-DDD in the dry season II (Σ*p,p'*-DDD = 43,205 ng/kg)>dry season I (Σ*p,p'*-DDD = 35,818 ng/kg)>wet season (Σ*p,p'*-DDD = 20,058 ng/kg)>short rain season (Σ*p,p'*-DDD = 16,692 ng/kg). The dry season II also recorded the highest frequency (100%), followed by the wet season (83.3%), the dry season I (76.7%) and the short rain season (63.3%).

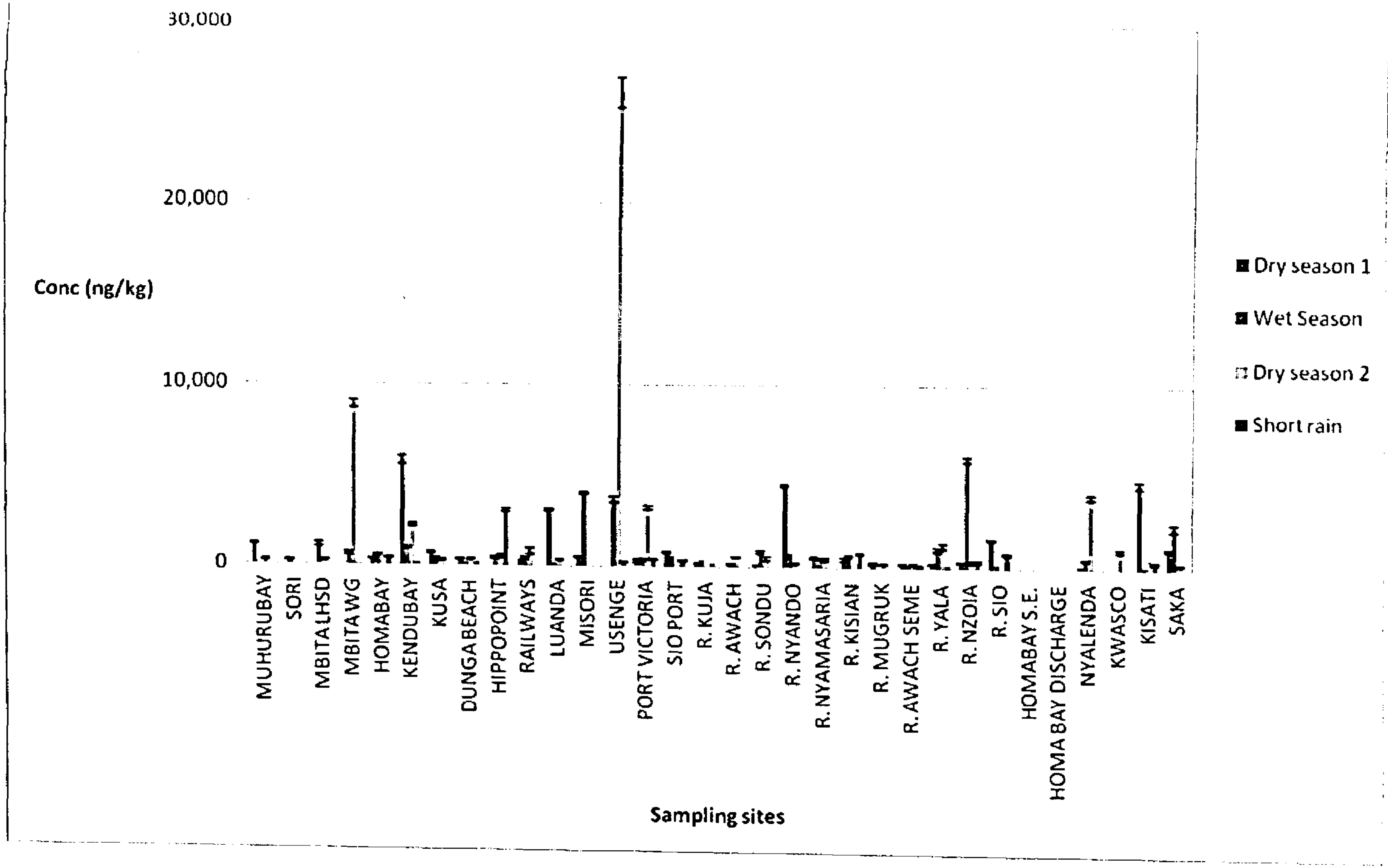

Figure 4.5.22: Concentration of p,p'-DDD in sediments

4.5.2.3 Endosulphan levels in Lake Victoria catchment sediments

Endosulphan I levels in the dry season I ranged between BDL and 10,560 ng/kg, whereas the wet season recorded concentrations between BDL and 3,479 ng/kg, from 85 to 47,883 ng/kg in dry season II, and from BDL to 4,186 ng/kg in the short rain season (Figure 4.5.23 and Annex Table 4.4.2A).

Sum endosulphan I in sediments was greatest in the dry season II (Σendosulphan I = 95,616 ng/kg), followed by the dry season I (Σendosulphan I = 39,706 ng/kg), wet season (Σendosulphan I = 13,080 ng/kg) and the short rain season (Σendosulphan I = 12,725 ng/kg).

The detection frequency of endosulphan I was highest in the dry season II (100%), followed by the wet season (83.3%), dry season I (76.7%) and the short rain season (60%). On the other hand the seasonal mean concentrations were highest in the dry season I (3,187ng/kg)>dry season II (1,323 ng/kg)>wet season (436 ng/kg)>short rain season (424 ng/kg).

The mean concentration of endosulphan II in sediment were highest in the dry season II (1,690 ng/kg), followed by the dry season I (1,220 ng/kg), wet season (1,103 ng/kg) and the short rain season (824 ng/kg). Whereas the concentration range varied from BDL to 11,188 ng/kg in the dry season I, from BDL to 15,988 ng/kg in the wet season, from 71 to 33,881 ng/kg in the dry season II and from BDL to 2,111 ng/kg in the short rain season (Figure 4.5.24 and Annex Table 4.4.2A).

The sum endosulphan II in the dry season II (Σendosulphan II = 50.710 ng/kg)>dry season I (Σendosulphan II = 36,610 ng/kg)>wet season (Σendosulphan II = 33,090 ng/kg)>short rain season (5,519 ng/kg). On the other hand, frequency was highest in the dry season II (100%), followed by the wet season (90%), the dry season I (76.7%) and the short rain season (63.3%).

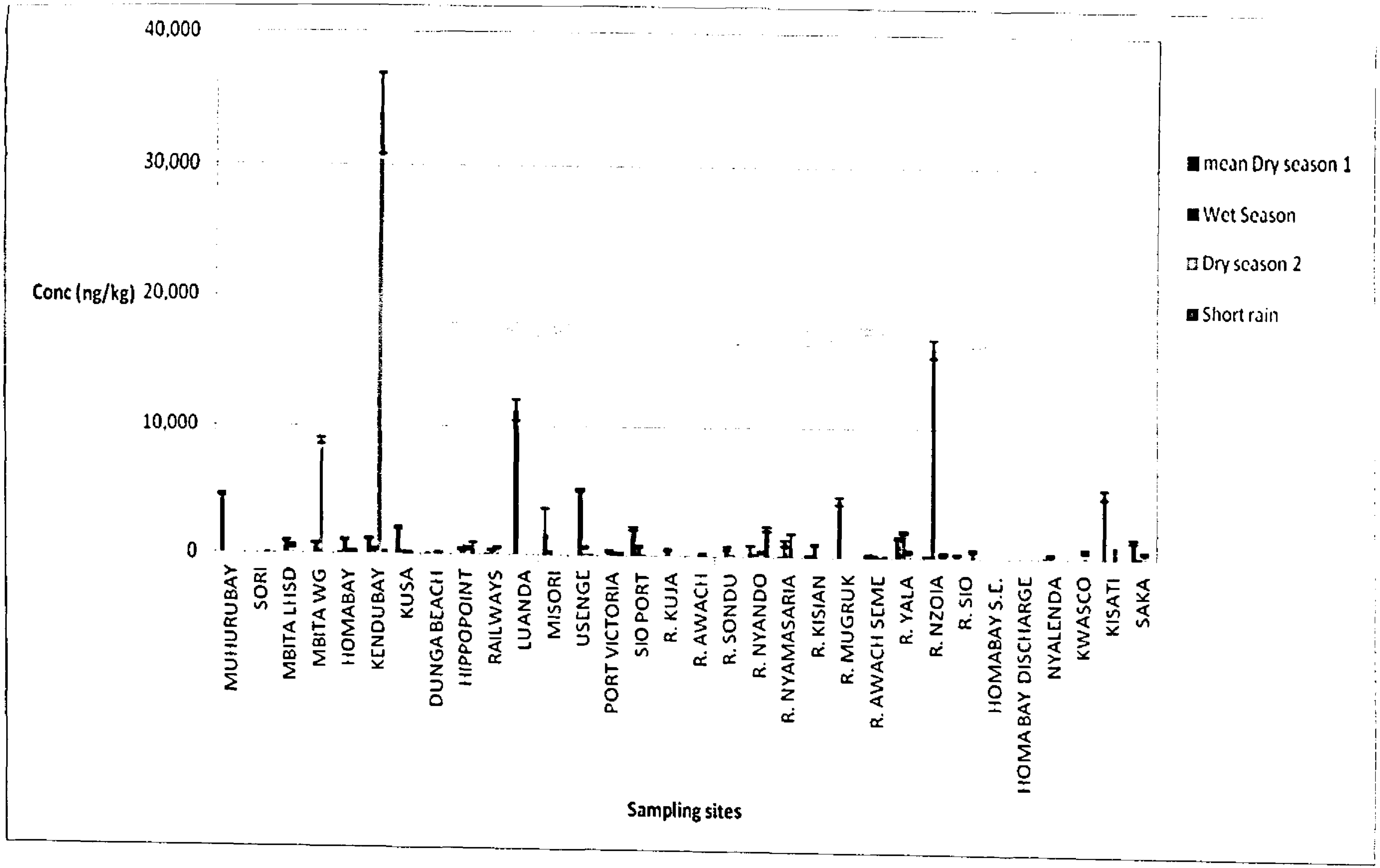

Figure 4.5.24: Concentration of endosulphan II in sediments

The concentration of endosulphan sulphate ranged between BDL and 132,134 ng/kg in the dry season I, between BDL and 29,382 ng/kg in the wet season, from BDL to 40,248 ng/kg in the dry season II, and from BDL to 45,517 ng/kg in the short rain season (Figure 4.5.25 and Annex Table 4.4.2A).

The sum endosulphan sulphate was highest in the dry season I (Σendosulphan sulphate = 214,038 ng/kg), followed by the dry season II (Σendosulphan sulphate = 150,891 ng/kg), the wet season (Σendosulphan sulphate = 106,963 ng/kg) and the short rain season (Σendosulphan sulphate = 68,943 ng/kg). On the other hand, the highest detection frequency was recorded in the dry season II (86.7%), followed by the wet season (80%), the dry season (76.7%), and the short rain season (53.3%).

The higher contrations of endusulphan sulphate detected compared to endosulphan I and II could be explained by environmental degradation, whereby the latter are mainly converted to the diol and the sulphate forms in water. According to Hose and co-workers [2003], endosulfan sulphate and diol may be further broken down to the ether, hydroxyl ether, lactone, and alcohol forms. However, among all the metabolites, endosulphan sulphate is considered to be the only one that is toxic [Berntssen *et al.*, 2008]. Endosulphan sulphate has been reported to be more persistent in water than the parent compounds, although both forms are more persistent in sediments [Leonard *et al.*, 2001; Wan *et al.*, 2005].

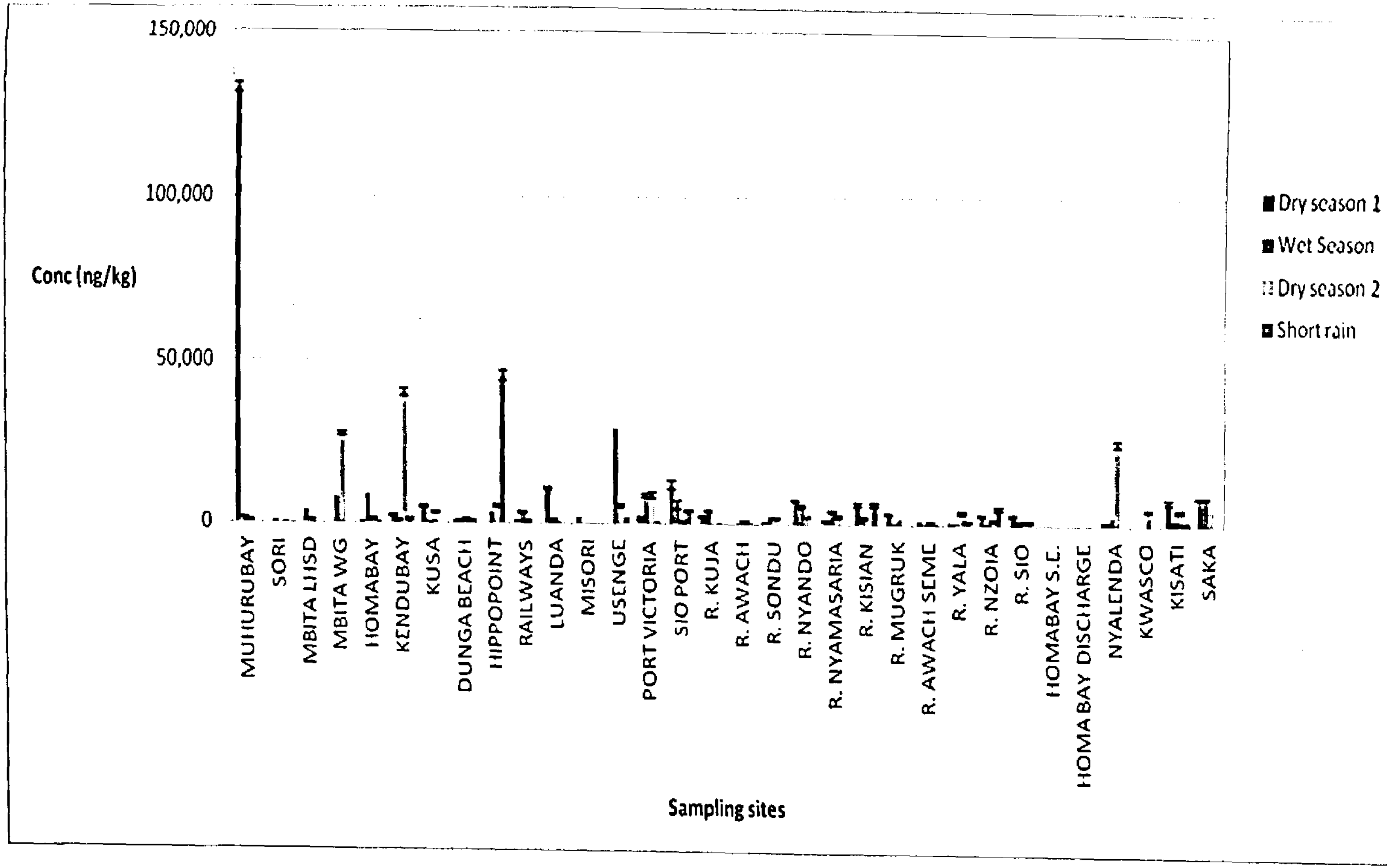

Figure 4.5.25: Concentration of endosulphan sulphate in sediments

4.5.2.4 Endrin and Endrin aldehyde in sediments

The mean concentration of endrin were highest in the dry season II (2,983 ng/kg)>dry season I (2,376 ng/kg)>wet season (1,146 ng/kg)>short rain season (590 ng/kg). However, the concentration ranges were between BDL and 28,338 ng/kg in the dry season I, from BDL to 14,596 ng/kg in the wet season, from 72 to 42,826 ng/kg in the dry season II, and from BDL to 4,944 ng/kg in the short rain season (Figure 4.5.26 and Annex Table 4.4.2A).

The sum endrin highest in the dry season II (Σendrin = 89,513 ng/kg), followed by the dry season I (Σendrin = 71,300 ng/kg), wet season (Σendrin = 34,391 ng/kg) and the short rain season (Σendrin = 17,725 ng/kg). Endrin detection frequency was highest in the dry season II (100%), followed by the wet season (93.3%), the dry season I (73.3%) and the short rain season (66.7%).

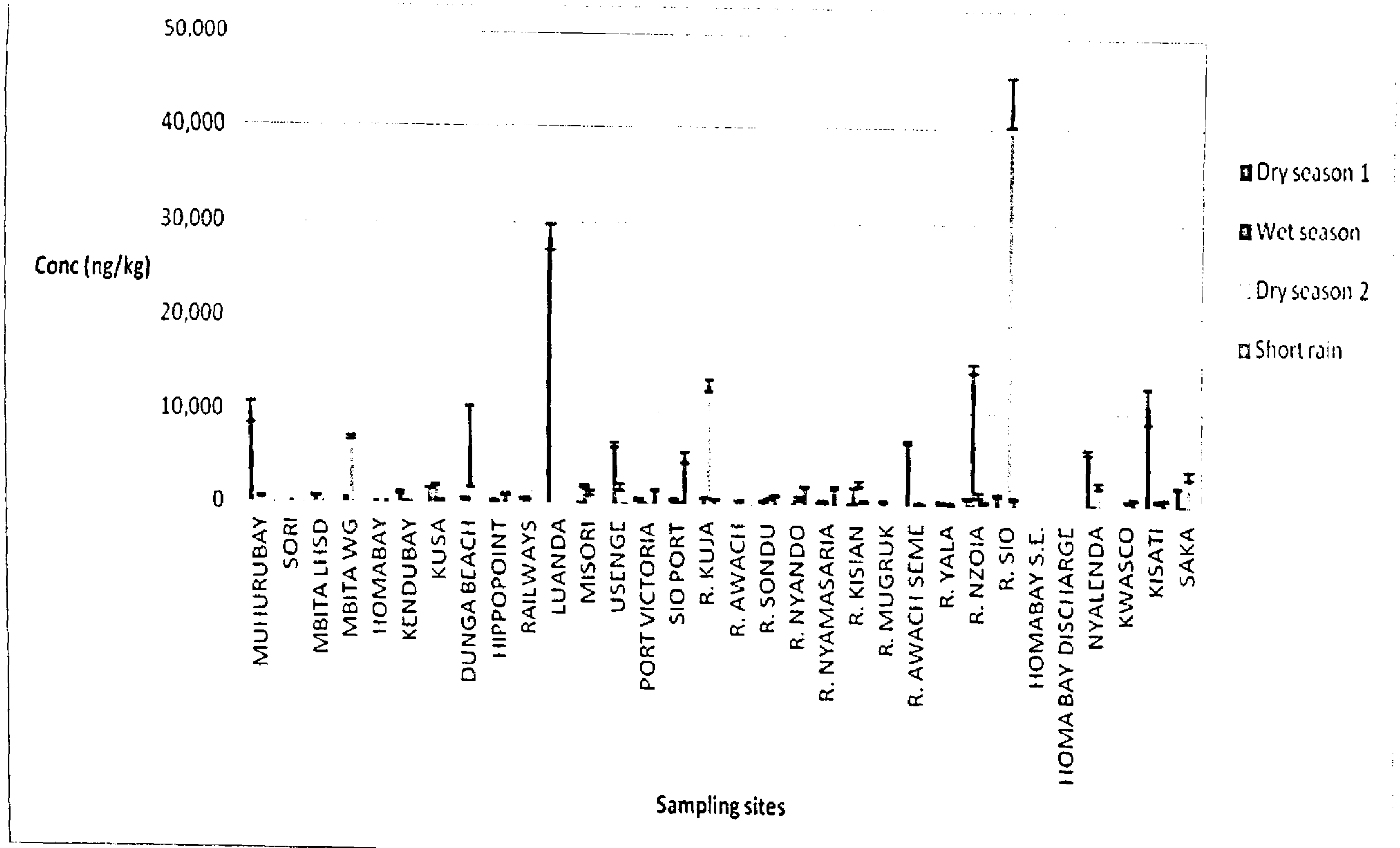

Figure 4.5.26: Concentration of endrin in sediments

Endrin aldehyde levels were generally higher in sediments compared to endrin. The highest mean concentration was recorded in the dry season I (49,180 ng/kg)>dry season II (22,073 ng/kg)>short rain season (8,355 ng/kg)>wet season (2,856 ng/kg). Seasonal ranges varied from BDL-590,118 ng/kg in the dry season I, BDL-27,531 ng/kg in the wet season, BDL-284 ng/kg in the dry season II and BDL-73,527 ng/kg in the short rain season (Figure 4.5.27 and Annex Table 4.4.2A).

The sum endrin aldehyde was highest in the dry season I (Σendrin aldehyde = 1,475,400 ng/kg)>dry season II (Σendrin aldehyde = 662,191 ng/kg)>short rain season (Σendrin aldehyde = 250,678 ng/kg)>wet season (Σendrin aldehyde = 85,704 ng/kg). But percentage detection was highest in the dry season II (80%), followed by the wet season (70%), the short rain season (63.3%) and the dry season I (56.7%).

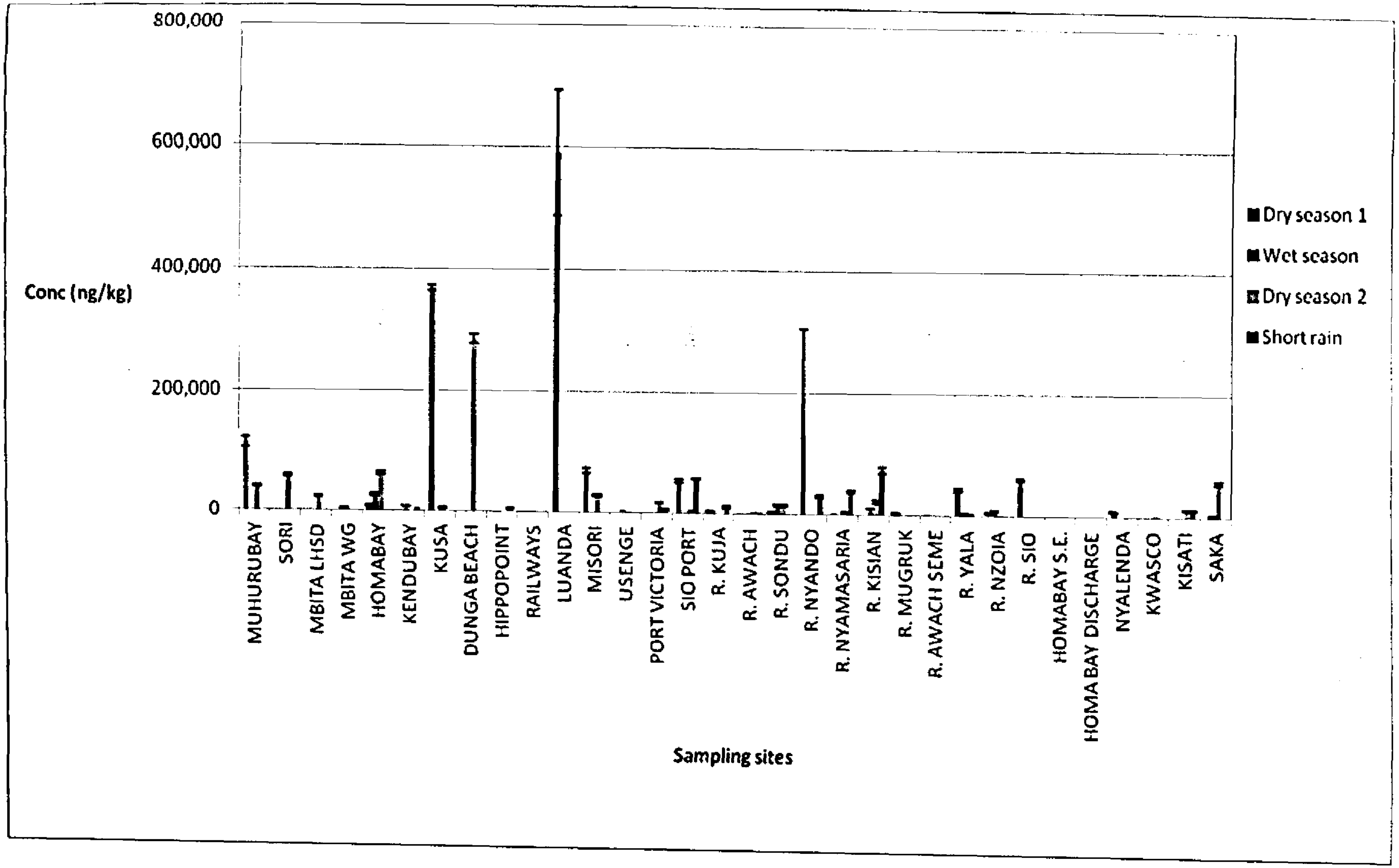

Figure 4.5.27: Concentration of endrin aldehyde in sediments

According to previous studies, endrin is more hydrophobic and less likely to accumulate in the water column compared to its metabolites endrin ketone and aldehyde which are slightly soluble [ATSDR, 1996]. Once in the water, endrin strongly adsorbs to sediment, thereby partitioning itself from the water and concentrating in the sediment. The concentrations of endrin and endril adehyde measured in this study show an agreement with these previous observations.

4.5.2.5 Hexachlorocyclohexane (HCH) isomers in sediments

Alpha HCH levels in sediments ranged between BDL and 6,134 ng/kg in the dry season I, from BDL to 949 ng/kg in the wet season, from BDL to 9,291 ng/kg in the dry season II, and from BDL to 4,463 ng/kg in the short rain season (Figure 4.5.28). The mean concentration was highest in the dry season II (1,685 ng/kg), followed by the dry season I (1,360 ng/kg), the short rain season (648 ng/kg) and the wet season (267 ng/kg) (Figure 4.5.28 and Annex Table 4.4.2A.

The sum α-HCH was highest in the dry season II (Σα-HCH = 50,571 ng/kg), followed by the dry season I (Σα-HCH = 40,815 ng/kg), the short rain season (Σα-HCH = 19,461 ng/kg) and the wet season (Σα-HCH = 8,038 ng/kg). But detection frequency of α-HCH was highest in the dry season II (83.3%) followed by the wet season (70%), the dry season I (66.7%) and the short rain season (53.3%).

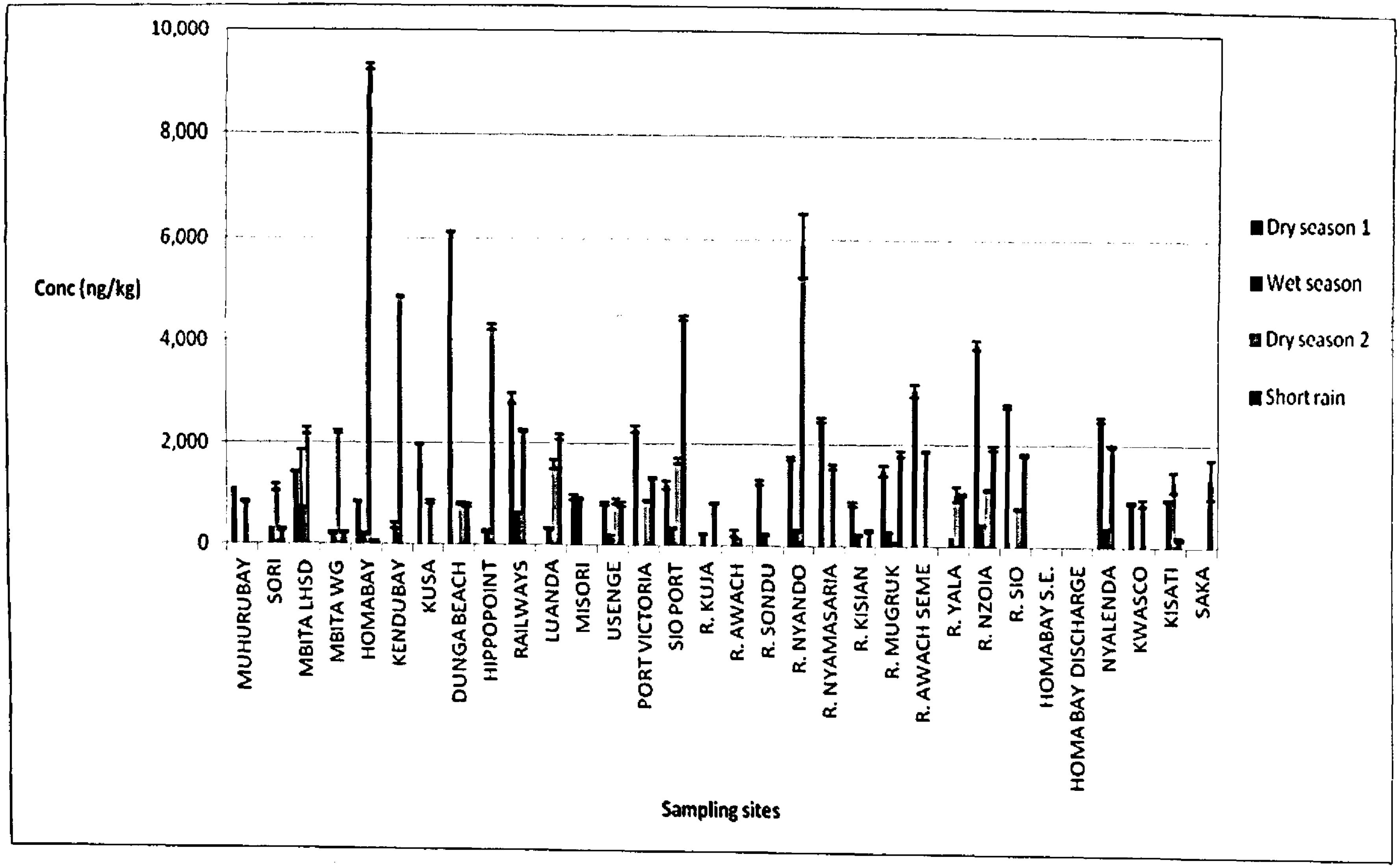

Figure 4.5.28: Concentration of α-HCH in sediments

Beta HCH concentration varied from BDL to 10,344 ng/kg in the dry season I, from BDL to 25,353 ng/kg in the wet season, from BDL to 15,251 ng/kg in the dry season II, and from BDL to 20,115 ng/kg in the short rain season (Figure 4.5.29). But the mean concentration was highest in the dry season I (1,843 ng/kg), followed by the short rain season (1,783 ng/kg), the wet season (1,591 ng/kg) and the dry season II (1,447 ng/kg).

The highest sum β-HCH was recorded in the dry season I (Σβ-HCH = 55,308 ng/kg), followed by the short rain season (Σβ-HCH = 53,490 ng/kg), the wet season (Σβ-HCH = 47,741 ng/kg) and the dry season II (Σβ-HCH = 43,424 ng/kg), whereas the frequency was highest in the dry season II (90%)>dry season I(60%)>short rain season (50%)>wet season (43.3%) (Figure 4.5.29 and Annex Table 4.4.2A).

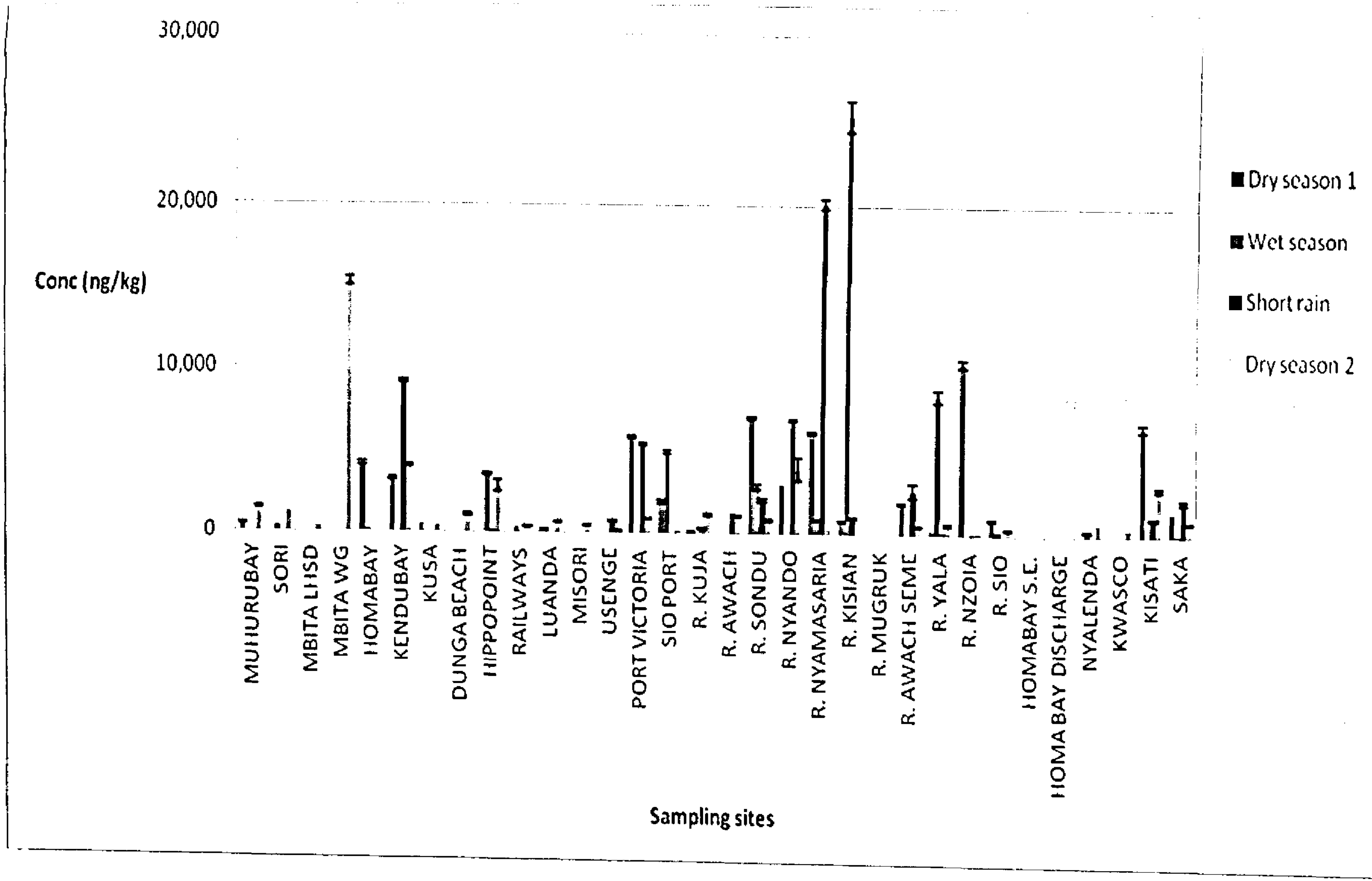

Figure 4.5.29: Concentration of β-HCH in sediments

The season variation in concentration of lindane ranged between BDL and 12,845 ng/kg in the dry season I, from BDL to 8,587 ng/kg in the wet season, from BDL to 8,565 ng/kg in the dry season II and from BDL to 2,619 ng/kg in the short rain season. The mean concentration was highest in the dry season I (2,126 ng/kg)>dry season II (1,523 ng/kg)>wet season (843 ng/kg)>short rain season (403 ng/kg) (Figure 4.5.30 and Annex Table 4.4.2A).

The sum γ-HCH was highest in the dry season I (Σγ-HCH = 63,789 ng/kg), followed by the dry season II (Σγ-HCH = 45,705 ng/kg), wet season (Σγ-HCH = 25,309 ng/kg) and the short rain season (Σγ-HCH = 12,097 ng/kg). The percentage detection frequency was highest in the dry season II (100%)>dry season I (76.7%)>wet season (70%)>short rain season (60%).

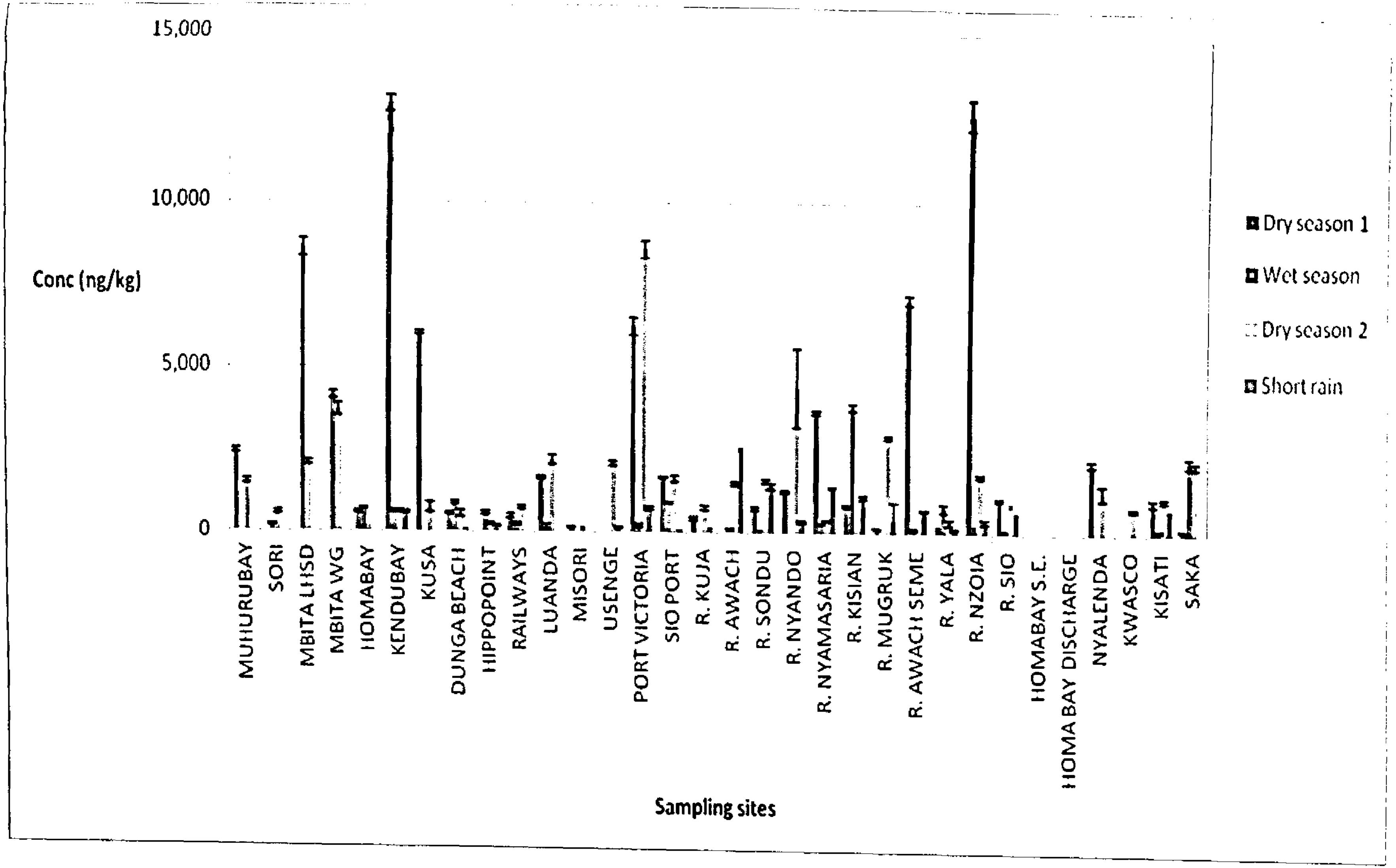

Figure 4.5.30 Concentration of γ-HCH in sediments

The mean concentration of delta HCH was highest in the dry season I (1,820 ng/kg)>dry season II (1.769 ng/kg)>wet season (1,509 ng/kg)>short rain season (680 ng/kg). Concentration ranges within the seasons varied from BDL to 8,726 ng/kg in the dry season, from BDL to 10,704 ng/kg in the wet season, from 779 to 8,677 ng/kg in the dry season II, and from BDL to 7,595 ng/kg in the short rain season (Figure 4.5.31 and Annex Table 4.4.2A).

The dry season I recorded the highest sum δ-HCH (Σδ-HCH = 54,603 ng/kg)>dry season II (Σδ-HCH = 53,069 ng/kg)>wet season (Σδ-HCH = 45,286 ng/kg)>short rain season (Σδ-HCH = 20,705 ng/kg). However, the frequency of detection was highest in the dry season II (100%), followed by the wet season (93.3%), the dry season I (76.7%) and the short rain season (60%).

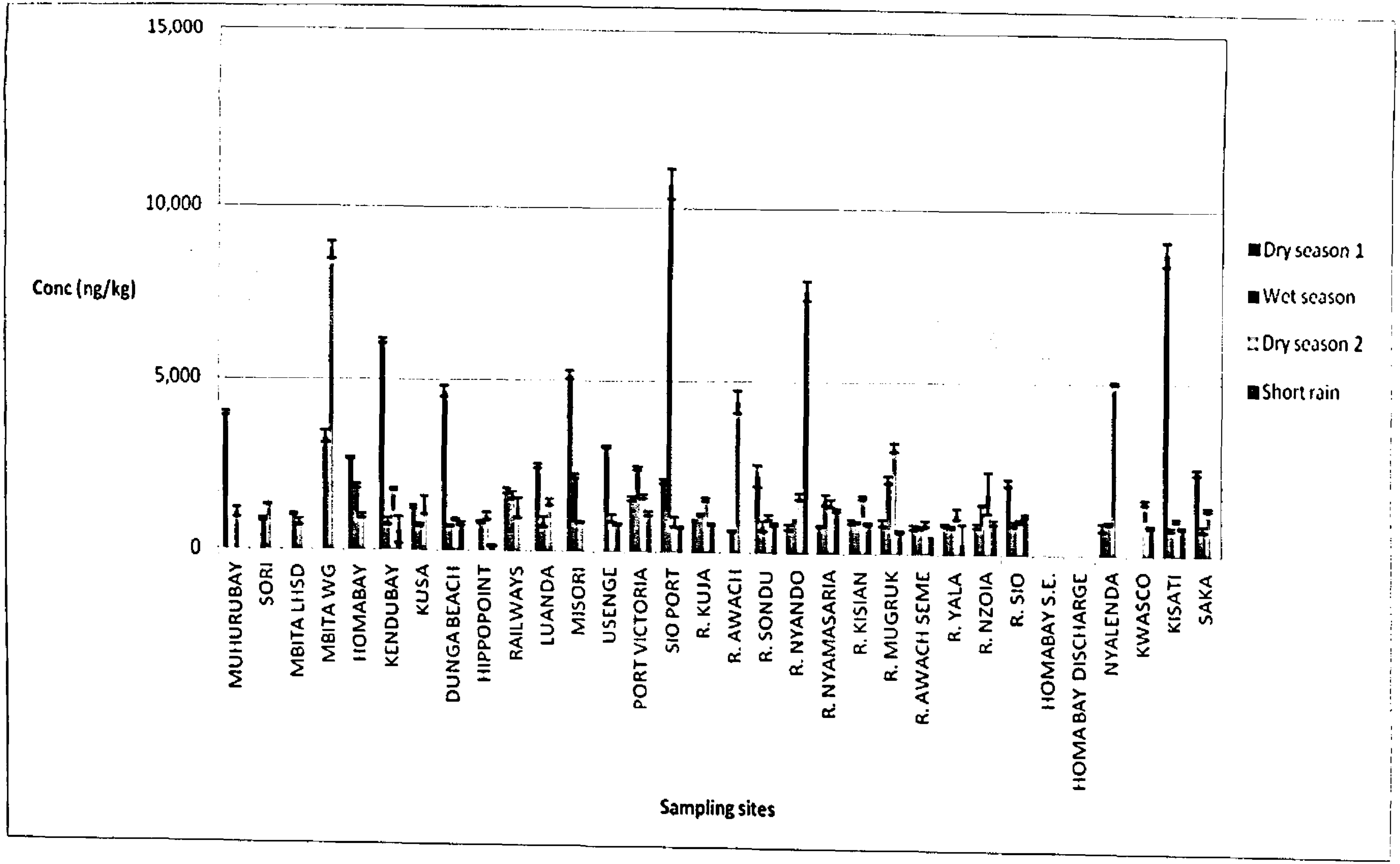

Figure 4.5.31: Concentration of δ-HCH in sediments

4.5.2.6 Heptachlor and Heptachlor epoxide

Heptachlor residues in sediments were between BDL and 33,422 ng/kg in the dry season I, from BDL to 24,599 ng/kg in the wet season, from 224 to 25,795 ng/kg in the dry season II, and from BDL to 56,248 ng/kg in the short rain season. The mean concentration measured in the dry season I (3,631 ng/kg)>short rain season (3,108 ng/kg)>dry season II (2,773 ng/kg)>wet season (1,976 ng/kg) (Figure 4.5.32 and Annex Table 4.4.2A).

Sum heptachlor was highest in the dry season I (Σheptachlor = 108,955 ng/kg)>short rain season (Σheptachlor = 93,243 ng/kg)>dry season II (Σheptachlor = 83,212 ng/kg)>wet season (Σheptachlor = 59,298 ng/kg). However, frequency of detection was highest in the dry season II (100%), followed by the dry season I (76.7%), the wet season (66.7%) and the short rain season (60%).

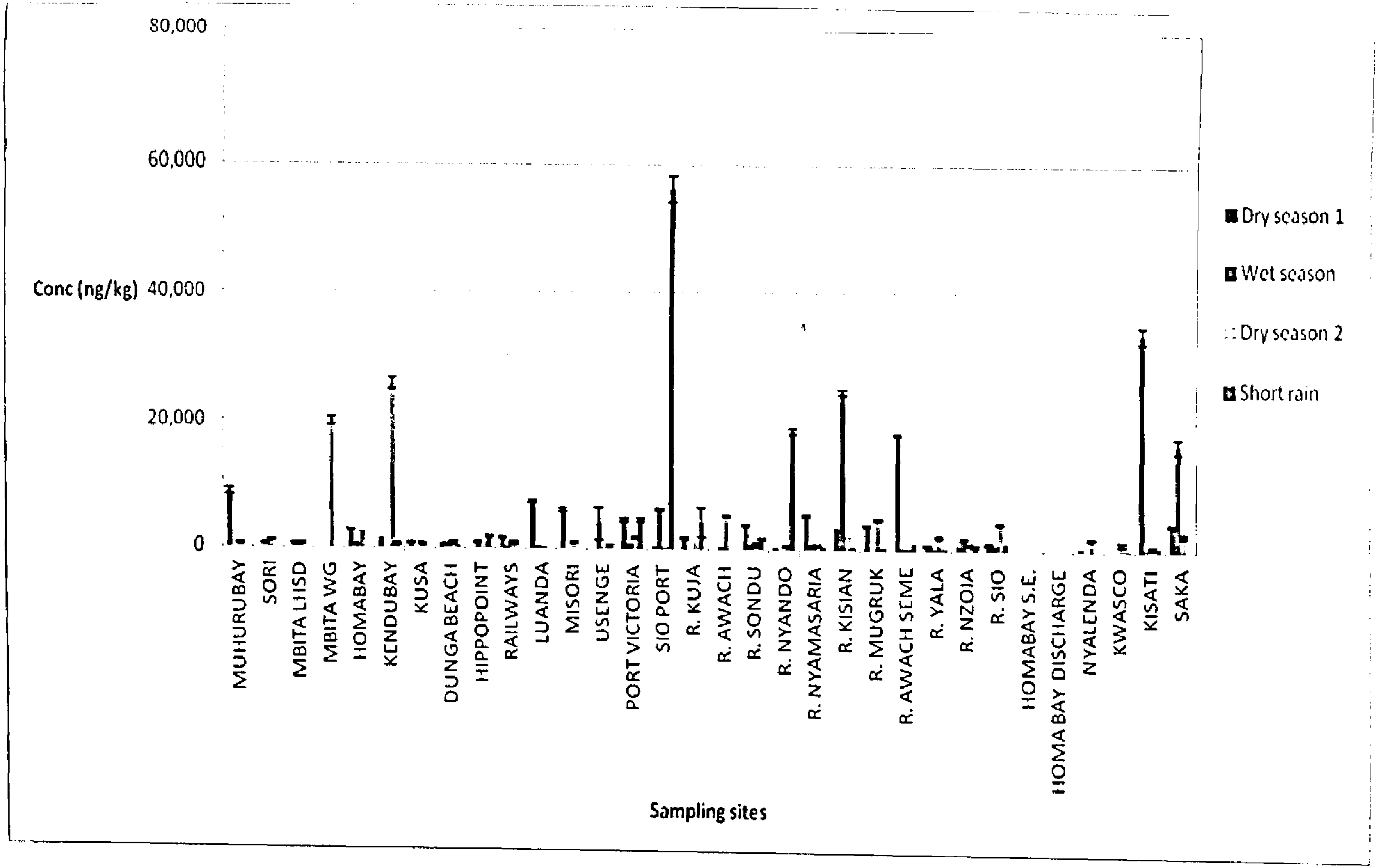

Figure 4.5.32: Concentration of heptachlor in sediments

The mean concentration of heptachlor epoxide was highest in the dry season I (1,570 ng/kg)>dry season II (880 ng/kg)>wet season (526 ng/kg)>short rain (491 ng/kg). The concentration range per season varied between BDL and 11,023 ng/kg in the dry season I, from BDL to 6,338 ng/kg in the wet season, from BDL to 7,111 ng/kg in the dry season II and from BDL to 2,507 ng/kg in the wet season (Figure 4.5.33 and Annex Table 4.4.2A).

The sum concentration per season was highest in the dry season I (Σheptachlor epoxide = 47,113 ng/kg)>dry season II (Σheptachlor epoxide = 26,416 ng/kg)>wet season (Σheptachlor epoxide = 15,784 ng/kg)>short rain season (14,750 ng/kg). The dry season II recorded the greatest frequency (96.7%), followed by the dry season I and wet season (76.7%) and the short rain season (53.3%) as shown in Figure 4.5.33 below.

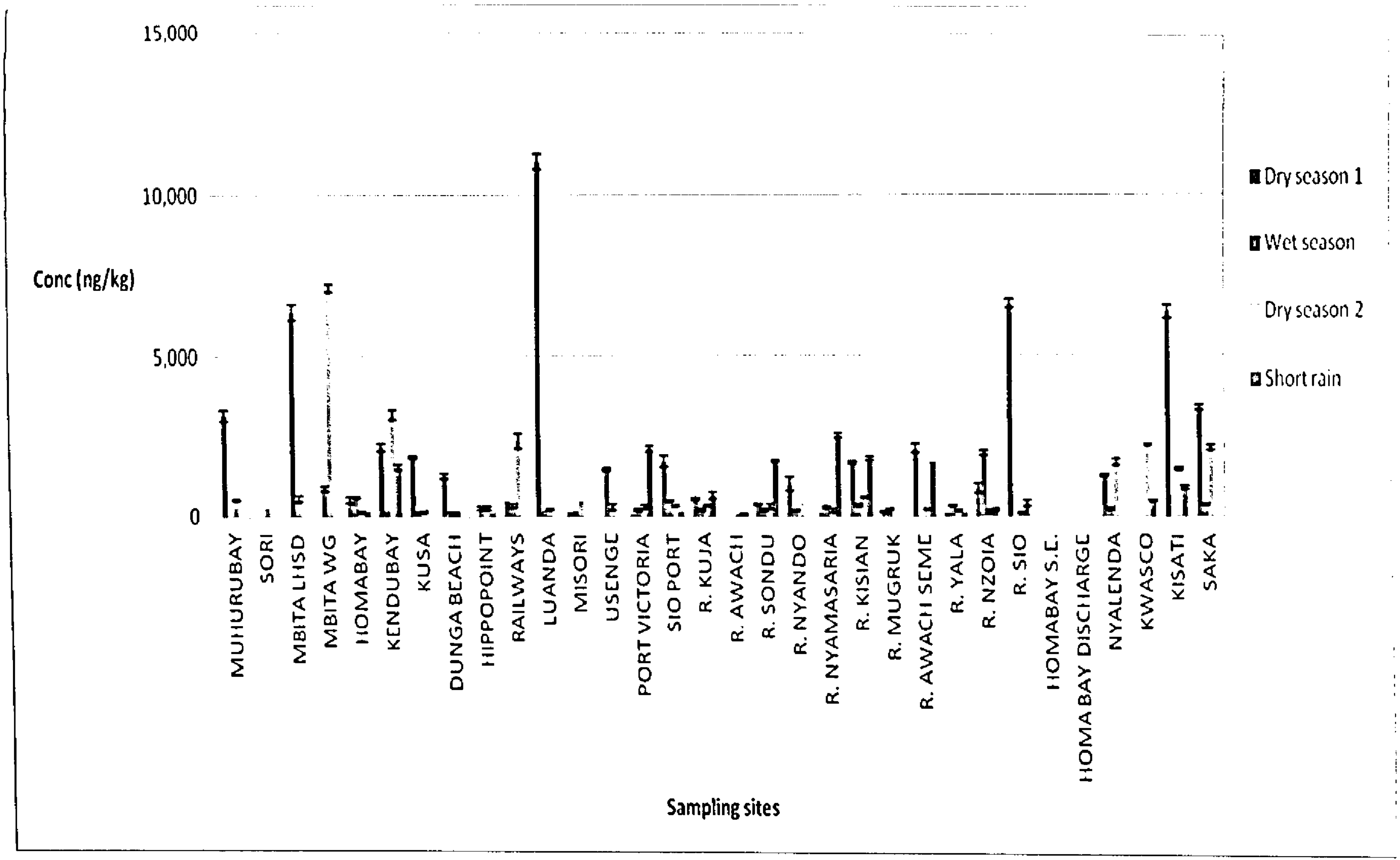

Figure 4.5.33: Concentration of heptachlor epoxide in sediments

4.5.2.7 Methoxychlor in sediments

Methoxychlor recorded concentration between BDL and 161,082 ng/kg in the dry season I, from BDL to 14,908 ng/kg in the wet season, from 117 to 141,326 ng/kg in the dry season II, and from BDL to 8,223 ng/kg in the short rain season.

The seasonal means were highest in the dry season I (19,800 ng/kg)>dry season II (12,079 ng/kg)>wet season (1,803 ng/kg)>short rain season (1,614 ng/kg) (Figure 4.5.34 and Annex Table 4.4.2A and Annex Table 4.4.3A).

The sum concentration per season was highest in the dry season I (Σmethoxychlor = 594,011 ng/kg)>dry season II (Σmethoxychlor = 362,393 ng/kg)>wet season (Σmethoxychlor = 54,101 ng/kg)> short rain season (Σmethoxychlor = 48,432 ng/kg). The differences were observed in detection frequencies, whereby the dry season II recorded the highest (100%), followed by the wet season (86.7%), dry season I (76.7%) and the short rain season (66.7%).

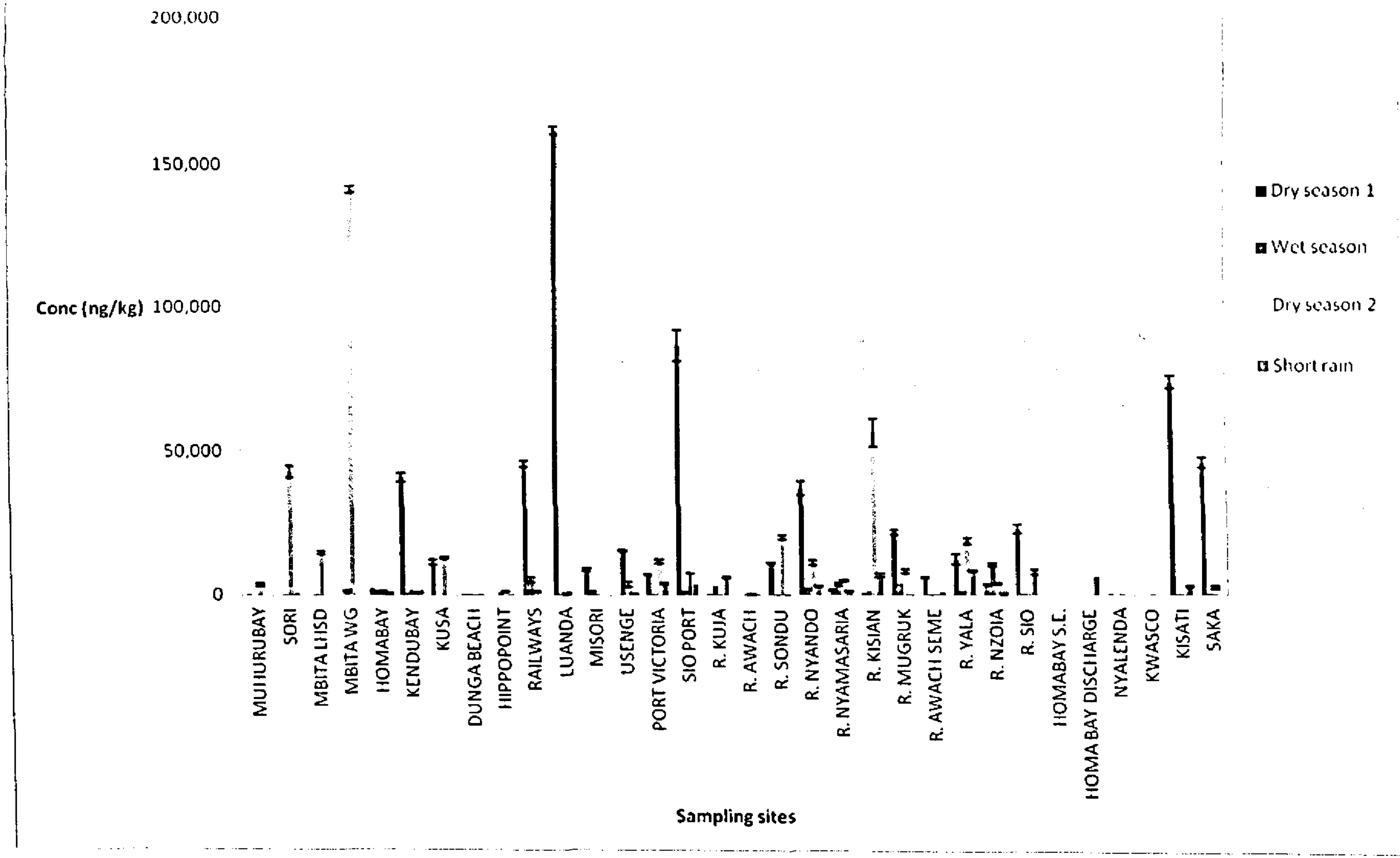

Figure 4.5.34: Concentration of methoxychlor in sediments

4.5.3 Pesticide residues in soil

Although the use of most organochhlorine pesticides was banned in the 80s and 90s in the country, elevated levels of these compounds are still detectable in Kenyan soils. Soil provides a more convenient environment for accumulation of hydrophobic chemicals such as organochlorine pesticides, due its heterogeneous nature and high organic carbon content, compared to water. Pesticides bound to soil organic matter are less accessible to microbial and other modes of degradation, and therefore tend to persist for longer periods. Consequently, analysis of soil samples would provide a good indicator of environmental contamination by these compounds compared to water.

4.5.3.1 Concentration of aldrin and dieldrin in soil

Aldrin concentration in soils varied from BDL to 5,359 ng/kg in the dry season I, from BDL to 14,656 ng/kg in the wet season, from BDL to 25,139 ng/kg in the dry season II, and from BDL to 25,383 ng/kg in the short rain. The highest concentration was in the short rain season (25,383 ng/kg) >dry season II (25,139 ng/kg) >wet season (14,656 ng/kg) >dry season I (5,359 ng/kg), whereas the highest detection frequency was in the wet season (70%) followed by the short rain (66.7%), the dry season I and the dry season II with 50% and 43.3%, respectively (Figure 4.5.35 and Annex Table 4.4.3A).

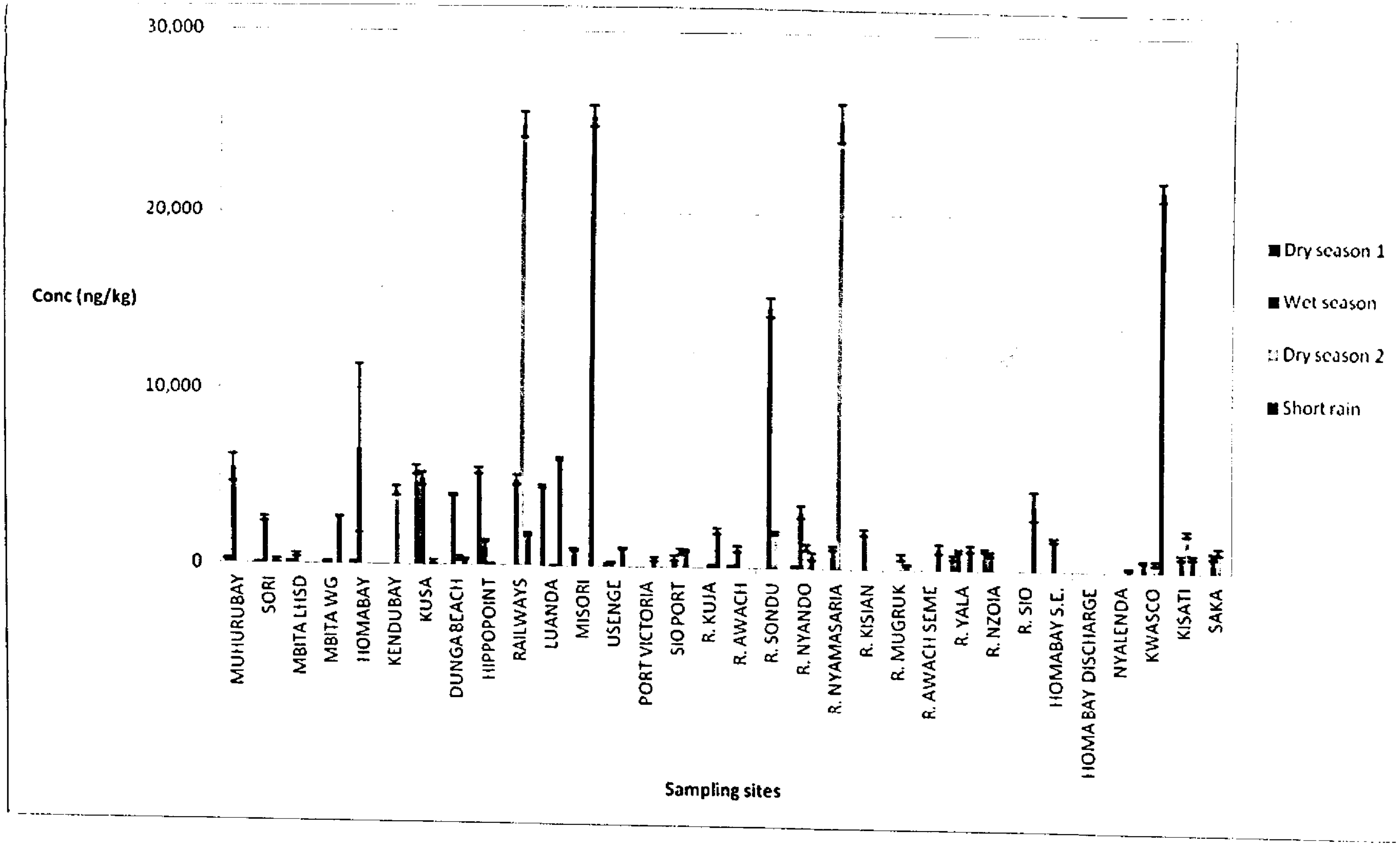

Figure 4.5.35: Concentration of aldrin in soil

The sum concentration of aldrin in soil was highest in the short rain season (Σaldrin = 70,102 ng/kg)>dry season II (Σaldrin = 63,281 ng/kg)>wet season (Σaldrin = 56,579 ng/kg)> dry season I (Σaldrin = 19,557 ng/kg).

The levels of dieldrin in the dry season I varied from BDL to 249,841 ng/l with the highest detected in soil from Nyalenda. The wet season had concentrations ranging from BDL to 206,076 ng/kg with the highest concentration measured in soil from Luanda Kotieno. Elevated residues levels were detected in the dry season II with mean ranging between BDL and 652,527 ng/kg, but this decreased in the short rain season to between BDL and 98,893 ng/kg (Figure 4.5.36 and Annex Table 4.4.3A).

Average concentration across the four seasons varied from Dry season II (24,955 ng/kg)>Wet season (8724 ng/kg)>dry season I (7,998 ng/kg)>short rain season (4,044 ng/kg). The short rain season recorded the highest dieldrin frequency at 60% detection, followed by the wet season (56.6%), the dry season 1 (46.6%) and the dry season 2 (40%).

The sum concentration of dieldrin in soil was highest in the dry season II (Σaldrin = 798,584 ng/kg)>wet season (Σaldrin = 279,198 ng/kg)>dry season I (Σaldrin = 255,946 ng/kg)> short rain season (Σaldrin = 125,522 ng/kg).

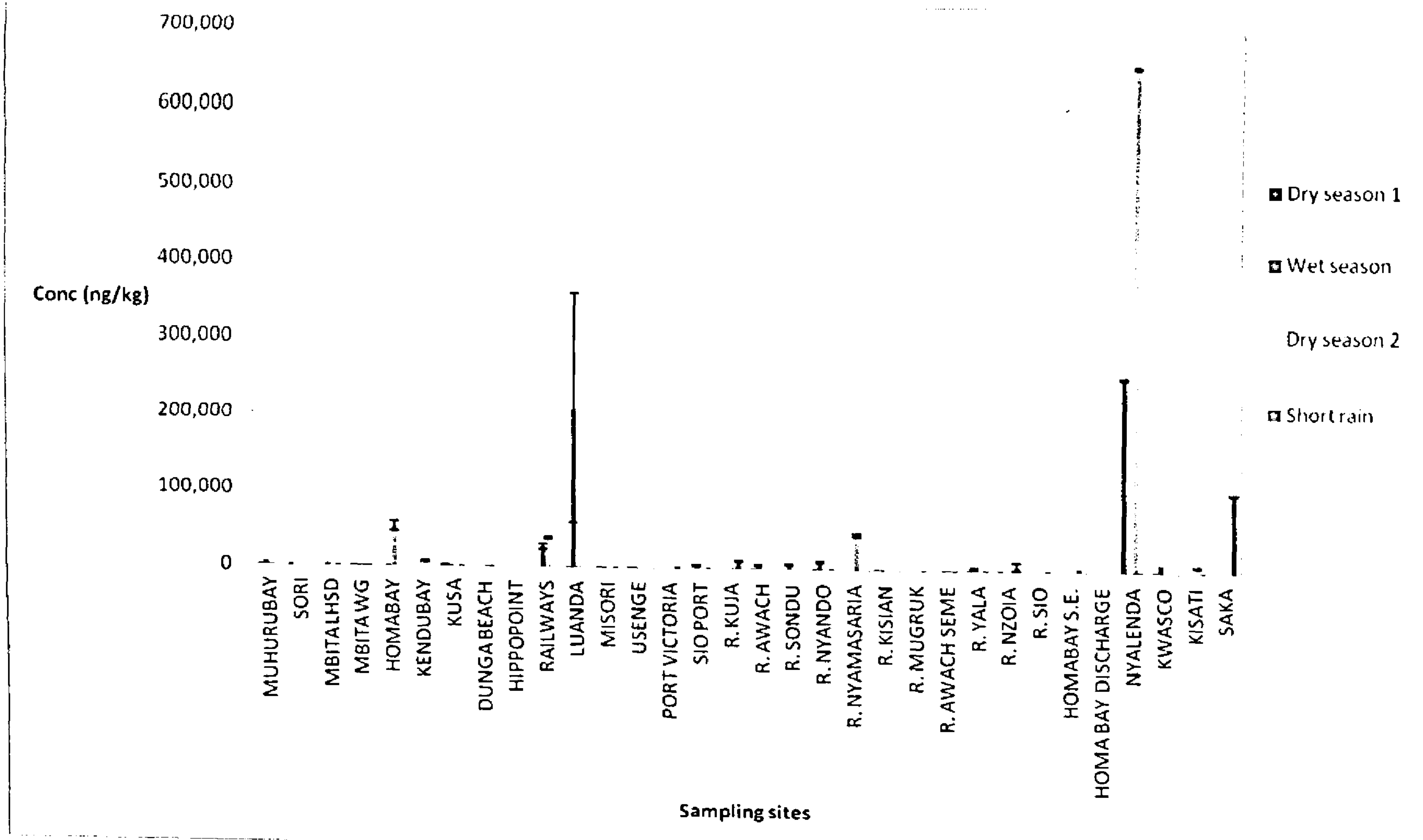

Figure 4.5.36: Concentration of dieldrin in soil

4.5.3.2 DDT and metabolites in soil

The levels of *p,p'*-DDT in soil varied from BDL to 203,698 ng/kg. The short rain season recorded the highest mean concentration with 22,266 ng/kg followed by the dry season II (21,041 ng/kg), the wet season (18,927 ng/kg) and the dry season I (8,564 ng/kg). *p,p'*-DDT in the dry season I varied from BDL to 56,457 ng/kg with the highest concentration measured in samples from River Yala soil. The concentrations varied from BDL to 182,441 ng/kg in wet season, from BDL to 176,717 ng/kg in the dry season II, and from BDL to 203,698 ng/kg in the short rain season (Figure 4.5.37 and Annex Table 4.4.3A).

The sum *p,p'*-DDT was highest in short rain season (Σ*p,p'*-DDT = 668,009 ng/kg), followed by the dry season II (Σ*p,p'*-DDT = 631,235 ng/kg), the wet season (Σ*p,p'*-DDT = 567,838 ng/kg) and the dry season I (Σ *p,p'*-DDE = 256,940 ng/kg).

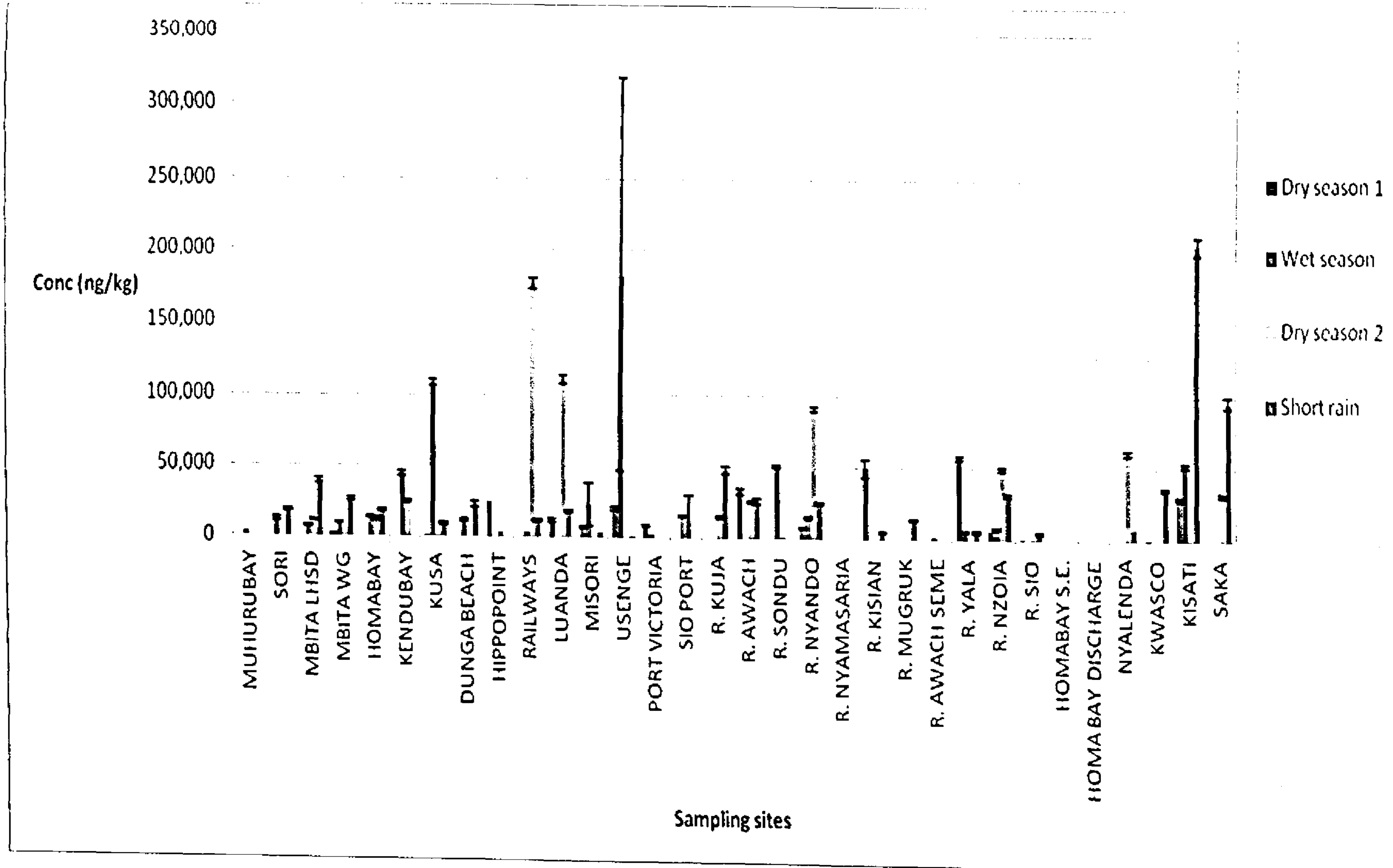

Figure 4.5.37: p,p'-DDT concentrations in soil

The mean *p,p'*-DDE was in the dry season II (2,963 ng/kg)> short rain season (1,792 ng/kg)>wet season (1,411 ng/kg)>dry season I (590 ng/kg) (Figure 4.5.38). A similar trend was observed for the sum *p,p'*-DDE, with the dry season II leading (Σ *p,p'*-DDE = 88,119 ng/kg), followed by the short rain season (Σ *p,p'*-DDE = 53,780 ng/kg), the wet season (Σ *p,p'*-DDE = 42,340 ng/kg) and the dry season I (Σ *p,p'*-DDE = 17,723 ng/kg).

The percentage frequency was, however, highest in the wet season (90%), followed by the short rain season (86.7%), the dry season II (73.3%) and the dry season I (70%). The key sites with high *p,p'*-DDE were Nyalenda (74,198 ng/kg), Saka drainage discharge (27,424 ng/kg) and Mbita main lake (17,901 ng/kg (Figure 4.5.38 and Annex Table 4.4.3A).

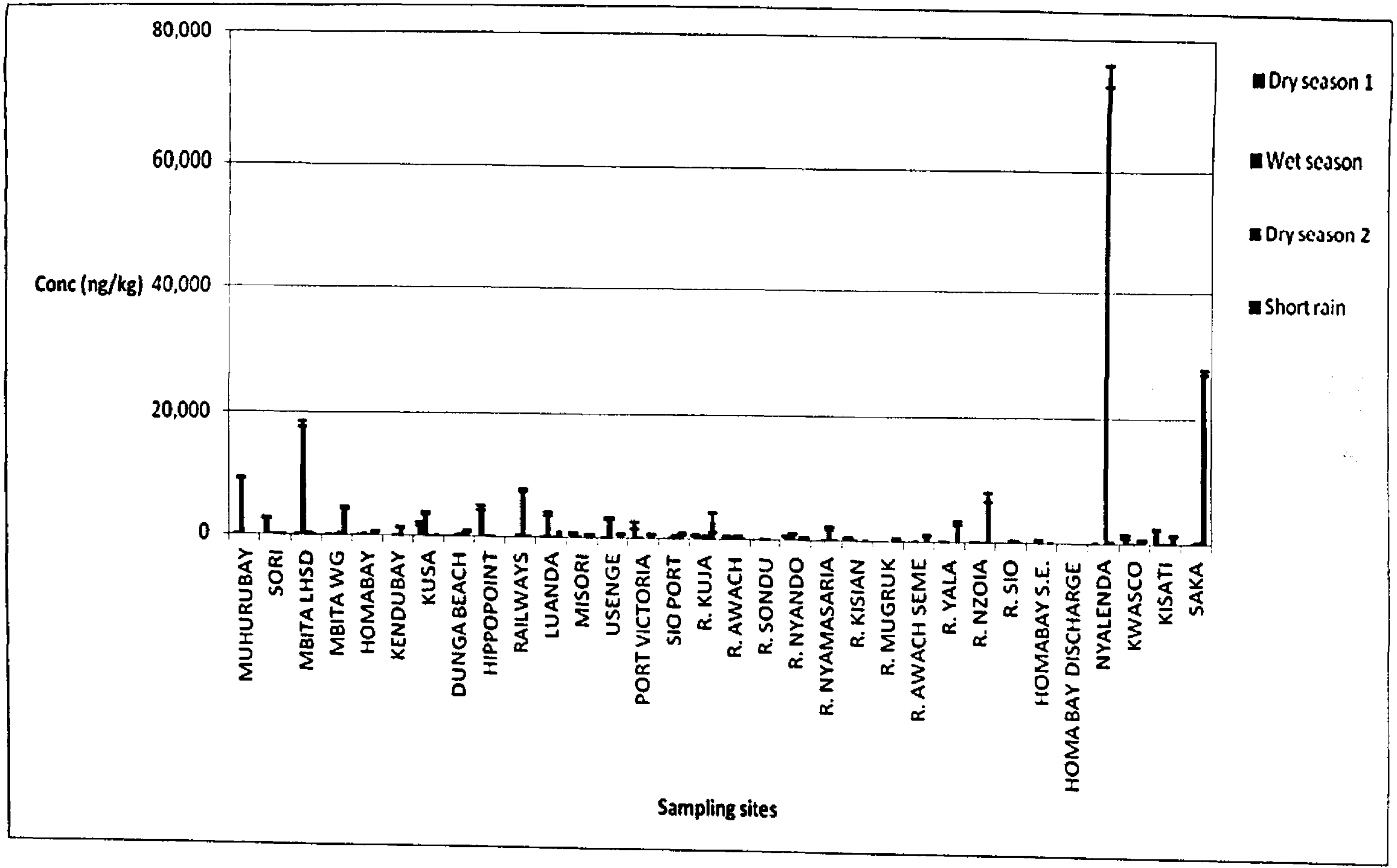

Figure 4.5.38: p,p'-DDE concentrations in soil

The levels of *p,p'*-DDD were lower than *p,p'*-DDT and *p,p'*-DDE in soil. The mean concentrations ranged from BDL to 291ng/kg in dry season I, from BDL to 560 ng/kg in the wet season, from BDL to 203 ng/kg in the dry season II, and from BDL to 444 ng/kg in the short rain season (Figure 4.5.39).

Comparison of sum *p,p'*-DDD showed the highest concentration in the wet season (Σ *p,p'*-DDD = 16,817 ng/kg), followed by the short rain season (Σ *p,p'*-DDD = 13,322 ng/kg), the dry season I (Σ*p,p'*-DDD = 7,337 ng/kg) and the dry season II (Σ *p,p'*-DDD = 6,090 ng/kg). On the other hand, percentage frequency of *p,p'*-DDD was highest in the wet and short rain seasons (86.7%), followed by the dry season II (73.3%) and the dry season I (66.7%) (Figure 4.5.39 and Annex Table 4.4.3A).

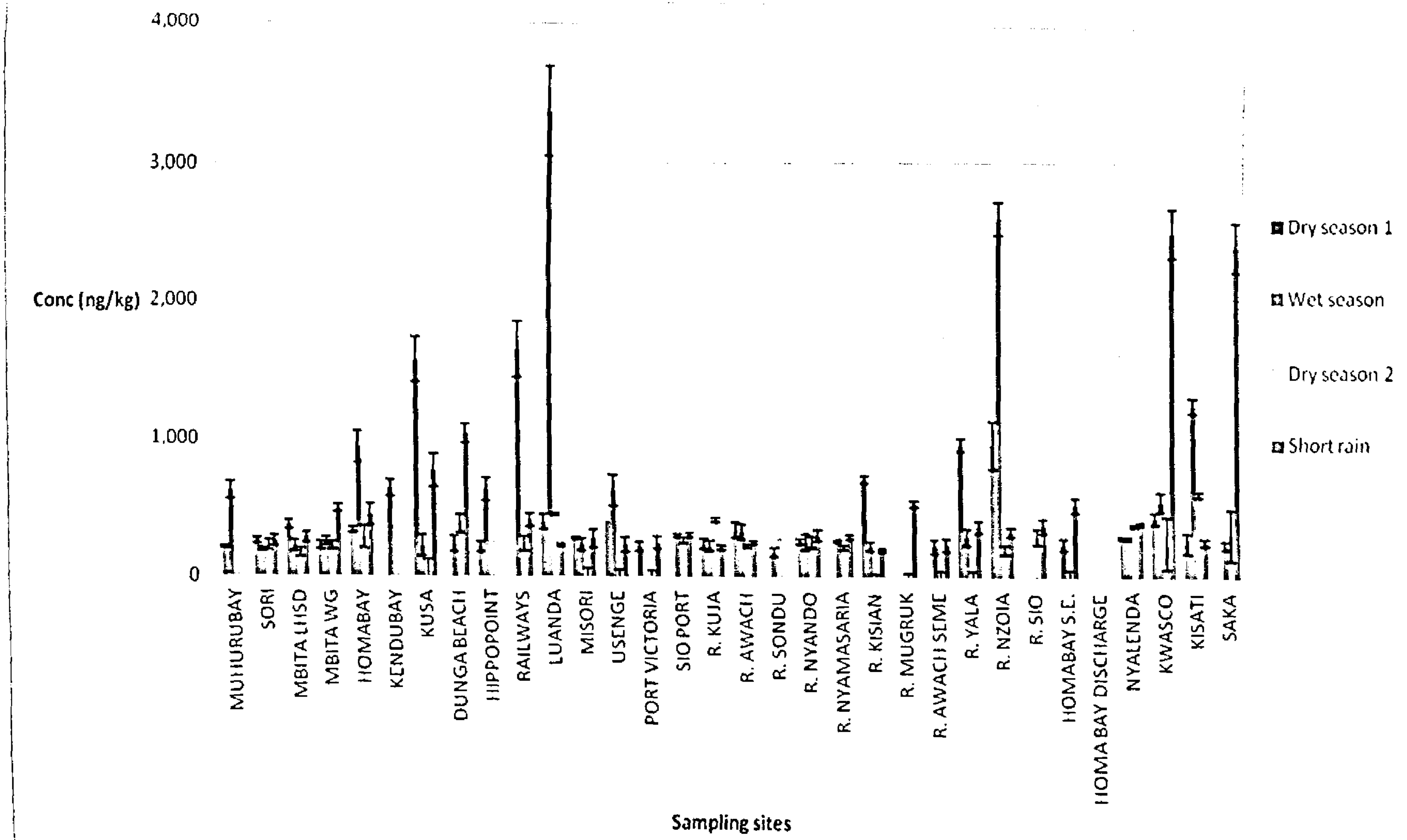

Figure 4.5.39: p,p'-DDD concentrations in soil

4.5.3.3 Endosulphan in soil

Endosulphan I concentrations varied from BDL to 17,444 ng/kg in the dry season I, from BDL to 4,851 ng/kg in wet season, from BDL to 17,141 ng/kg in the dry season II and from BDL to 12,571 ng/kg in the short rain season (Figure 4.5.40 and Annex Table 4.4.3A).

The sum concentration of endosulphan I was highest in the dry season I (Σ Endosulphan I = 49,627 ng/kg), followed by the short rain season (Σ Endosulphan I = 35,288 ng/kg), the dry season II (Σ Endosulphan I = 35,188 ng/kg) and the wet season (Σ Endosulphan I = 31,191 ng/kg). However, the highest frequency was recorded in the wet season (88.3%), followed by the short rain season (86.7%), the dry season II (70%) and the dry season I (66.7%).

Endosulphan is a sulphur bearing polychlorinated cyclodiene and the technically active parent compound is a diastereomeric mixture of two biologically active isomers; 70% alpha (α)- and 30% beta (β)-endosulphan [Rand *et al.*, 2010]. In environment, endosulphan can adsorb to particulates and persist in soil and/or sediment, but is also known to dissipate as a result of volatility and drift to locations far removed from the initial site of use [GFEA, 2007].

Endosulphan sulphate is the main transformation product through oxidation in freshwater and saltwater, including sediment [Shivaramaiah *et al.*, 2005], but the diol, a-hydroxy-ether, ether and lactone have also been reported [NRCC, 1975]. The beta isomer (β-endosulphan) and endosulphan sulphate are documented as highly persistent compounds, especially in sediment [NRCC, 1975]. The main isomers of endosulphan analysed in soil were: α-Endosulphan, β-endosulphan and endosulphan sulphate, the main metabolite.

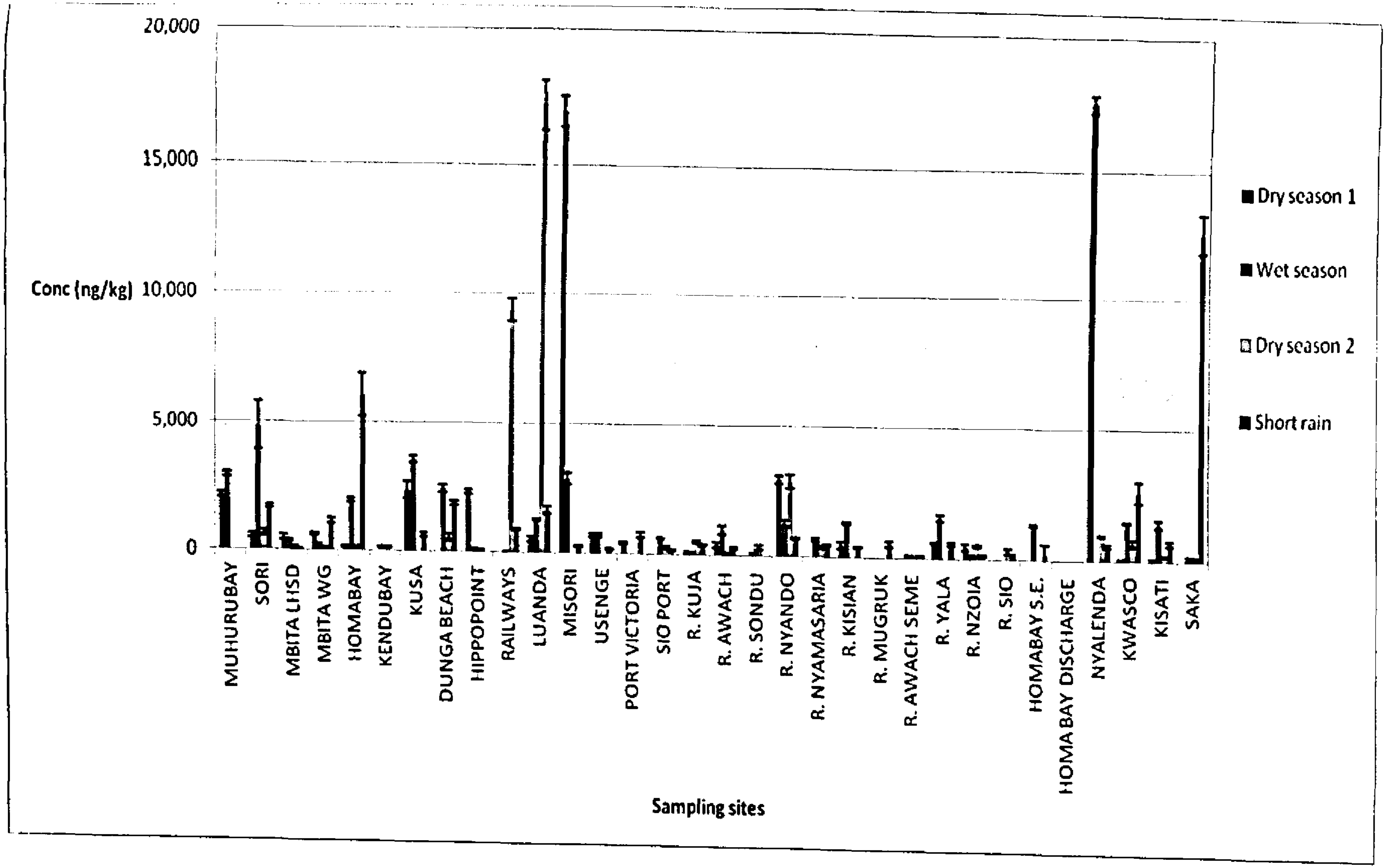

Figure 4.5.40: Endosulphan I concentrations in soil

The mean concentration for endosulphan II was highest in the wet season (810 ng/kg), followed by the dry season II (340 ng/kg), the dry season I (287 ng/kg) and the short rain season (255 ng/kg). But concentration range varied from BDL to 3,054 ng/kg in the dry season I, from BDL to 12,624 ng/kg in the wet season, from BDL to 4,874 ng/kg in the dry season II, and from BDL to 1,808 ng/kg in the short rain season (Figure 4.5.41 and Annex Table 4.4.3A).

The highest sum endosulphan II was obtained in the wet season (Σendosulphan II = 24,311 ng/kg), followed by the dry season II (Σendosulphan II = 10,211 ng/kg), the dry season I (Σendosulphan II = 8,625 ng/kg) and the short rain season (Σendosulphan II = 7,654 ng/kg). On the other hand, the detection frequency was highest in the wet season (90%), followed by the short rain season (86.7%), then the dry season II (73.3%) and the dry season I (63.3%).

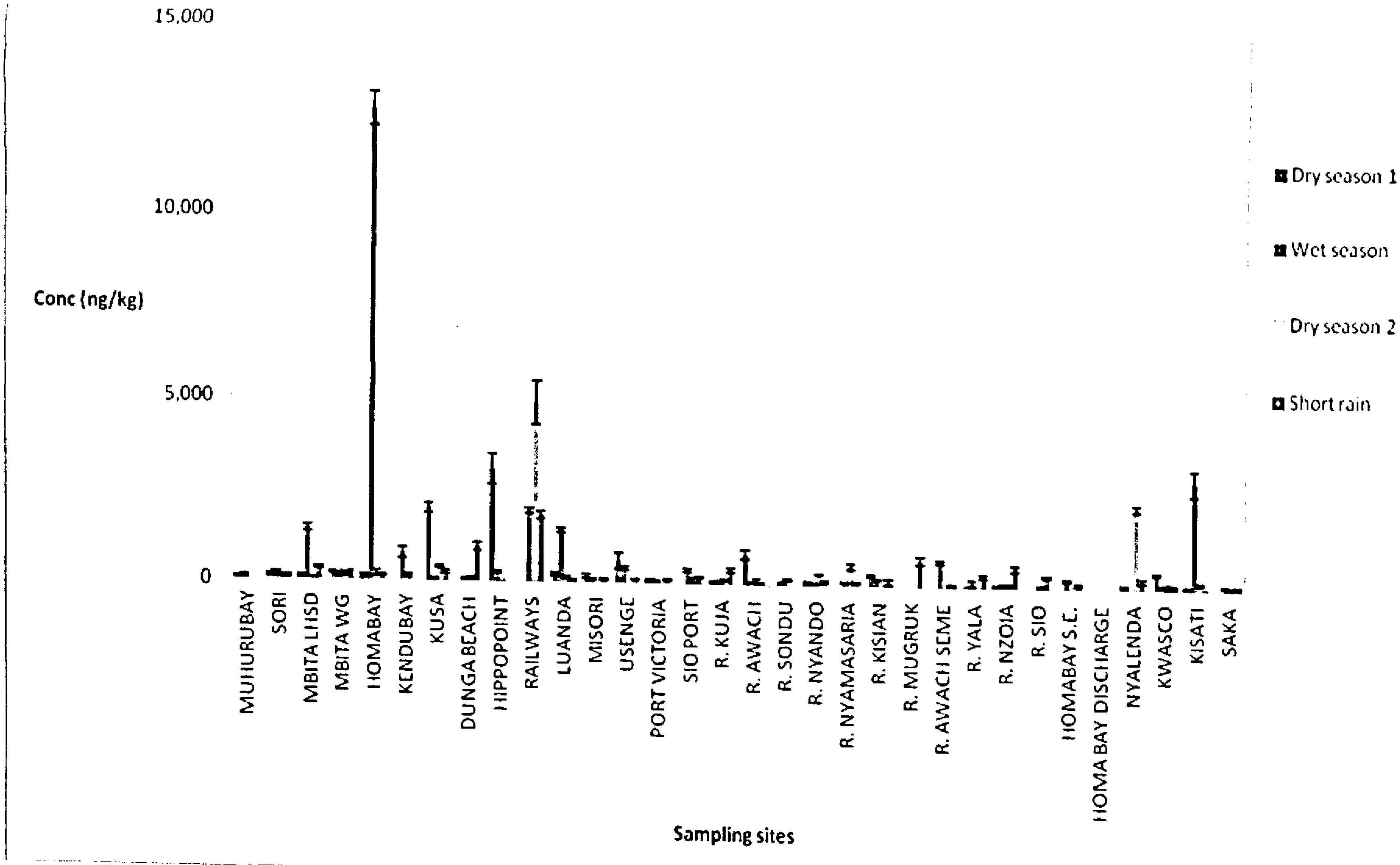

Figure 4.5.41: Endosulphan II concentration in soil from Lake Victoria Basin

The concentration of endosulphan sulphate varied from BDL to 7,411 ng/kg in the dry season I, from BDL to 50,775 ng/kg in the wet season, from BDL to 40,662 ng/kg in the dry season II, and from BDL to 68,713 ng/kg in the short rain season.

The mean concentration was highest in the wet season (2,701 ng/kg), followed by the short rain season (2,624 ng/kg), the dry season II (1,896 ng/kg) and the dry season I (826 ng/kg). In general, a lower detection frequency was observed for endosulphan sulphate compared to the parent compounds. The wet season registered the highest frequency (60%), followed by the dry season I (53.3%), the dry season II (43.3%) and the short rain which recorded only 40% detection (Figure 4.5.42 and Annex Table 4.4.3A).

The sum endosulphan sulphate showed the highest concentration in the wet season (Σendosulphan sulphate = 81,033 ng/kg), followed by the short rain season (Σendosulphan sulphate = 78,748 ng/kg), the dry season II (Σendosulphan sulphate = 56,960 ng/kg) and the dry season I (Σendosulphan sulphate = 24,783 ng/kg).

High levels of residues in the dry season were detected in soils from Rive Kuja (7,411 ng/kg) and Kisian (4,925 ng/kg), whereas highest levels in the wet season recorded in samples from Railways (50,775 ng/kg) and Kisati (4,610 ng/kg). The dry season II recorded the highest levels in samples from Nyalenda (40,662 ng/kg) and Railways (10,848 ng/kg), whereas Luanda (68,713 ng/kg) and Nyalenda (2,059 ng/kg) recoreded the highest concentrations in the short rain season.

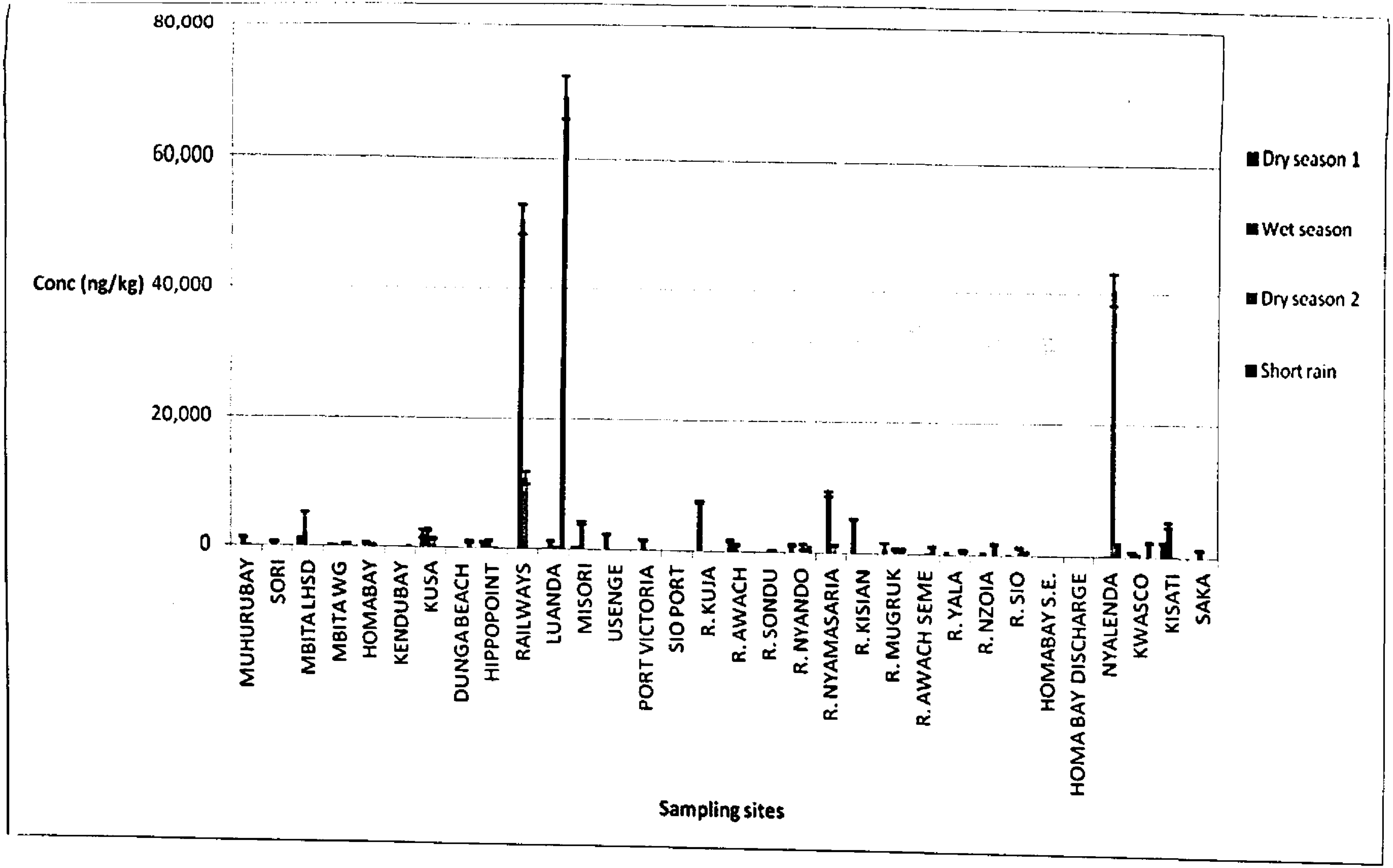

Figure 4,5.42: Endosulphan sulphate concentration in soil

4.5.3.4 Endrin and Endrin aldehyde in soil

The mean concentration of endrin varied from BDL to 213,290 ng/kg in the dry season I, from BDL to 6,619 ng/kg in the wet season, from BDL to 487,167 ng/kg in the dry season II, and from BDL to 88,820 ng/kg in the short rain seasons. The levels were particularly lower in the wet and short rain seasons compared to the dry seasons.

The sum endrin was highest in the wet season (Σendrin = 503,157 ng/kg), followed by the dry season I (Σendrin = 255,415 ng/kg), the short rain season (Σendrin = 153,213 ng/kg) and the wet season (Σendrin = 5,333 ng/kg). The highest detection frequency was recorded in the short rain season and the dry season I (60%), followed by the wet season (40%) and the dry season II (30%). But highest seasonal concentrations were measured in the dry season II (487,167 ng/kg) and the dry season I (213,290 ng/kg) (Figure 4.5.43 and Annex Table 4.4.3A).

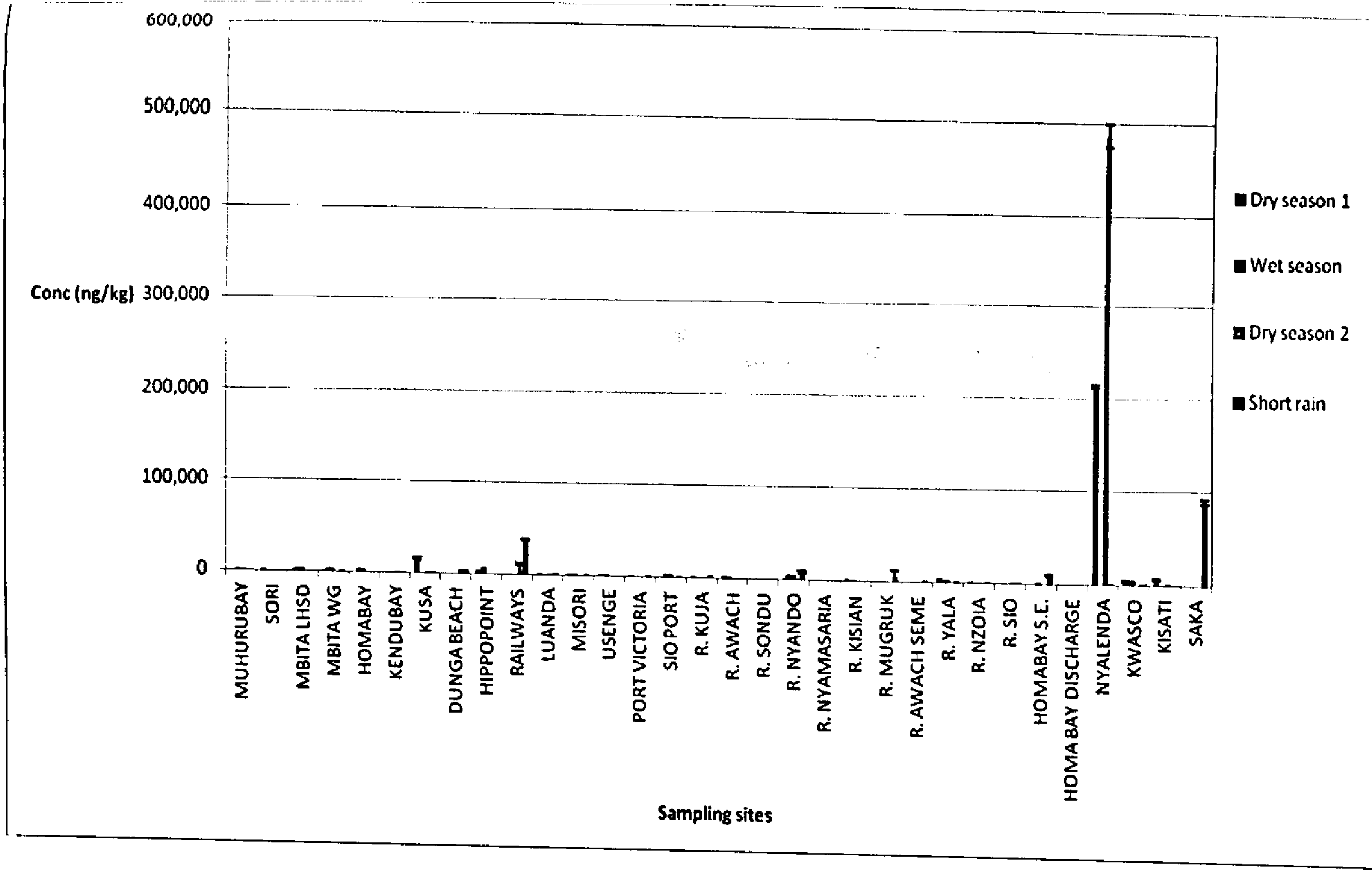

Figure 4.5.43: Endrin concentration in soil

The mean concentration of endrin aldehyde varied from BDL to 81,248 ng/kg in the dry season I, from BDL to 381,145 ng/kg in the wet season, from BDL to 304,068 ng/kg in the dry season II, and from BDL to 214,661ng/kg in the short rain (Figure 4.5.44 and Annex Table 4.4.3A). However, higher frequencies were observed for endrin aldehyde in soil compared to the parent compound (endrin).

The wet season recorded the highest sum endrin aldehyde (Σendrin aldehyde = 1,209,862 ng/kg), followed by dry season II (Σendrin aldehyde = 767,532 ng/kg), the short rain season (Σendrin aldehyde = 568,424 ng/kg) and the dry season I (302,647 ng/kg). Percentage frequency of detection was highest in the wet and dry season I (63.3%), followed by the short rain season (60%) and the dry season II (56.7%).

According to USEPA [1998], the under environmental conditions, endrin is affected by a combination of processes such as volatilization, photodegradation and heat transformation, and is primarily transformed into endrin ketone, with minor amounts of endrin aldehyde, accounting for the rapid decrease in endrin residues on soil surfaces exposed to bright sunlight. However, further studies conducted by Nash and Woolson [1967], they revealed that endrin is also strongly persistent in the soil and is less susceptible to biodegradation and hydrolysis reacttions, and this agrees with the high levels of endrin detected in the soils under this study.

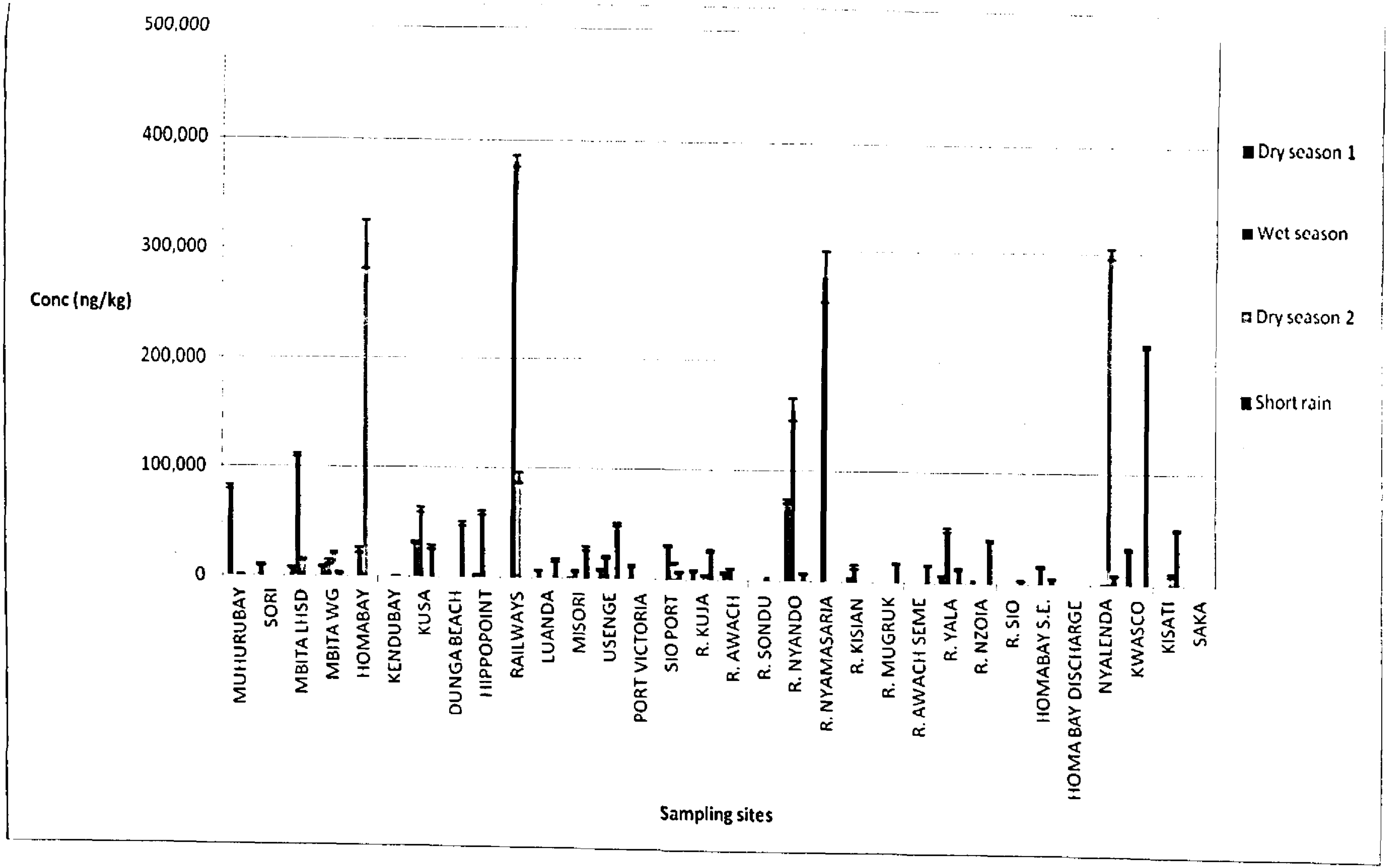

Figure 4.5.44: Endrin aldehyde concentration in soil

4.5.3.5 Hexachlorocyclohexane (HCH) isomers in soil

The mean concentration of α-HCH was highest in the dry season II (7,188 ng/kg), followed by the dry season I (4,298 ng/kg), the short rain season (3,582 ng/kg) and the wet season (2,568 ng/kg) (Figure 4.5.45 and Annex Table 4.4.3A).

The sum α-HCH followed a similar trend as mean concentrations, with the highest total concentration recorded in the dry season II (Σα-HCH = 215,648 ng/kg)>dry season I (Σα-HCH = 128,956 ng/kg)>short rain (Σα-HCH = 107,471 ng/kg)>the wet season (Σα-HCH = 77,063 ng/kg).

The percentage frequency was highest in the wet season (90%), followed by the dry season II (73.3%), the dry season II (70%) and the short rain season (66.7%).

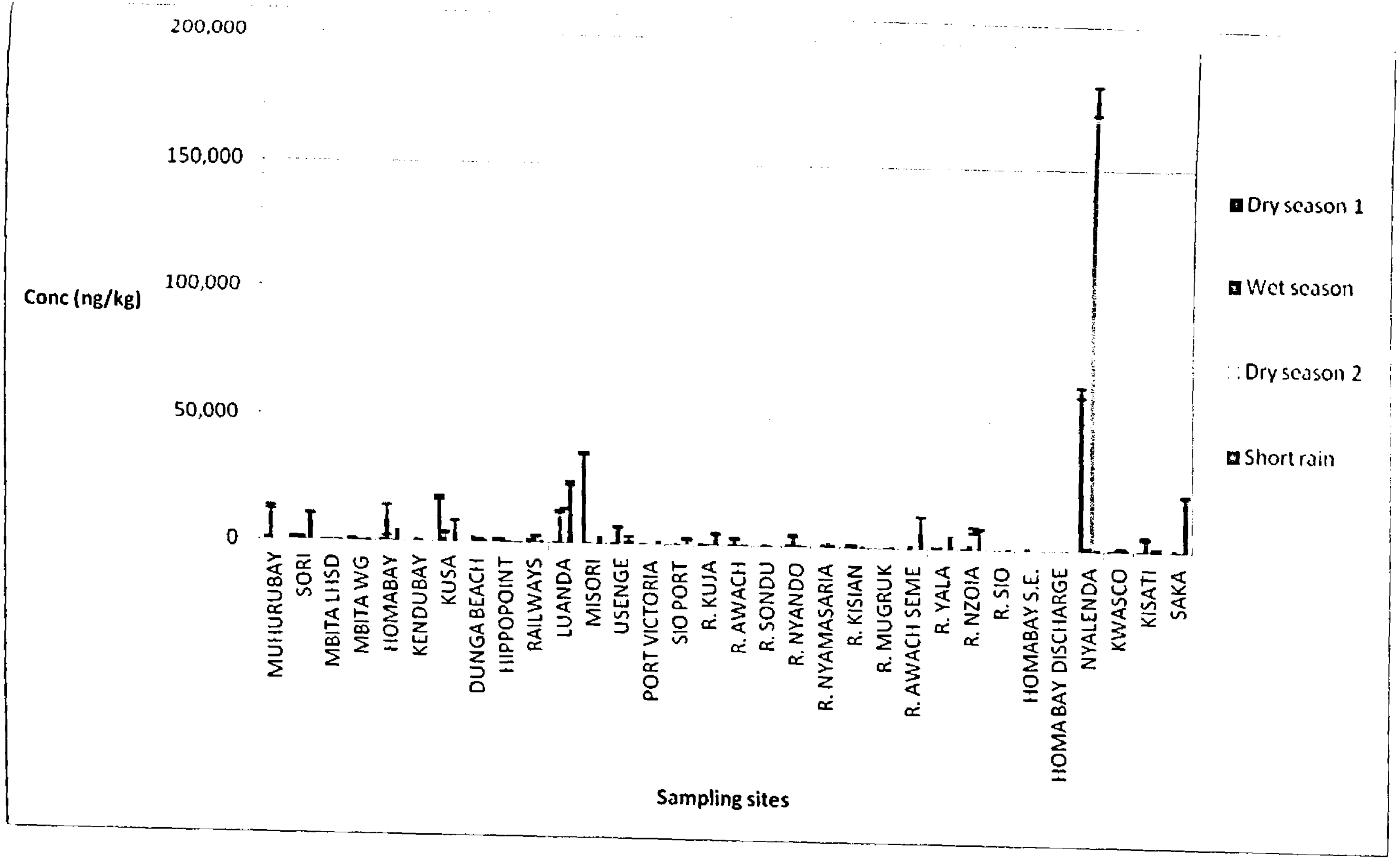

Figure 4.5.45 Alpha-HCH concentration in soil from Lake Victoria Basin

The highest levels of beta HCH (β-HCH) were recorded in the dry season II (455,600 ng/kg), followed by the wet season (207,399 ng/kg), the dry season I (17,834 ng/kg) and the short rain season (12,468 ng/kg). Nyalenda (455,600 ng/kg), Luanda (163,256 ng/kg) and Homa Bay (109,565 ng/kg) recorded the highest levels of β-HCH in the dry season II, whereas Muhuru Bay (207,399 ng/kg), Kusa (10,422 ng/kg) recorded the highest concentration in the wet season (Figure 4.5.46 and Annex Table 4.4.3A).

The mean concentrations per season were highest in the dry season II (31,251 ng/kg)>wet season (30,044 ng/kg)>dry season I (1,926 ng/kg)>short rain season 1,241 ng/kg).

The sum β-HCH was highest in the dry season II (Σβ-HCH = 937,546 ng/kg), followed by the wet season (Σβ-HCH = 901,322 ng/kg), the dry season I (Σβ-HCH = 57,789 ng/kg) and the short rain season (Σβ-HCH = 37,251 ng/kg). Comparatively higher frequency of β-HCH was recorded compared to α-HCH, with the highest observed in the wet season (86.7%) followed by the dry season II (70%), whereas the short rain and the dry season I recorded equal frequencies of 60%.

The concentrations of β-HCH were the highest among all the HCH isomers measured in soil in this study. This could be explained by the fact that β-HCH is reported to be persistent is soil than the α- and γ-HCHs [Quintero *et al.*, 2005], therefore, β-HCH is likely to accumulate in the soil compared to other HCH isomers.

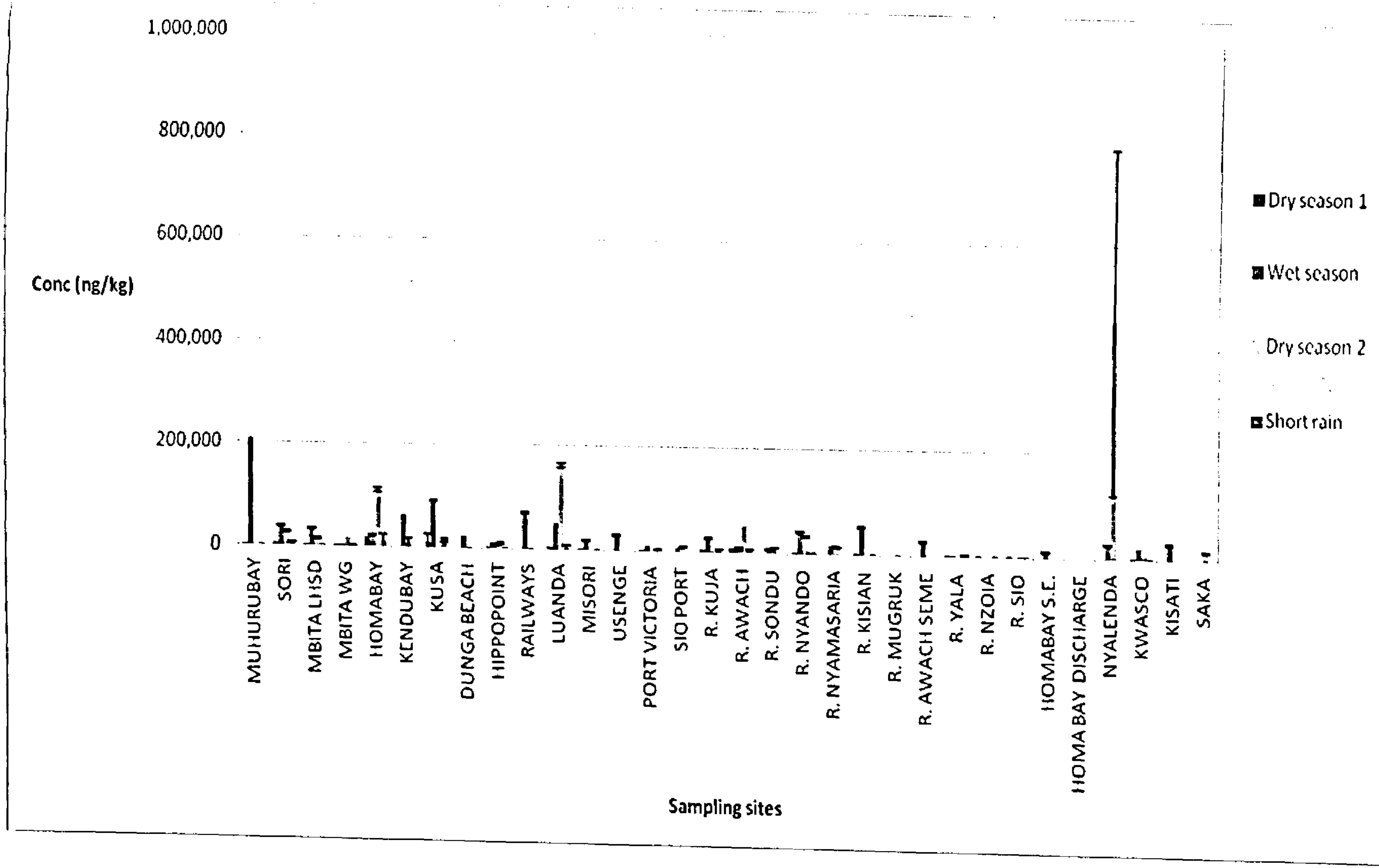

Figure 4.5.46: Beta-HCH concentration in soil

The study revealed γ-HCH levels ranging from BDL to 7,054 ng/kg in the dry season I, from BDL to 61,572 ng/kg in the wet season, from BDL to 259,589 ng/kg in the dry season II, and from BDL to 121,997 ng/kg in the short rain season (Figure 4.5.47 and Annex Table 4.4.3A).

The sum γ-HCH was highest in the short rain season (Σγ-HCH = 367,110 ng/kg), followed by the dry season II (Σγ-HCH = 333,837 ng/kg), the wet season (Σγ-HCH = 218,983 ng/kg) and the dry season I (Σγ-HCH = 16,374 ng/kg). However, the greatest detection frequency was recorded in the wet season (93.3%), followed by the short rain season (86.7%), the dry season II (73.3%) and the dry season I (70%). High detection frequency was attributed to previous application of the compound in in seed treatment to protect crops against termites.

Lindane (γ-HCH) is the most insecticidal of all the isomers of HCH. However, its agricultural use has been banned due to high persistence in environment which contributes to its high occurrence in environmental samples, which increases the risk of exposure of this compound to human and wildlife. The results of this study established high concentrations of lindane in the soil samples from Lake Victoria Basin.

However, a comparison of the concentrations measured in this study and the levels reported in the past studies [Getenga *et al.*, 2004b], reveal a gradual decrease in concentration of lindane, that could be attributed to the breakdown of the previously applied γ-HCH.

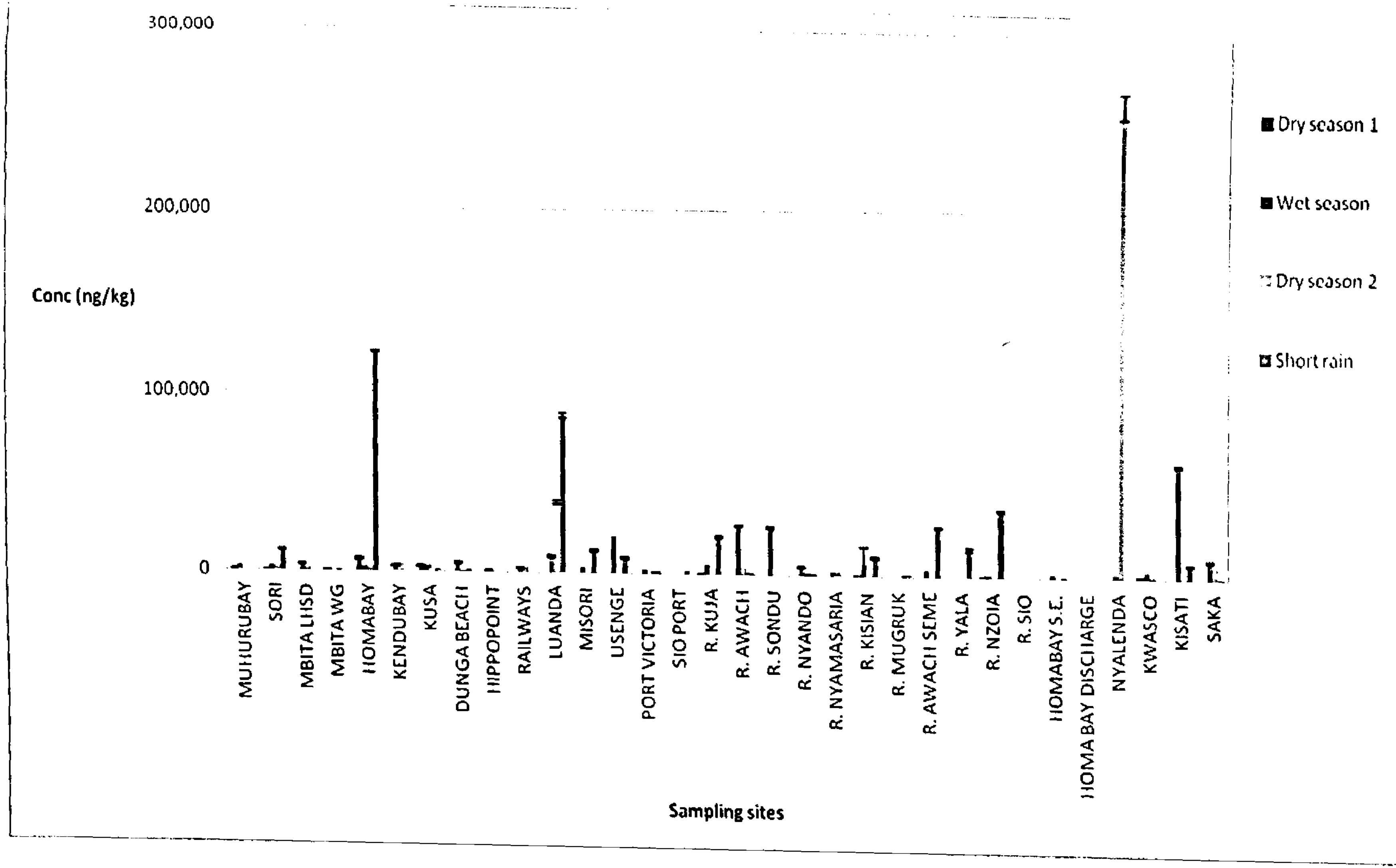

Figure 4.5.47: Gamma-HCH concentration in soil

Delta HCH (δ-HCH) concentrations ranged from BDL to 14,165 ng/kg in the dry season I, from BDL to 30,539 ng/kg in the wet season, from BDL to 353,617 ng/kg in the dry season II, and from BDL to 36,467 ng/kg in the short rain season (Figure 4.5.48). The seasonal mean concentrations were highest in the dry season II (18,840 ng/kg), followed by the rain season (7,400 ng/kg), the short rain season (4,977 ng/kg) and the dry season I (1,379 ng/kg).

The sum δ-HCH showed highest concentration in the dry season II (Σδ-HCH = 565,218 ng/kg), followed by the wet season (Σδ-HCH = 222,003 ng/kg), the short rain season (Σδ-HCH = 149,334 ng/kg) and the dry season I (Σδ-HCH = 41,369 ng/kg). On the other hand, the percentage detection frequency was highest in the wet season (93.3%), followed by the short rain season (83.3%), the dry season II (73.3%) and the dry season I (66.7%) (Figure 4.5.48 and Annex Table 4.4.3A)

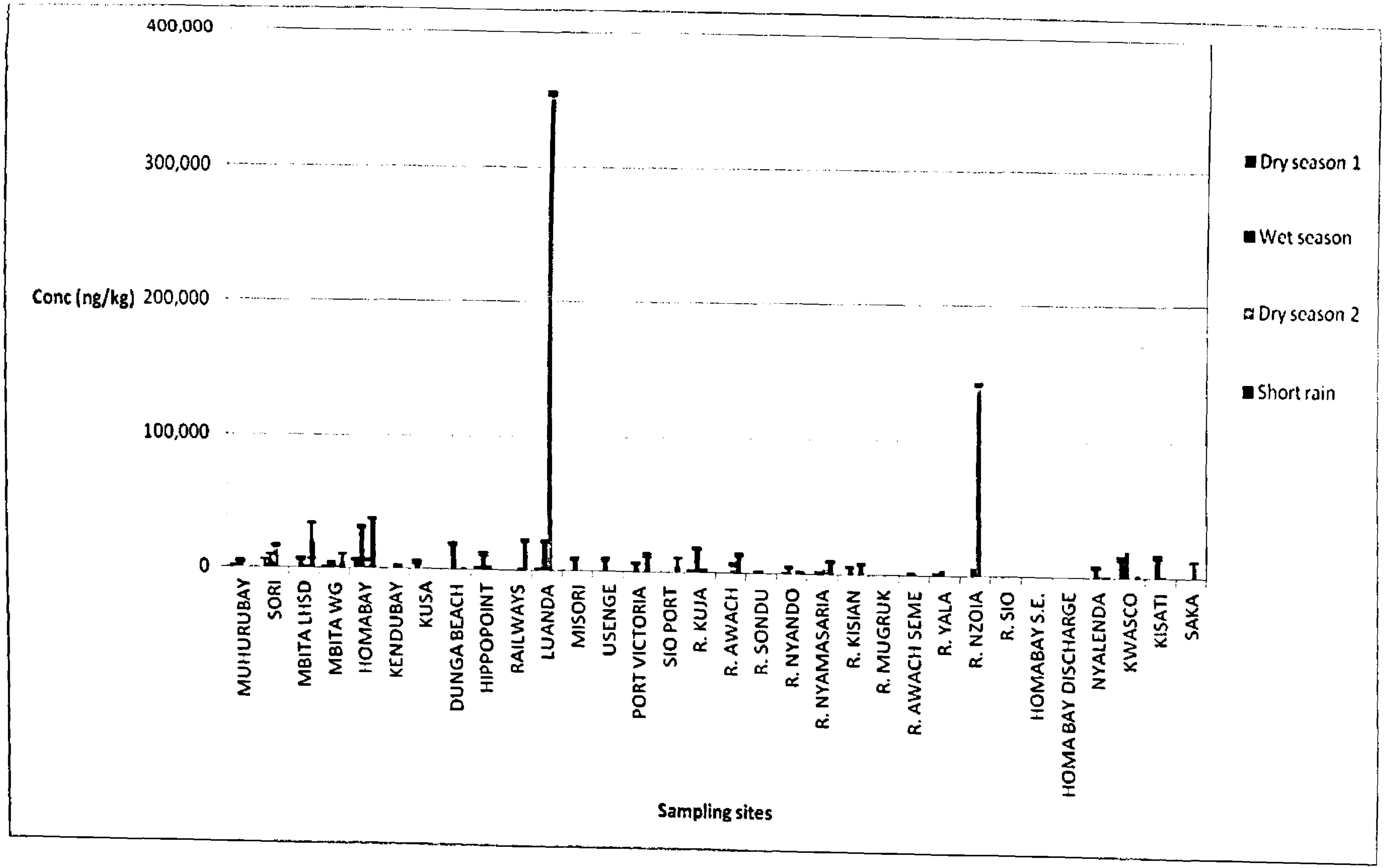

Figure 4.5.48: Delta-HCH concentration in soil

The results show that although HCH isomers have been banned under the Stockholm Convention, the residues of these compounds are still high in the soils due to high persistence. Lindane was one of the most widely used insecticides [Quintero *et al.*, 2005] prior to its banning due to toxicity to non-target species, persistence in environment, long-range transport effects and potential carcinogenic effects. The persistence of lindane and other HCH isomers in soil is attributed to resistance to microbial degradation [Alexander, 1981].

Degradation of lindane has been reported to form different intermediate metabolites such as tetrachlorocyclohexene (TCCH) and tetrachlorocyclohexenol (TCCOL) [Singh and Kuhad, 2000; Mougin *et al.*, 1996], or organochloride compounds such as ethanone-1-(3-chloro-4-methoxyphenyl)- and 1-benzenecarbonyl chloride, 2,4-dichloro-3-methoxy under fungal degradation [Quintero *et al.*, 2008]. Usually α and γ isomers are less persistent in soil than the β and δ isomers [Quintero *et al.*, 2005].

4.5.3.6 Heptachlor and heptachlor epoxide in Soil

The levels of heptachlor in the soil ranged between BDL and 39,212 ng/kg in the dry season I, between BDL and 7,545 ng/kg in the wet season, from BDL to 386,805 in dry season II, and from BDL to 3,639 ng/kg in the short rain season. Seasonal mean concentration was highest in the dry season II (16,176 ng/kg)>short rain season (8,262 ng/kg)>wet season (5,545 ng/kg) and the dry season I (1,840 ng/kg).

The sum heptachlor followed a similar trend with the highest recorded in the dry season II (ΣHeptachlor = 485,281 ng/kg), followed by the short rain season (ΣHeptachlor = 247,398 ng/kg), wet season (ΣHeptachlor = 157,133 ng/kg) and the dry season I (ΣHeptachlor = 55,212 ng/kg). However, the highest detection frequency was recorded in the wet season (86.7%), followed by the short rain season (83.3%), the dry season II (76.7%) and the dry season I (66.7%). This was attributed to the effect of storm water washing the pesticide residues from the catchment into the aquatic systems within the basin (Figure 4.5.49 and Annex Table 4.4.3A).

Heptachlor is a cyclodiene insecticide that was widely used in the past in the control of termites, however, its use has been banned due to persistence and toxicity to non-target organisms. The current presence of methoxychlor in the soils could be attributed to previous use and volatilization from the surfaces of previous application. However, volatilization of heptachlor incorporated into soil is slower due to high adsorption coefficient, although this in part accounts for its frequent detection in environmental samples since the soil bound pesticides are not accessible to microbial degradation proceses. In soil, heptachlor is known to degrade to 1-hydroxychlordene, heptachlor epoxide and anunidentified metabolites less hydrophilic than heptachlor epoxide, depending on environmental conditions.

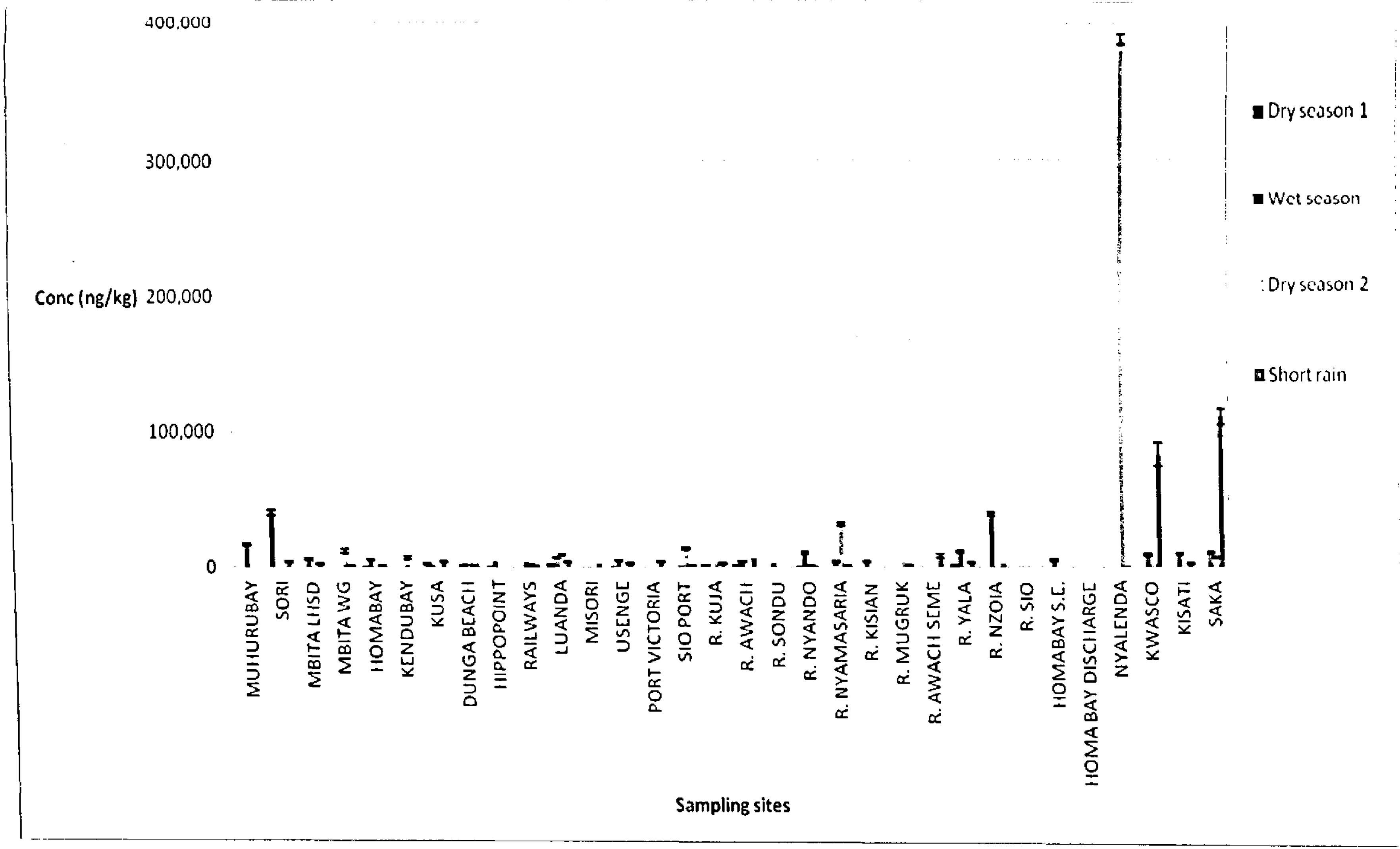

Figure 4.5.49: Heptachlor concentration in soil

The levels of heptachlor epoxide ranged between BDL and 3,627 ng/kg in the dry season I, from BDL to 17,177 ng/kg in the wet season, from BDL to 26,864 ng/kg in the dry season II, and from BDL to 14,354 ng/kg in the short rain season (Figure 4.5.50). The dry season II recorded the highest mean (2,410 ng/kg), followed by the wet season (2,273 ng/kg), the short rain season (1,376 ng/kg) and the dry season I (262 ng/kg).

The sum heptachlor epoxide was highest in the dry season II (ΣHeptachlor epoxide = 72,322 ng/kg)> wet season (ΣHeptachlor epoxide = 68,208 ng/kg)> short rain season (ΣHeptachlor epoxide = 41,291 ng/kg)>dry season I (ΣHeptachlor epoxide = 7,864 ng/kg). But detection frequency was highest in the wet season (90%) compared to the short rain season (73.3%), dry season II (66.7%) and the dry season I (53.3%) (Figure 4.5.50 and Annex Table 4.4.3A).

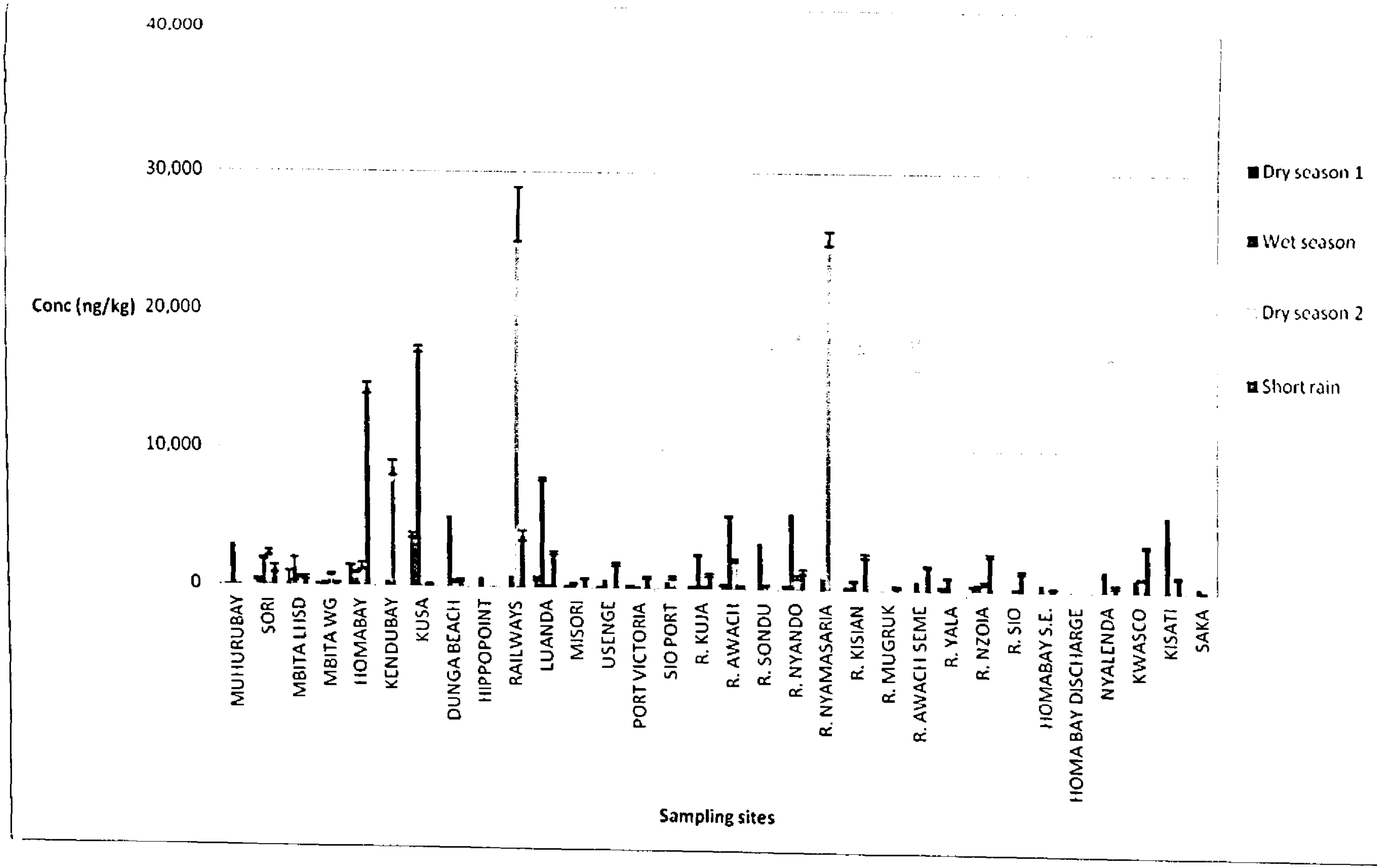

Figure 4.5.50: Heptachlor epoxide concentration in soil

4.5.3.7 Methoxychlor in soil

The levels of methoxychlor in soil varied from BDL to 61,885 ng/kg in the dry season I, from BDL to 12,583 ng/kg in the wet season, from BDL to 176,662 ng/kg in the dry season II, and from BDL to 21,735 ng/kg in the short rain season (Figure 4.5.51 and Annex Table 4.4.3A).

The sum methoxychlor was highest in the dry season II (Σmethoxychlor = 215,648 ng/kg), followed by the dry season I (Σmethoxychlor = 128,956 ng/kg), the short rain season (Σmethoxychlor = 107,471 ng/kg) and the wet season (Σmethoxychlor = 77,063 ng/kg). The wet season recorded highest occurrence (90%) followed by the dry season II (73.3%), the dry season I (70%), and the short rain season (66.7%).

Methoxychlor is poorly soluble in water and highly immobile in most soils, whereas the main environmental degradation metabolites are dechlorinated and demethylated products, which are formed preferentially under anaerobic rather than aerobic conditions. The poor solubility in water accounts for the low concentrations of this compound detected in the water samples compared to the high levels measured in the soil and sediments samples.

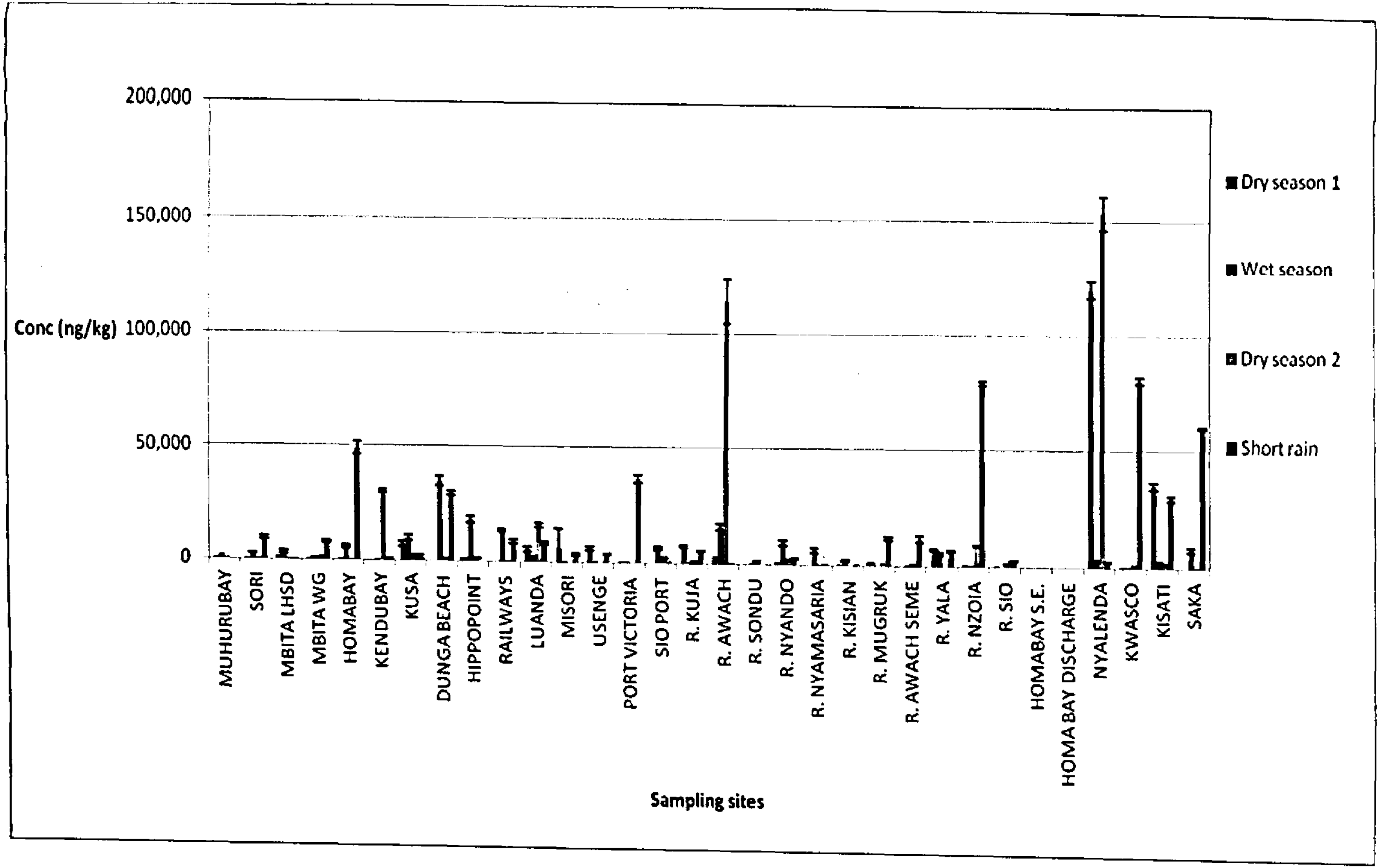

Figure 4.5.51: Methoxychlor concentration in soil

4.6 PESTICIDE FATE IN LAKE VICTORIA BASIN SOILS

4.6.1 Degradation of pesticides in selected soils

Degradation experiments were carried out in an incubator at a controlled temperature of 30 °C. The experiments included testing the fate of lindane in three soils (River Nyando, River Nzioa and River Yala) selected based on residues detected in the field samples.

4.6.2 Calculation of $t_{1/2}$ for Biphasic Degradation Rates

Calculation of degradation rates followed the first order kinetics:

$$Ln(C/Co) = -\alpha t \quad (8.1)$$

For the 1st rate: $Ln(C/Co) = -\alpha_1 t$ for $t \leq t^*$ (8.2)

For the 2nd rate: $Ln(C/Co) = -\alpha_2 t - A$ for $t \geq t^*$ (8.3)

The point of intersection of the two lines gives t*

$$t^* = A/(\alpha_1 - \alpha_2) \quad (8.4)$$

Where α_1 and α_2 are degradation rate coefficients; t* is the time when the two lines meet; A is the intercept.

Using Eq. 8.2, the value of C/Co in the system at time t* was calculated based on the equation:

$$C/Co = C^* = Exp(-\alpha_1 t^*) \quad (8.5)$$

$$\text{If } C^* \leq 0.5 \text{ then } t_{1/2} = Ln(0.5)/(-\alpha_1) \quad \text{(days)} \quad (8.6)$$

$$\text{If } C^* > 0.5 \text{ then } t_{1/2} = t^* + Ln(1/(2C^*))/(-\alpha_2) \text{ (days)} \quad (8.7)$$

The $t_{1/2}$ values calculated using equations 8.6 and 8.7 give the process half-life using one or both of the degradation rate coefficients. While applying type-2 it was assumed that at the time t* the initial concentration is $C_i^* = C^*Co$, thus to determine how long it would take to achieve C/Co = 0.5, since C*Co > 0.5, Co was calculated from the expression:

$$[Co/2] = Co\ C^*Exp(-\alpha_2 t) \quad (8.8)$$

$$t = Ln\ (1/2C^*)/(-\alpha_2) \quad (8.9)$$

$t_{½} = t^* + Ln\ (1/2C^*)/(-\alpha_2)$ as was shown in 8.7 above.

4.6.2 Degradation of lindane in Nyando soil

The plot of concentration against time revealed that the breakdown of lindane in Lake Victoria catchment soils follow biphasic first order kinetics, with the first rapid phase occurring within the first four weeks, followed by a slower second phase. Degradation in non-amended Nyando soil was faster ($t_{½}$ = 28 days) compared to amended soil (238 days). The possible reason could be gradual increase in non-available pesticide concentration affecting degradation in amended soil. Degradation of lindane in soil treated with other additional pesticide was slower compared to degradation in soils treated with lindane alone. This implied that either the microorganisms preferred the alternative pesticide or the mixture of different pesticide affected the efficiency of the microorganisms to break down lindane.

Pesticide degradation in soil is affected by multiple factors. According to by Guo and coworkers [2000], sorption initially favours degradation, but over the long term decreases degradation when desorption kinetics becomes the limiting factor in the degradation process. Further studies by Si *et al.* [2011] using charcoal amendments showed that charcoal greatly increased adsorption but reduced biodegradation. In addition, Ghafoor *et al.* [2011] noted that pH, microbial composition and organic matter content are the key factors and cause variations in degradation rates among different soils. Soil type was also noted as a critical factor in pesticide degradataion [Pal *et al.,* 2006]. In view of all the arguments made in the previous studies, addition of compost had similar effect as increasing organic matter composition and therefore increased lindane adsorption in Nyando soil significantly affecting degradation rates.

Soils treated with mercuric chloride exhibited longer half-life (total of the two phases = 592 days) showing toxic effects of the compound on microorganisms, affecting their ability to breakdown lindane (Table 4.6.1).

Table 4.6.1: Degradation of lindane in Nyando soil under different treatment

	Degradation in River Nyando soil	**t***	**C***	**$T_{1/2}$**
1	Non-amended soil	5.93	0.68	28.03
2	Amended soil	8.52	0.93	238.42
3	Non-amended soil mixed with other pesticide	18.37	0.42	1751.24
4	Amended soil mixed with other pesticide	14.26	0.38	360.84
5	Non-amended soil treated with $HgCl_2$	24.42	0.79	591.76

Figure 8.1 shows the rate constants for degradation of lindane in Nyando soil under different treatments. Biphasic first order kinetics was observed in all the cases of soil treatment, characterised by a faster first phase and a slower second phase. It is apparent that soil amendment reduced the rate of degradation, a similar effect as that of treating the soil with different pesticides.

Degradation of lindane in soil spiked with other organochlorine pesticides exhibited longer half-lives for both amended and non-amended soils, compared with half-lives determined in soils spiked with lindane alone. This was attributed to microbial presence for other chemical compounds and possible changes in the sorption desorption kinetics of lindane in the presence of other chemical compounds.

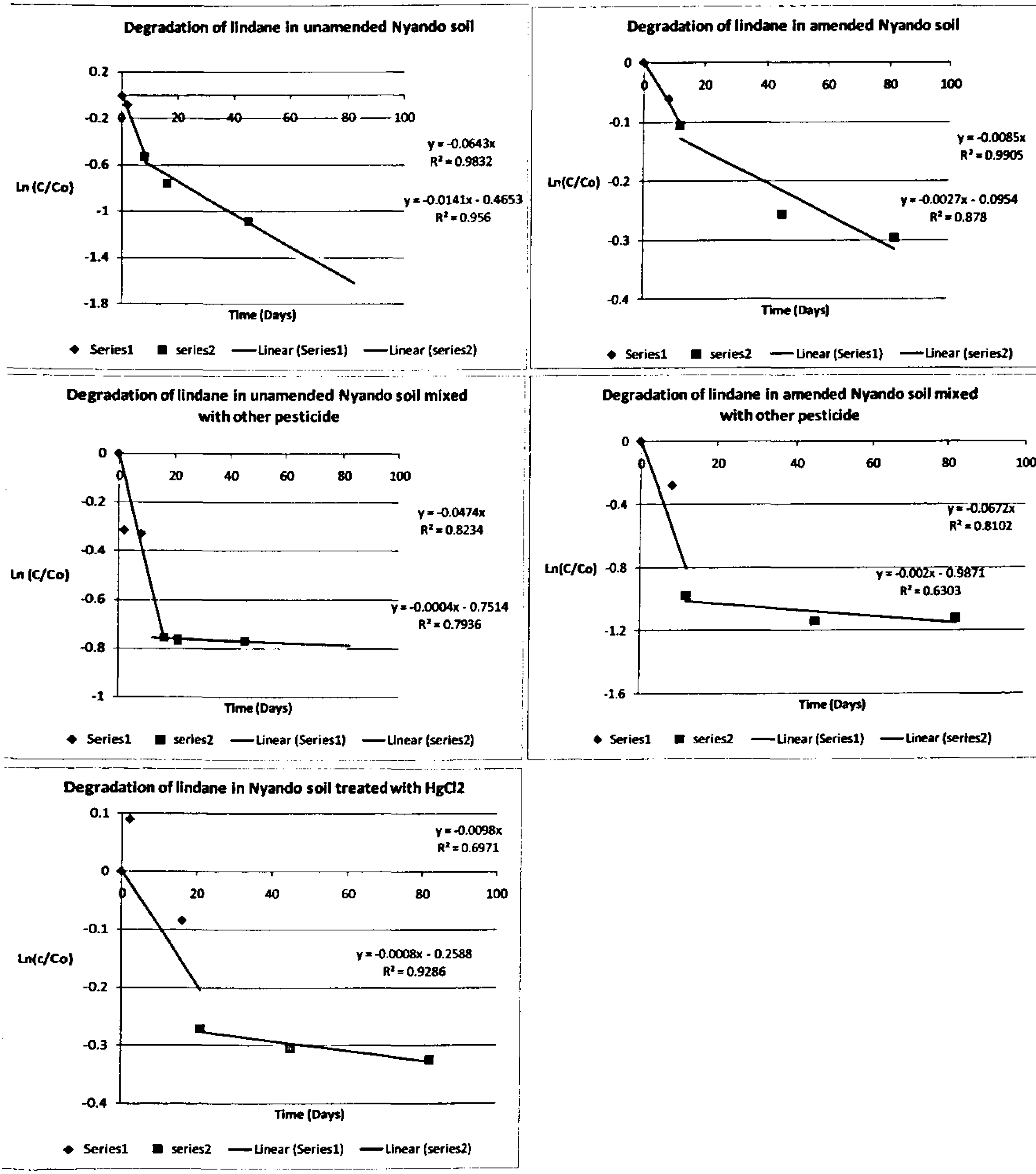

Figure 4.6.1: Degradation of Lindane in River Nyando Soil

4.6.3 Degradation of Lindane in River Nzoia Soil

Degradation kinetics with half lives ranging from 25 days to 323 days was observed in Nzoia soil. The highest degradation was observed in amended soil mixed with other pesticide (combined $t_{½}$ = 25 days) followed by non-amended soil (combined $t_{½}$ = 53 days). Although soil treatment with mercuric chloride had less effect on degradation compared to that observed in Nyando soil, it generally reduced degradation (Total $t_{½}$ = 323 days) compared to non-amended soil ($t_{½}$ = 66 days). From the experimental results of amended and non-amended soils, the soil amendment was observed to enhance persistence of lindane (Table 4.6.2).

Table 4.6.2: Degradation of lindane in Nzoia soil under different treatment

	Degradation in River Nzoia soil	t*	C*	$T_{1/2}$
1	Non-amended soil	10.60	0.61	66.18
2	Amended soil	12.32	0.93	571.87
3	Non-mended soil mixed with other pesticide	14.18	0.55	52.90
4	Amended soil mixed with other pesticide	11.99	0.53	24.87
5	Non-amended soil treated with $HgCl_2$	8.27	0.83	323.58

Figure 4.6.2 below shows the first order degradation curves for lindane in Nzoia soil. Biphasic first order kinetics was observed under all conditions of treatment for Nzoia soil.

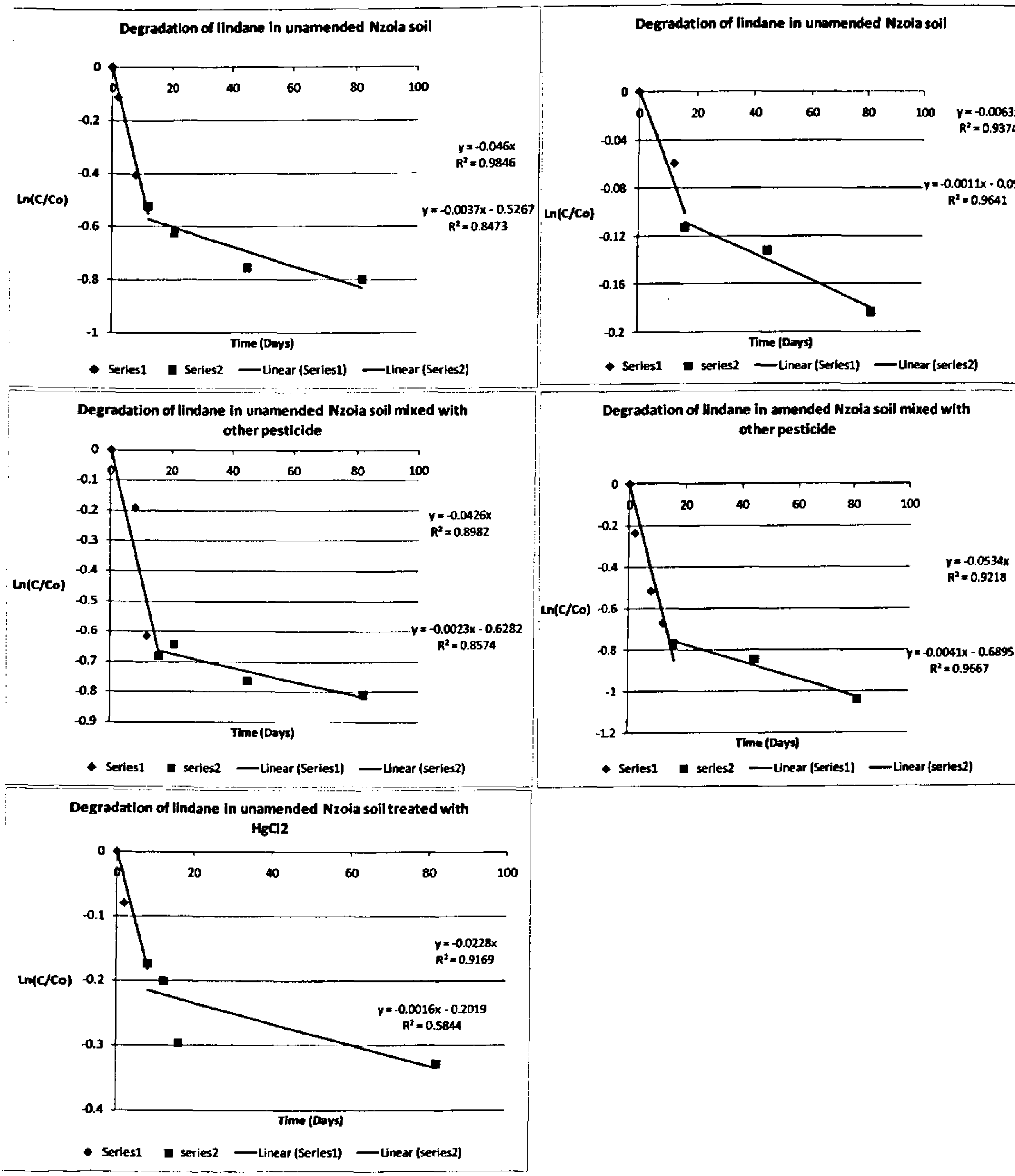

Figure 4.6.2: Degradation of lindane in Nzoia Soil

4.6.4 Degradation of Lindane in River Yala Soil

Degradation half-lives in Yala soils varied from 160 days to 372 days. Soil amendment was observed to reduce degradation in Yala soil in either of the treatments tested. Application of mercuric chloride reduced the rate of pesticide breakdown which prolonged the half-life to about one year (Table 4.6.3). However, degradation in non-amended soil treated with other pesticide was faster than in non-amended soil treated with lindane alone. A similar trend was observed in the case of amended soil treated with lindane alone and amended soil treated with lindane and other pesticides, where the latter had a shorter halflife. The mode of degradation rate enhancement was not well understood in this case, however it could be attributed to changes in soil-pesticide and pesticide-microorganism interaction dynamics. In general, the rate of degradation in non-amended soil treated with other pesticide> non-amended soil>amended soil treated with other pesticide>amended soil>soil treated with $HgCl_2$.

Table 4.6.3: Degradation of lindane in Yala soil under different treatment

	Degradation in River Nzoia soil	t*	C*	$T_{1/2}$
1	Non-amended soil	8.21	0.92	210.80
2	Amended soil	11.55	0.69	274.39
3	Non-amended soil mixed with other pesticide	10.43	0.84	160.21
4	Amended soil mixed with other pesticide	7.94	0.76	358.08
5	Non-amended soil treated with $HgCl_2$	15.37	0.67	372.67

Figure 4.6.3 below illustrates the behaviour of lindane degradation in Yala soil under different treatment. Biphasic kinetics was observed in all soil treatements.

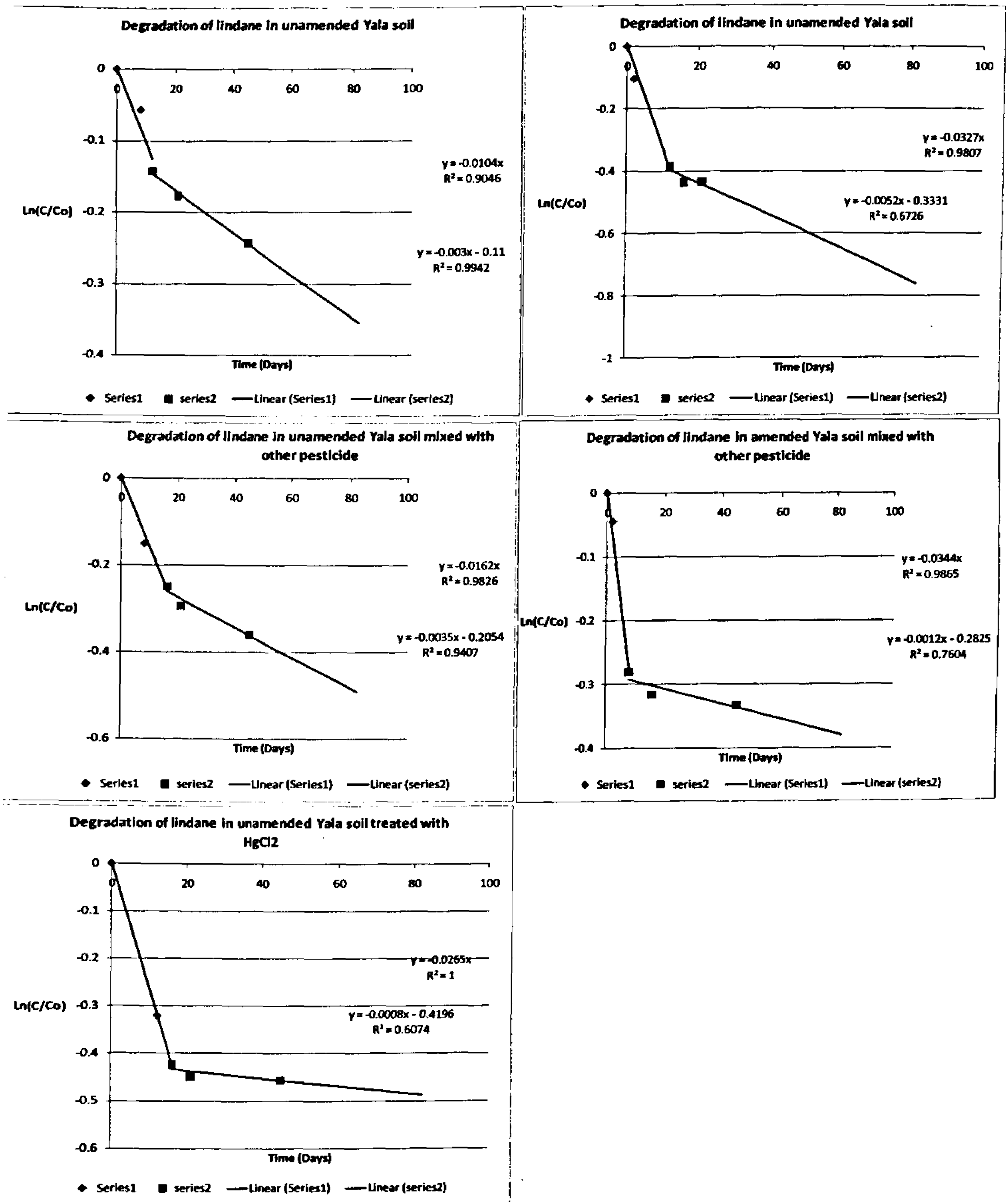

Figure 4.6.3 Degradation of Lindane in River Yala Soil

4.6.5 Effect of soil treatment on degradation of Lindane

Degradation of lindane was fastest in Nyando non-amended soil>Nzoia non-amended >Yala non-mended soil. However, the negative effect of amendment of soils with compost was more evidenced in Nzoia soil>Yala soil>Nyando soil. The two experiments revealed that soil composting or increasing organic matter and simultaneously application of hydrophobic pesticides could be a factor contributing to persistence of organochlorine pesticides in soils.

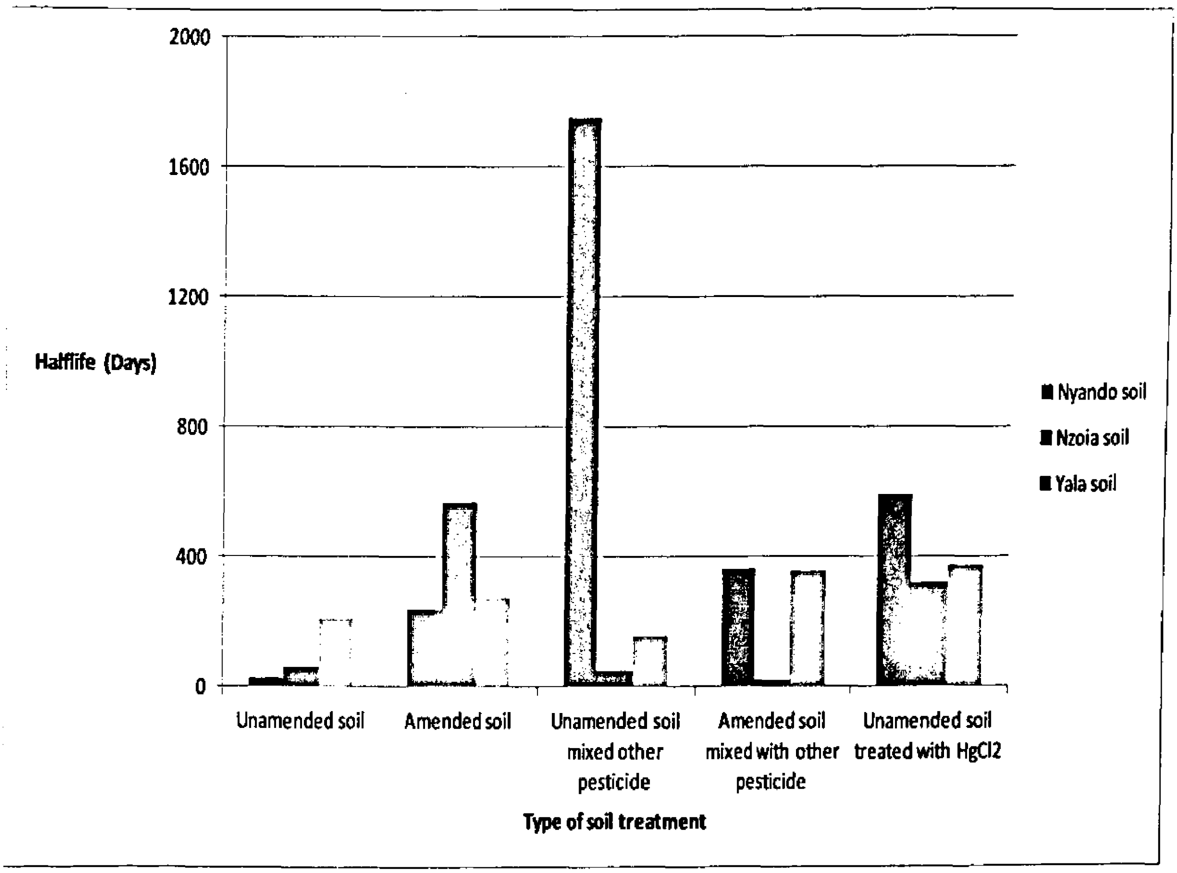

Figure 4.6.4: Effect of soil treatment on degradation of Lindane in the Lake Basin

Multiple pesticide residues in the soil contributed to persistence of lindane, but the extent varied from one type of soil to the other. Degradation in Nyando soil experienced the highest reduction, followed by Yala and Nzoia soils. However, the multiple effects of additional pesticide compounds and compost was observed to cause a net increase in degradation compared to effect recorded in some non-amended soils.

In all the three soils, addition of mercuric chloride was found to reduce degradation rate of lindane significantly, with the highest effect recorded in Nyando soil>Yala soil>Nzoia soil. Alternatively, human activities interferering with performance of microorganisms would increase persistence of pesticides in the basin. Both Nyando and Yala soils had high percent sand content (about 80%) compared to Nzoia with less than 70%, although the later was richer in silt content. But all the three soils had comparable clay composition (less than 20%). The strong impact of mercuric chloride on the reduction of degradation could therefore be attributed to interruption of microbial activities in the Nyando and Yala soil compared to Nzoia soil. In addition, one would expect higher microbial activities in better aerated soils than poorly aerated soils containing less sand, as evidenced in the Nzoia soil.

4.7 CORRELATION OF PESTICIDES AND PHOSPHORUS LEVELS

This section discusses pesticide and phosphorus dynamics in the lake basin based on the findings from physiochemical parameters, phosphorus speciation, pesticide residues, and transport and fate experiments. Analysis of the physical and chemicals parameters revealed high concentration of phosphorus and nitrogen in the soils, which is likely to be transported into the aquatic system through runoff or leaching processes. The correlation analysis was conducted to determine inter-dependence between different parameters such as soil type, physico-chemical parameters, and phosphorus and pesticides dynamics in the catchment.

4.7.1 Comparative analysis of pesticide residues in water

Comparative analysis of the overall sum, maximum, minimum and median concentration of pesticides in water across the four seasons revealed Σendrin aldehyde>Σ*p,p'*-DDD>Σγ-HCH> ΣHeptachlor>Σheptachlor expoxide. The highest concentration recorded across the sites was *p,p'*-DDT, followed by endosulphan II, *p,p'*-DDD, aldrin and γ-HCH.

The concentrations of pesticide transformation products were significantly higher than the parent compounds, implying that most of the compounds measured were from previous application rather than present use. Endrin, endosulphan I, δ-HCH recorded the lowest sum concentrations compared to the rest of the compounds. Compared to the previous studies conducted elsewhere (Wandiga et al., 2002; Getenga and Keng'ara, 2004), the levels reported in the current study were much lower, which could signify decreasing trend of organochlorine pesticides residues in the enivironment. However, similar trends in detections frequencies were observed compared to those reported by the previous studies, where by DDTs and HCHs had high occurrencies [Wandiga *et al.,* 2002a and 2002b; Getenga *et al.,* 2004]. DDT and its metabolites, and HCHs have also been reported in the past in mothers' milk from Kenya, with high DDT/DDE rations ranging from 1.1 to 18.7 [Kanja *et al.,* 1986]. The study attributed the occurrence of pesticide residues in mothers' milk to diatery habits and agricultural activities, but from this study, it is evident that the consumption of untreated water could also be a contributing factor to pesticide residues detected in human milk.

4.7.2 Comparative analysis of pesticide residues in soil

Organochlorine pesticide residues in soil and sediments were higher than the levels measured in water by factors of 1 to 3 logs. This could be attributed to high organic matter content in the soil and sediments which tends to retain hydrophobic pesticides through adsorption process. Usually, soils act like sinks of pesticides and gradually release them into aquifer through runoff. As a result, contaminated soils tend to cause prolonged contamination of water resources through runoff and leaching processes.

Calculation of the total concentrations showed that Σ*p,p'*-DDT>Σendrinaldehyde>Σβ-HCH>Σdieldrin> Σmethoxychlor>Σheptachlor>Σδ-HCH>Σγ-HCH >Σendrin. However, for the mean concentrations in the soil, dieldrin recorded the highest, followed by endrin, endrin aldehyde and β-HCH. Pesticide transformation products such as dieldrin, *p,p'*-DDE, endosulphan sulphate, endrin aldehyde, had significantly high concentrations which could be attributed to degradation activities in soil, whereas the high concentration of *p,p'*-DDT in soil compared to water could be attributed to hydrophobic nature of the pesticide contributing to its persistence in the soil.

Comparison of the levels of pesticide residues measured in soil under this study, to those reported in the previous studies, showed that the current levels are lower. For instance Getanga and co-workers [2004b], in their report on pesticide residues in soil from River Nyando Drainage Basin of Lake Victoria found concentrations in the range of 10 to 100 times higher than those reported in this study. Although the difference in levels could be explained, partly, by the differences in sampling sites, but the fact that the latter study was conducted almost a decade ago [Getenga *et al.,* 2004], the variations in concentrations measured could be attributed to degradation in the soil, and therefore accounting for the lower pesticide residue levels observed in soil under this study.

4.7.3 Mean and sum pesticide residues in sediments

The trend in sum concentration of pesticides in sediments was similar to soil, and 1 to 3 logs higher concentrations than water. DDT and other legacy POPs such as endrin, endosulphan, methoxychlor and dieldrin exhibited high concentrations in sediments and soil samples. This could be attributed to the long pesistence of these compounds in soils and sediments due to to adsorption to organic carbon.

The sum concentration of pesticide revealed that the total Σ*p,p'*-DDT>Σendrin aldehyde>Σmethoxychlor>Σendosulphan sulphate>Σheptachlor>Σdieldrin in sediment samples. Pesticides with lowest concentrations in sediments included aldrin, *p,p'*-DDD, endosulphan II.

Although the concentrations of pesticides measured in most of the samples from the Lake sediments were comparable to the levels reported in sediments from the Ugandan side of Lake Victorias [Wasswa et al., 2011] which reported levels from 0.01 to 16 μg/kg of sediments, and in the coastal parts of Kenya as reported by Wandiga and co-workers [2002b], afew sites were noted to contain higher concentrations of pesticides residues.

Further, it is notable that although the current study did not address pesticide residues in fish samples, however, the pesticide residues measured in water column and sediments can find their way into the aquatic organisms through bioaccumulation processes. For instance, pesticide residues have been reported in Nile perch and Nile tilapia samples from the Ugandan part of Lake Victoria, with concentrations of p,p'-DDT up to 6.1 μg/kg in Nile perch and up to 3.4 μg/kg in Nile tilapia [Kasozi *et al.,* 2006]. Other persistent pesticides also reported in the fish samples included aldrin, dieldrin, γ-HCH, α-endosulphan and p,p'-DDE [Kasozi *et al.,* 2006]. As a consequence, it is important to note that despite the fact that most of the organochlorine pesticides have been banned from use, effort is needed to ensure that pesticides applied in the agricultural farms do not find their way into water bodies.

4.7.4 Phosphorus loading from Kenyan Catchment of Lake Victoria

According to LVEMP reports on nutrient loading in Lake Victoria, 6,955 t-BOD/y, 3028 t-Total-N/y and 2,686 t-Total P/y were recorded in riverine systems whereas 102,000 t/y of Total-N and 24,000 t/y of Total-P was attributed to atmospheric deposition, accounting for 45% and 64% total nitrogen and total phosphorus loading, respectively (LVEMP 2001, 2002 and 2003). However, findings of this study show that phosphorus influx from the rivers was underestimated in the previous studies [COWI, 2002; LVEMP, 2003]. The average discharge rates calculated based on the dry and short rain seasons only gave 35,200 t-Total P/y as shown in Table 4.7.1. The exact input could go beyond this figure if the discharge rates in the wet seasons are well measured.

Table 4.7.1 Riverine phosphorus loading from Kenyan Catchment

River	Discharge rates m^3/s	Average total P conc (mg/l)	Tons/year
R. KUJA	143.22	2.08	9,389.10
R. AWACH	1.02	1.46	46.86
R. SONDU	86.88	2.41	6,591.67
R. NYANDO	61.40*	1.29	2,505.49
R. NYAMASARIA	-	2.84	0.00
R. KISIAN	1.08	2.51	84.92
R. MUGRUK	0.84	1.98	52.50
R. AWACH SEME	0.96	2.52	75.76
R. YALA	60.00	2.55	4,827.87
R. NZOIA	125.00*	2.32	9,135.31
R. SIO	32.16	2.46	2,490.83
Rivers total phosphorus loading (tonnes)			35,200.30

Average of dry and short rain season only; * based on dry season discharge only; - Not determined

4.7.5 Correlation of soil, sediments and water parameters with phosphorus

Increase in soil pH was observed to increase phosphorus release from the soil into the aqueous phase, with a Pearson correlation of $r = 0.5$ ($p<0.05$) (Annex Table 4.5.1A-4.5.17A). This implied that higher pH would trigger dissolution of phosphorus from the soil particles to water column, whereas lower pH would fix phosphorus into the soil. A similar effect was observed in water column where total reactive phosphorus, total hydrolysable phosphorus and total phosphorus all recorded $r>0.5$ ($p<0.05$) in correlation with pH, signifying higher availability of phosphorus in water as pH increases (Annex Table 4.5.1A). The findings of this study are in line with other studies conducted elsewhere, for instance Yuan *et al.* [2009] while studying pH effect on P sorption in Kaolinite observed that pH range of 4–8, P sorption on $LaCl_3$ - modified kaolinite could reach over 80%, with a maximum of 97% at pH 5, but decreased thereafter. Accordingly, there is potential of internal phosphorus loading the lake basin from desorption of sediment fixed phosphorus as the pH increases.

In addition, a strong correlation was observed between the nitrogen concentration and organic matter ($r = 0.995$, $p<0.01$) indicating the significance of the contribution of decomposing organic materials to the nitrogen input in soil and sediments (Annex Table 4.5.3A). Increasing sediment and water pH was found to enhance phosphorus release and hence, it will increase internal phosphorus pollution from lake sediments. On the other hand, manganese and iron concentrations were found to decrease as pH increases ($p<0.05$), whereas calcium increased with increasing pH ($p<0.05$) (Annex Table 4.5.4A).

Increase in the levels of calcium had a positive effect on the concentration of manganese, magnesium, electrical conductivity and soil available phosphorus concentration ($P<0.05$) (Annex Table 4.5.5A). The positive correlation ($p<0.001$) was also noted between calcium and potassium, sodium and electrical conductivity in sediments, but less for Mn and Mg (Annex Table 4.5.6A). Further, a positive correlation ($p<0.001$) was observed between N-OC, N-Cu and Mn-Fe. Changes in concentration of manganese also showed a significant effect ($p<0.01$) on bio-available phosphorus in sediments (Annex Tables 4.5.1A-4.5.8A).

4.7.6 Correlation of pesticide residues with soil, sediments and water parameters

Organic carbon and nitrogen revealed positive correlation with a number of pesticides such as endosulphan II, endrin aldeldehyde and heptachlor epoxide ($p<0.05$). But pH and phosphorus did not have significant effects on pesticide residues in soil. This could be attributed to the hydrophobic behaviour of most organochlorine pesticides and therefore not likely to be affected by pH effects. However, pH has been reported to affect organic matter by modifying the structure of humus and hence may indirectly affect organochlorine binding to organic carbon as well as the efficiency of microbial degradation in the soil [Zhang *et al.*, 2006]. In sediments, no significant effect was observed between the physiochemical properties and pesticide concentration. However, indirect effects could occur due to a strong N-OC carbon correlation ($p<0.01$) since organic carbon strongly affects hydrocarbons. The water chemistry showed more interactions between physico-chemical properties and pesticide residues. In particular, pH showed strong correlation ($p<0.05$) with dieldrin, *p,p'*-DDD, γ-HCH, and methoxychor concentration in the water column. Further analysis revealed a strong association between TDS and *p,p'*-DDD, γ-HCH, dieldrin, endosulphan II, endosulphan sulphate and heptachlor epoxide, which suggested impact of runoff on the influx of pesticides residues into the aquatic systems in the basin.

4.7.7 Correlation of soil, sediments and water phosphorus with pesticide residues

The results of correlation analysis between phosphorus and pesticides in various matrices displayed variations from one matrix to the other as summarized in Annex Table 4.5.7A to Annex Table 4.5.20. Soil available phosphorus (SAP) strongly correlated with pesticide residues in the soil (Annex Table 4.5.12A). Specifically, dieldrin, endrin, α-HCH, methoxychlor and heptachlor all showed the Pearson correlation, $r>0.9$ ($p<0.001$), whereas p,p-DDE, γ- and β-HCH had r between 0.7 and 0.9 ($p<0.001$) (Annex Table 4.5.12A). This indicated a strong impact of catchments soil on the input of both phosphorus and pesticide residues. However, there was no significant relationship between the soil available phosphorus and pesticide residues in water column, possibly signifying multiple factors contributing to water pesticide residues in the catchment. Ideally, limited agricultural activities take place at the lakeshores and the immediate surroundings of the river mouths as compared to intensive agricultural activities in the upstream. In most of the cases the shoreline is characterised by fishing and subsistence agriculture and limited application of agricultural pesticides. Therefore, the major input of pesticides and phosphorus fertilizers lies in the upper catchments. In sediments, *p,p'*-DDT was observed to correlate with bio-available phosphorus compared to sediment exchangeable phosphorus concentration.

CHAPTER 5

5.0 CONCLUSIONS AND RECOMMENDATIONS

The results of various analyses and laboratory experiments conducted in this study using soils, sediments and water samples collected from the Lake Victoria Basin revealed that pesticides and phosphorus residues in the lake basin are controlled by a conglomerate all the activities taking place in the entire lake basin, in addition to the shoreline socio-economic activities. Based on these results, a number of conclusions and recommendations were made as summarized below.

5.1 Conclusions

The calculation of phosphorus loading from the Kenyan catchments, based on the levels measured in the rivers water, revealed that the drainage basin contributes over 35,200 t/y total phosphorus into the lake, therefore contributing to the eutrophication of the lake and the depletion of soil nutrients from agricultural land in Lake Victoria Basin.

The results of analysis of residue levels of pesticide and phosphorus in the water, soil and sediments revealed that the highest concentrations are in the soil and sediments and the lowest levels are in the water column. Therefore, the residues accumulated in the soil and sediments will have a long term impact on recontamination of the water column, especially during the rain seasons, whereas the release of residues bound in the sediments will be strongly influenced by sediment and water chemistry.

The results of correlation analysis of soil and sediment physico-chemical properties revealed that pH and organic carbon have a strong influence on phosphorus and pesticides adsorption and degradation kinetics in the Lake Victoria Basin, and therefore, alteration of physico-chemical properties of soil and sediments will affect the influx of pesticides and phosphorus into the water column.

The results of phosphorus adsorption studies and pesticide degradation studies revealed that soil amendments using compost will increase phosphorus and organochlorine pesticide binding onto the soil particles and hence minimise losses caused by runoff into aquifer systems, however, these should be complemented with buffer zoning to filter suspended materials and particle bound phosphorus and pesticides.

The results of analyses of phosphorus levels in wastewater treatment effluent samples revealed that the concentration of phosphorus in effluents exceeded the recommended guidelines for phosphorus levels in effluents for direct discharge into rivers and lakes. Therefore, if continuous discharge of such effluent is not checked, it will suffocate the lake by triggering prolonged eutrophication effects.

The results of analysis of pesticide residues in water samples showed that the concentrations of all pesticide residues in water were all below WHO guidelines, however, the concern is raised due to bioaccumulation and biomagnifications effects of these pesticides which can increase the residue levels in organisms to reach critical concentrations that can trigger toxic effects in biological systems.

5.2 General recommendations

The results of this study revealed high levels of phosphorus in the rivers, soil and sediment samples. Therefore, there is a need to control influx of phosphorus into the lake and rivers, through targeted measures that reduce the impact of human activities on the loss of this vital plant nutrient from agricultural land, into the rivers and the lake. In this context, targeted education and awareness creation activities should be conducted, focusing on the key stakeholders at the shoreline and the upper catchments in the basin.

Results of analyses of water, soil and sediment samples revealed high concentrations of different forms of phosphorus that has the potential to stimulate eutrophication of the lake and rivers. There is, therefore, a need for targeted research and mitigation activities to control transport of the acculated phosphorus in soil and sediments from reaching the water column and stimulating eutrophication of the aquatic system in the basin.

The results of correlation analysis revealed that various physico-chemicals parameters such as soil and sediment pH, organic carbon and metals have a strong impact on phosphors and pesticide concentrations in the water column. Thus human activities, which are likely to affect soil physico-chemical parameters, such as biomass burning, over fertilization, excessive liming and solid waste disposal should be controlled in order to manage phosphorus load into the water bodies in the basin.

5.3 Policy recommendations

The results of analysis of phosphorus in water samples revealed high concentration of phosphorus in effluent discharged into the lake; therefore, there is a need for stringent regulations to control discharge of effluents into the lake in order to protect the water quality and the riparian communities' health.

The concentrations of phosphorus in water samples from the rivers were higher than the recommended guidelines for aquatic systems indicating influence from human activities in the catchment. Therfore, farming and settlement activities along the lake-shores, and along the rivers in the upper catchments should be controlled to minimize their effect on phosphorus load into the rivers and the lake.

The levels of phosphorus and pesticide residues measured in the samples from the catchment were relatively high, especially considering long term impacts on the lake water quality. Hence, a continuous water quality monitoring programme should be established, under the framework of the existing projects within the Lake Basin, to support production of water quality data to monitor and ensure restoration of the lake basin water resources.

This study established that soil and sediments within the Lake Victoria Basin have high concentration pesticides and phosphorus. Therefore, there is need strengthen research on transport and fate of pesticides, fertilizers and other chemicals applied in the Lake Basin to ensure sustainable utilisation and conservation of the lake basin water resources as well as stimulate their economic potential.

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ANNEX 1

PESTICIDE IMPORTS IN KENYA

Table 1.1A: Pesticide importations in Kenya (Metric tonnes)

	Insecticides and acaricides	Herbicides	Fungicides	Others	Total
1986	1076	112	654	808	2650
1987	1206	1311	715	697	3929
1988	1089	2108	4259	801	8257
1989	1571	1148	4327	665	7711
1990	1572	1134	1330	857	4893
1991	1072	844	1568	570	4054
1992	1670	1122	2634	1164	6590
1993	839	882	1503	309	3533
1994	1049.9	747.4	1671.8	563.3	4032.4
1995	1413.3	870.6	2323	501.9	5108.8
1996	1876.2	997.9	3469.8	602.5	6946.4
1997	2077.8	703.1	2391	655.6	5827.5
1998	1814.4	1407.8	4225.4	158.8	7606.4
1999	2186	593	2284	1116	6179
2000	1762	633.4	1665.9	370.6	4431.9
2001	2320	1398	1779	154	5651
2002	2747	1506	2139	434	6826
2003	2665	1396	1657	723	6441
2004	2881	1538	2031	597	7047
2005	2844	1311	2361	1192	7708
2006	2475	1859	3190	1225	8749
2007	2887	2289	2651	1330	9157
2008	2995	2340	2933	1413	9681
2009	3181	2415	1840	1396	8832

Table 1.2A: Monetary value of pesticides importation in Kenya (Million Shillings)

	Insecticides and acaricides	Herbicides	Fungicides	Others	Total
1986	134.9	121.3	281.3	42.6	580.1
1987	182.3	173.4	357.3	28.1	741.1
1988	158.9	145.2	329.9	28.5	662.5
1989	202.2	154.2	328.8	30.7	715.9
1990	260.3	159.4	169.2	55.6	644.5
1991	202.2	146.8	223.8	41.8	614.6
1992	505	228.5	457.1	101.7	1292.3
1993	428.7	272.2	441.8	64.1	1206.8
1994	479.3	286.5	432.8	84.5	1283.1
1995	707	312.1	682.6	74.4	1776.1
1996	1405.4	389.9	1049.1	102.1	2946.5
1997	1164	301.5	827.2	113	2405.7
1998	1196.9	521.3	1358.5	37.7	3114.4
1999	1178	259	891	181	2509
2000	1114.1	298.6	713.9	74.7	2201.3
2001	2201	324	957	713	4195
2002	2030	406	1012	109	3557
2003	2411	571	925	142	4049
2004	2077	650	1113	133	3973
2005	2031	620	1506	337	4494
2006	1181	324	1251	362	3118
2007	3909	206	602	191	4908
2008	2079	3153	944	1167	7343
2009	2,493	3,874	939	918	8224

ANNEX 2

Table 2.1A: Pesticides used in Lake Victoria Basin

CROP/LIVESTOCK	INSECTICIDE/ ACARICIDE	FUNGICIDE	HERBICIDE
Sugarcane	Diazinon Lebaycid	Dithane M-45 Dursban	Roundup Diuron NaTa 2,4-D Atrazin Asulam Metribuzin
Horticulture	Diazinon Ambush Doom powder Karate Dimethoate	Dithane super Ridomil Mithane super Antracol	
Rice	Furadan Carbofuran Diazinon Lebaycid	Benlate	
Tobacco	Rogor/ Othene Lebaycid Orthene	Dithane M-45	Copper chloride Dithane M-45
Coffee	Diazinon Dasis Fenitrothion Fenthion	Copper nordox Dithane M-45 Antracol Copper-oychloride	Roundup
Tea	Fenitrothion Dimethoate Diazinon Karate	Copper, zinc spray Dithane M-45 Marshal Ridomil	Roundup Touch down Gramoxone Afalon 2,4-D auxin (72%)

ANNEX 3

Table 3.1A: GPS Locations of the sampling sites

No.	SAMPLING SITE	LATITUDES	LONGITUDES	ALTITUDE (M)
1	MUHURU BAY	005654S	0340753E	1127
2	SORI	005657S	0341231E	1129
3	MBITA WINAM GULF	002511S	0341229E	1139
4	MBITA MAIN LAKE	002514S	0341227E	1134
5	HOMABAY	003120S	0342712E	1137
6	KENDUBAY	002057S	0343924E	1135
7	KUSA	001834S	0345054E	1170
8	DUNGA BEACH	000847S	0344412E	1139
9	HIPPO POINT	000729S	0344433E	1145
10	CAR WASH	000542S	0344458E	1126
11	LUANDA	002313S	0341653E	1123
12	MISORI	002308S	0341655E	1125
13	USENGE	000421S	093450E	1198
14	PORT VICTORIA	000555N	0335802E	1138
15	SIO PORT	001326N	0340049E	1142
16	R. KUJA	005701S	0341235E	1136
17	R. AWACH	002106S	0343906E	1150
18	R. SONDU MIRIU	002052S	0344728E	1140
19	R. NYANDO	011450S	0364642E	1730
20	R. NYAMASARIA	000705S	0344718E	1136
21	R. KISIAN	000416S	0344002E	1160
22	R. MUGRUK	000542S	0343847E	1178
23	R. AWACH SEME	000545S	0342829E	1191
24	R. YALA	000006S	0340831E	1166
25	R. NZOIA	000540N	0335931E	1153
26	R. SIO	002302N	0340846E	1157
29	NYALENDA DISCHAGE	000732S	0344443E	1140
30	KWASCO	000717S	0344443E	1127
31	KISATI	000458S	0344456E	1179
32	SAKA	000431S	0344238E	1176

ANNEX 4.1

PHYSIOCHEMICAL CHARACTERISTICS OF WATER, SOIL AND SEDIMNTS

Table 4.1.1A: Water conductivity (µS/cm)

TDS	WET SEASON	stdev	DRY SEASON II	stdev	SHORT RAIN SEASON	stdev	DRY SEASON I	stdev
MUHURUBAY	55.33	7.09	51.50	5.26	47.33	0.58	73.00	5.29
SORI	57.50	0.71	47.33	0.58	54.50	7.78	51.67	0.58
MBITA LHSD	52.33	1.53	48.00	0.00	49.00	0.00	34.82	23.71
MBITA WG	68.00	2.65	56.50	0.71	65.00	1.41	58.50	6.36
HOMABAY	84.00	4.58	84.00	4.24	110.00	32.70	83.00	2.83
KENDUBAY	72.00	5.66	73.33	0.58	84.00	7.07	78.33	1.53
KUSA	134.67	9.02	105.00	26.21	126.50	0.71	118.00	21.21
DUNGA BEACH	98.00	12.73	95.50	26.16	80.50	0.71	63.00	0.00
HIPPOPOINT	74.50	40.31	75.30	0.42	83.50	0.71	73.00	1.41
RAILWAYS	103.50	3.54	93.50	4.95	90.50	2.12	94.00	7.81
LUNDA	77.50	6.36	59.00	1.41	63.00	1.41	68.67	13.28
MISORI	58.00	4.24	48.33	0.58	55.00	0.00	58.67	0.58
USENGE	56.50	6.36	46.00	0.00	46.50	2.12	48.67	0.58
PORT VICTORIA	51.00	0.00	48.33	1.53	54.33	0.58	54.00	6.08
SIO PORT	53.00	2.83	45.25	15.11	58.50	2.12	51.67	0.58
R. KUJA	61.00	0.00	60.67	1.15	57.00	6.08	60.33	0.58
R. AWACH	60.50	9.19	45.67	0.58	44.50	0.71	44.00	2.83
R. SONDU	26.91	17.26	22.50	0.71	31.00	1.00	79.00	70.16
R. NYANDO	121.33	1.53	95.33	0.58	132.00	46.16	134.67	14.47
R. NYAMASARIA	46.50	0.71	46.67	0.58	55.00	0.00	54.00	0.00
R. KISIAN	65.50	30.41	50.50	0.71	36.00	0.00	45.50	0.71
R. MUGRUK	50.50	4.95	89.00	8.49	50.50	0.71	67.50	2.12
R. AWACH SEME	88.50	4.95	108.50	0.71	94.00	0.00	94.50	2.12
R. YALA	44.00	0.00	49.67	2.52	41.67	0.58	45.00	1.00
R. NZOIA	47.50	0.71	57.33	8.39	69.00	10.39	65.33	0.58
R. SIO	45.00	1.41	58.00	0.00	50.67	6.43	51.67	0.58
HOMABAY S.E.	594.50	16.26	734.50	58.69	778.00	59.43	725.67	50.64
HOMA BAY DISCHARGE	649.50	6.36	432.00	334.54	313.25	362.11	726.00	21.21
NYALENDA	96.50	9.19	61.00	1.41	174.00	1.41	225.33	1.53

KWASCO	101.00	1.41	107.00	7.07	98.50	2.12	103.50	0.71
KISATI	366.33	11.72	522.00	41.01	226.00	3.00	159.50	0.71
SAKA	110.00	4.24	246.50	3.54	232.00	0.00	71.50	0.71

Table 4.1.2A: Total dissolved solids (mg/l)

TDS	WET SEASON	stdev	DRY SEASON II	stdev	SHORT RAIN SEASON	stdev	DRY SEASON I	stdev
MUHURUBAY	55.33	7.09	51.50	5.26	47.33	0.58	73.00	5.29
SORI	57.50	0.71	47.33	0.58	54.50	7.78	51.67	0.58
MBITA LHSD	52.33	1.53	48.00	0.00	49.00	0.00	34.82	23.71
MBITA WG	68.00	2.65	56.50	0.71	65.00	1.41	58.50	6.36
HOMABAY	84.00	4.58	84.00	4.24	110.00	32.70	83.00	2.83
KENDUBAY	72.00	5.66	73.33	0.58	84.00	7.07	78.33	1.53
KUSA	134.67	9.02	105.00	26.21	126.50	0.71	118.00	21.21
DUNGA BEACH	98.00	12.73	95.50	26.16	80.50	0.71	63.00	0.00
HIPPOPOINT	74.50	40.31	75.30	0.42	83.50	0.71	73.00	1.41
RAILWAYS	103.50	3.54	93.50	4.95	90.50	2.12	94.00	7.81
LUNDA	77.50	6.36	59.00	1.41	63.00	1.41	68.67	13.28
MISORI	58.00	4.24	48.33	0.58	55.00	0.00	58.67	0.58
USENGE	56.50	6.36	46.00	0.00	46.50	2.12	48.67	0.58
PORT VICTORIA	51.00	0.00	48.33	1.53	54.33	0.58	54.00	6.08
SIO PORT	53.00	2.83	45.25	15.11	58.50	2.12	51.67	0.58
R. KUJA	61.00	0.00	60.67	1.15	57.00	6.08	60.33	0.58
R. AWACH	60.50	9.19	45.67	0.58	44.50	0.71	44.00	2.83
R. SONDU	26.91	17.26	22.50	0.71	31.00	1.00	79.00	70.16
R. NYANDO	121.33	1.53	95.33	0.58	132.00	46.16	134.67	14.47
R. NYAMASARIA	46.50	0.71	46.67	0.58	55.00	0.00	54.00	0.00
R. KISIAN	65.50	30.41	50.50	0.71	36.00	0.00	45.50	0.71
R. MUGRUK	50.50	4.95	89.00	8.49	50.50	0.71	67.50	2.12
R. AWACH SEME	88.50	4.95	108.50	0.71	94.00	0.00	94.50	2.12
R. YALA	44.00	0.00	49.67	2.52	41.67	0.58	45.00	1.00
R. NZOIA	47.50	0.71	57.33	8.39	69.00	10.39	65.33	0.58
R. SIO	45.00	1.41	58.00	0.00	50.67	6.43	51.67	0.58
HOMABAY S.E.	594.50	16.26	734.50	58.69	778.00	59.43	725.67	50.64
HOMA BAY DISCHARGE	649.50	6.36	432.00	334.54	313.25	362.11	726.00	21.21
NYALENDA	96.50	9.19	61.00	1.41	174.00	1.41	225.33	1.53
KWASCO	101.00	1.41	107.00	7.07	98.50	2.12	103.50	0.71
KISATI	366.33	11.72	522.00	41.01	226.00	3.00	159.50	0.71
SAKA	110.00	4.24	246.50	3.54	232.00	0.00	71.50	0.71

Table 4.1.3A: Water pH

PH	WET SEASON	STDEV	DRY SEASON II	STDEV	SHORT RAIN SEASON	STEDV	DRY SEASON I	STEDV
MUHURUBAY	7.61	0.13	7.62	0.36	7.50	0.12	8.13	0.59
SORI	7.61	0.11	7.24	0.36	7.05	0.59	7.69	0.05
MBITA LHSD	7.54	0.06	7.93	0.18	6.65	0.01	7.60	0.14
MBITA WG	7.74	0.17	7.45	0.00	7.26	0.86	7.74	0.06
HOMABAY	7.49	0.09	7.18	0.33	7.11	0.54	7.32	0.40
KENDUBAY	7.44	0.16	7.39	0.08	7.46	0.03	7.76	0.13
KUSA	7.56	0.07	7.63	0.46	7.80	0.13	7.41	0.23
DUNGA BEACH	7.52	0.13	7.38	0.74	7.42	0.01	6.85	0.83
HIPPOPOINT	7.71	0.06	7.44	0.01	8.50	1.42	7.38	0.42
RAILWAYS	7.50	0.00	7.78	0.18	7.53	0.04	7.25	0.08
LUNDA	7.64	0.18	6.95	0.63	6.49	0.21	6.73	0.34
MISORI	7.55	0.10	7.85	0.95	7.65	0.17	7.64	0.03
USENGE	7.71	0.40	7.62	1.03	7.47	0.11	7.47	0.20
PORT VICTORIA	7.74	0.20	7.22	0.36	7.66	0.02	7.79	0.14
SIO PORT	7.51	0.04	7.47	0.90	7.43	0.01	7.72	0.09
R. KUJA	7.57	0.05	7.29	0.02	7.50	0.06	7.50	0.17
R. AWACH	7.58	0.01	7.66	0.19	7.71	0.10	7.66	0.00
R. SONDU	7.66	0.03	7.56	0.81	7.07	0.56	7.67	0.04
R. NYANDO	7.56	0.11	7.46	0.66	7.52	0.55	7.23	0.29
R. NYAMASARIA	7.64	0.21	7.00	0.38	7.54	0.05	7.74	0.06
R. KISIAN	7.80	0.20	7.40	0.06	7.67	0.06	8.06	0.40
R. MUGRUK	7.68	0.24	7.38	0.47	7.76	0.06	7.53	0.24
R. AWACH SEME	7.54	0.12	7.68	0.37	7.65	0.09	7.72	0.01
R. YALA	7.92	0.12	6.92	0.14	7.47	0.07	7.67	0.06
R. NZOIA	7.83	0.38	7.35	0.58	7.58	0.02	7.86	0.10
R. SIO	7.47	0.09	7.57	0.29	7.40	0.02	7.88	0.05
HOMABAY S.E.	6.91	1.53	7.85	0.09	8.01	0.47	8.07	0.41
HOMA BAY DISCHARGE	7.51	0.13	7.74	0.71	7.60	0.80	7.63	0.07
NYALENDA	7.65	0.04	7.46	0.06	7.34	0.03	7.56	0.23
KWASCO	7.56	0.02	6.86	0.03	7.38	0.14	7.09	0.05
KISATI	7.88	0.50	6.86	0.16	7.28	0.03	7.66	0.08
SAKA	7.72	0.20	7.10	0.28	7.31	0.05	7.76	0.11

Table 4.1.4A: Rivers discharge rates

	Discharge rate Short rain season (M^3/s)	Discharge rate Dry season II (M^3/s)	Average (M^3/s)
R. KUJA	214.84	71.59	143.215
R. SONDU	122.93	50.82	86.875
R. AWACH	1.67	0.36	1.015
R. NYANDO	113.29	9.51	61.4
R. KISIAN	1.28	0.87	1.075
R. MUGRUK	0.93	0.75	0.84
R. AWACH SEME	1.29	0.62	0.955
R. YALA	80.23	40.36	60.295
R. NZOIA	-	125.57	125.57
R. SIO	39.41	24.91	32.16
R. SAKA	0.05	0.51	0.28

Table 4.1.5A: Pearson correlation analysis of TDS levels across the seasons

		WET SEASON	DRY SEASON I	SHORT RAIN SEASON	DRY SEASON 2
WET SEASON	Pearson Correlation	1.000	.920	.848**	.946**
	Sig. (2-tailed)	.	.000	.000	.000
	N	32	32	32	32
DRY SEASON I	Pearson Correlation	.920**	1.000	.916**	.822**
	Sig. (2-tailed)	.000	.	.000	.000
	N	32	32	32	32
SHORT RAIN SEASON	Pearson Correlation	.848**	.916**	1.000	.866**
	Sig. (2-tailed)	.000	.000	.	.000
	N	32	32	32	32
DRY SEASON 2	Pearson Correlation	.946**	.822**	.866**	1.000
	Sig. (2-tailed)	.000	.000	.000	.
	N	32	32	32	32

** Correlation is significant at the 0.01 level (2-tailed).

Table 4.1.6A: Pearson Correlation analysis of Soil physico-chemical parameters

		Ph	N%	OC%	P%	K%	Ca %	Mg %	Mn %	Cu	Fe	Zn	Na %	Ec mS/cm	Ph soil	N% soil	OC % soil	P% soil	K% soil	Ca % soil	Mg % soil	Mn % soil	Cu soil	Fe soil	Zn soil	Na % soil	Ec mS/cm soil
Ph	Pearson Correlation	1.000	-.120	-.142	-.744	-.076	.204	-.084	-.230	-.152	-.302	-.045	.085	-.100	.089	-.094	-.084	.115	-.099	-.008	.325	-.208	-.016	-.129	.075	.135	368
	Sig. (2-tailed)	.	.528	.454	.000	.690	.280	.659	.222	.421	.105	.814	.656	.635	.645	.628	.667	.553	.609	.968	.086	.279	.934	.506	.698	.485	.215
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	29	29	29	29	29	29	29	29	29	29	29	29	13
N%	Pearson Correlation	-.120	1.000	.997	-.023	-.061	.005	.069	.152	.693	.028	.367	-.114	.261	.099	.345	.361	-.022	.281	.176	.083	-.069	-.100	-.078	-.086	.108	.012
	Sig. (2-tailed)	.528	.	.000	.903	.750	.978	.716	.421	.000	.884	.046	.550	.207	.611	.067	.054	.908	.140	.361	.667	.722	.604	.689	.659	.575	.968
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	29	29	29	29	29	29	29	29	29	29	29	29	13
OC%	Pearson Correlation	-.142	.997	1.000	.005	-.052	-.005	.095	.150	.692	.031	.357	-.114	.251	.093	.331	.345	-.004	.273	.168	.062	-.087	-.111	-.069	-.098	.108	.009
	Sig. (2-tailed)	.454	.000	.	.978	.783	.979	.618	.428	.000	.870	.053	.549	.226	.633	.080	.067	.983	.152	382	.751	.652	.567	.723	.614	.577	977
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	29	29	29	29	29	29	29	29	29	29	29	29	13
P%	Pearson Correlation	-.744	-.023	.005	1.000	.218	-.120	.243	.181	.156	.145	-.111	.159	.414	-.120	-.039	-.034	-.155	.083	-.005	-.281	.082	-.113	-.061	-.142	.192	-.120
	Sig. (2-tailed)	.000	.903	.978	.	.247	.528	.196	.337	.410	.444	.559	.401	.040	.537	.840	.861	.423	.667	.981	.140	.673	.561	.726	.462	.318	.695
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	29	29	29	29	29	29	29	29	29	29	29	29	13
K%	Pearson Correlation	-.076	-.061	-.052	.218	1.000	.737	-.009	.421	.127	.032	.161	.697	.604	-.209	.168	.172	.050	-.179	-.092	-.148	.256	-.135	-.103	-.098	-.025	-.073
	Sig. (2-tailed)	.690	.750	.783	.247	.	.000	.962	.020	.505	.866	.396	.000	.001	.276	.384	.373	.796	.352	.636	.443	.180	.486	.596	.614	.896	.812
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	29	29	29	29	29	29	29	29	29	29	29	29	13
Ca%	Pearson Correlation	.204	.005	-.005	-.120	.737	1.000	-.129	.210	.094	.095	.179	.856	.170	-.380	.260	.271	.046	-.059	-.144	.026	.433	-.130	-.043	-.097	.004	-.033
	Sig. (2-tailed)	.280	.978	.979	.528	.000	.	.497	.266	.622	.618	.344	.000	.417	.042	.173	.155	.811	.761	.456	.893	.019	.501	.827	.618	.982	.915
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	29	29	29	29	29	29	29	29	29	29	29	29	13
Mg %	Pearson Correlation	-.084	.069	.095	.243	-.009	-.129	1.000	-.165	.001	-.147	-.017	-.182	-.190	.088	-.334	-.326	-.167	-.083	-.019	-.075	-.289	-.116	-.145	-.188	-.025	-.218
	Sig. (2-tailed)	659	.716	618	.196	.962	.497	.	.385	.998	.437	.927	.335	.363	.651	.076	.084	.387	.669	.924	.698	.129	.550	.454	.329	896	.475
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	29	29	29	29	29	29	29	29	29	29	29	29	13
Mn%	Pearson Correlation	-.230	.152	.150	.181	.421	.210	-.165	1.000	.324	.623	.192	.139	.498	-.094	.139	.179	-.024	.139	014	.026	.203	-.116	.001	-.188	006	-.089
	Sig. (2-tailed)	.222	.421	.428	.337	.020	.266	.385	.	.081	.000	.310	.463	.011	.629	.473	.353	.902	.473	.941	.895	.292	.547	997	.329	977	773
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	29	29	29	29	29	29	29	29	29	29	29	29	13

Cu	Pearson Correlation	-.152	.693	.692	.156	.127	.094	.001	.324	1.000	.270	.377	.187	.301	-.103	.354	.385	.110	.207	-.081	.050	.042	-.099	-.081	-.088	-.048	-.307
	Sig. (2-tailed)	.421	.000	.000	.410	.505	.622	.998	.081	.	.150	.040	.322	.144	.596	.059	.039	.570	.282	.674	.796	.827	.610	.677	.651	.804	.308
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	29	29	29	29	29	29	29	29	29	29	29	29	13
Fe	Pearson Correlation	-.302	.028	.031	.145	.032	.095	-.147	.623	.270	1.000	.085	.144	-.173	-.332	.206	.250	.201	.361	-.042	.192	.363	-.023	.364	-.128	-.111	-.195
	Sig. (2-tailed)	.105	.884	.870	.444	.866	.618	.437	.000	.150	.	.654	.449	.409	.078	.283	.191	.295	.054	.827	.319	.053	.904	.052	.510	.566	.524
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	29	29	29	29	29	29	29	29	29	29	29	29	13
Zn	Pearson Correlation	-.045	.367	.357	-.111	.161	.179	-.017	.192	.377	.085	1.000	.110	.170	.069	.267	.303	.111	.085	.117	.236	-.095	-.140	-.231	-.020	-.145	-.115
	Sig. (2-tailed)	.814	.046	.053	.559	.396	.344	.927	.310	.040	.654	.	.563	.416	.721	.161	.110	.568	.660	.546	.219	.623	.467	.227	.918	.452	.708
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	29	29	29	29	29	29	29	29	29	29	29	29	13
Na %	Pearson Correlation	.085	-.114	-.114	.159	.697	.856	-.182	.139	.187	.144	.110	1.000	.142	-.464	.268	.279	.144	-.111	-.256	-.005	.394	-.155	.020	-.077	.034	-.014
	Sig. (2-tailed)	.656	.550	.549	.401	.000	.000	.335	.463	.322	.449	.563	.	.497	.011	.159	.143	.457	.565	.180	.981	.035	.423	.918	.690	.859	.963
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	29	29	29	29	29	29	29	29	29	29	29	29	13
Ec mS/cm	Pearson Correlation	-.100	.261	.251	.414	.604	.170	-.190	.498	.301	-.173	.170	.142	1.000	.101	.125	.130	-.051	-.273	.114	-.067	-.040	-.149	-.008	-.111	-.207	.034
	Sig. (2-tailed)	.635	.207	.226	.040	.001	.417	.363	.011	.144	.409	.416	.497	.	.639	.561	.544	.812	.197	.594	.756	.852	.486	.971	.607	.331	.917
	N	25	25	25	25	25	25	25	25	25	25	25	25	25	24	24	24	24	24	24	24	24	24	24	24	24	12
Ph soil	Pearson Correlation	.089	.099	.093	-.120	-.209	-.380	.088	-.094	-.103	-.332	.069	-.464	.101	1.000	-.328	-.327	-.428	-.118	.450	-.113	-.439	.072	-.393	-.014	.048	-.132
	Sig. (2-tailed)	.645	.611	.633	.537	.276	.042	.651	.629	.596	.078	.721	.011	.639	.	.077	.078	.018	.534	.013	.553	.015	.704	.031	.943	.800	.668
	N	29	29	29	29	29	29	29	29	29	29	29	29	24	30	30	30	30	30	30	30	30	30	30	30	30	13
N% soil	Pearson Correlation	-.094	.345	.331	-.039	.168	.260	-.334	.139	.354	.206	.267	.268	.125	-.328	1.000	.995	.279	-.006	-.029	.094	.433	.268	.147	.460	-.162	.213
	Sig. (2-tailed)	.628	.067	.080	.840	.384	.173	.076	.473	.059	.283	.161	.159	.561	.077	.	.000	.135	.976	.879	.621	.017	.152	.437	.010	.392	.485
	N	29	29	29	29	29	29	29	29	29	29	29	29	24	30	30	30	30	30	30	30	30	30	30	30	30	13
OC% soil	Pearson Correlation	-.084	.361	.345	-.034	.172	.271	-.326	.179	.385	.250	.303	.279	.130	-.327	.995	1.000	.276	.035	-.018	.117	.444	.262	.135	.448	-.132	.217
	Sig. (2-tailed)	.667	.054	.067	.861	.373	.155	.084	.353	.039	.191	.110	.143	.544	.078	.000	.	.139	.855	.926	.537	.014	.163	.478	.013	.488	.477
	N	29	29	29	29	29	29	29	29	29	29	29	29	24	30	30	30	30	30	30	30	30	30	30	30	30	13
P% soil	Pearson Correlation	.115	-.022	-.004	-.155	.050	.046	-.167	-.024	.110	.201	.111	.144	-.051	-.428	.279	.276	1.000	.112	-.228	.182	.117	-.139	.177	.022	-.174	.042
	Sig. (2-tailed)	.553	.908	.983	.423	.796	.811	.387	.902	.570	.295	.568	.457	.812	.018	.135	.139	.	.555	.225	.335	.538	.463	.349	.906	.359	.892
	N	29	29	29	29	29	29	29	29	29	29	29	29	24	30	30	30	30	30	30	30	30	30	30	30	30	13
K% soil	Pearson Correlation	-.099	.281	.273	.083	-.179	-.059	-.083	.139	.207	.361	.085	-.111	-.273	-.118	-.006	.035	.112	1.000	.378	.311	.144	-.098	.218	-.065	.392	-.166
	Sig. (2-tailed)	.609	.140	.152	.667	.352	.761	.669	.473	.282	.054	.660	.565	.197	.534	.976	.855	.555	.	.040	.094	.448	.605	.247	.731	.032	.588
	N	29	29	29	29	29	29	29	29	29	29	29	29	24	30	30	30	30	30	30	30	30	30	30	30	30	13

Ca% soil	Pearson Correlation	-.008	.176	.168	-.005	-.092	-.144	-.019	.014	-.081	-.042	.117	-.256	.114	.450	-.029	-.018	-.228	.378	1.000	.474	-.125	.004	.074	-.036	.197	.727
	Sig. (2-tailed)	.968	.361	.382	.981	.636	.456	.924	.941	.674	.827	.546	.180	.594	.013	.879	.926	.225	.040	.	.008	.509	.983	.699	.850	.296	.005
	N	29	29	29	29	29	29	29	29	29	29	29	29	24	30	30	30	30	30	30	30	30	30	30	30	30	13
Mg % soil	Pearson Correlation	.325	.083	.062	-.281	-.148	.026	-.075	.026	.050	.192	.236	-.005	-.067	-.113	.094	.117	.182	.311	.474	1.000	-.024	-.299	.149	-.201	.113	.613
	Sig. (2-tailed)	.086	.667	.751	.140	.443	.893	.698	.895	.796	.319	.219	.981	.756	.553	.621	.537	.335	.094	.008	.	.899	.108	.430	.286	.551	.026
	N	29	29	29	29	29	29	29	29	29	29	29	29	24	30	30	30	30	30	30	30	30	30	30	30	30	13
Mn% soil	Pearson Correlation	-.208	-.069	-.087	.082	.256	.433	-.289	.203	.042	.363	-.095	.394	-.040	-.439	.433	.444	.117	.144	-.125	-.024	1.000	.447	.359	.452	.037	-.033
	Sig. (2-tailed)	.279	.722	.652	.673	.180	.019	.129	.292	.827	.053	.623	.035	.852	.015	.017	.014	.538	.448	.509	.899	.	.013	.051	.012	.847	.914
	N	29	29	29	29	29	29	29	29	29	29	29	29	24	30	30	30	30	30	30	30	30	30	30	30	30	13
Cu soil	Pearson Correlation	-.016	-.100	-.111	-.113	-.135	-.130	-.116	-.116	-.099	-.023	-.140	-.155	-.149	.072	.268	.262	-.139	-.098	.004	-.299	.447	1.000	.210	.919	.072	-.019
	Sig. (2-tailed)	.934	.604	.567	.561	.486	.501	.550	.547	.610	.904	.467	.423	.486	.704	.152	.163	.463	.605	.983	.108	.013	.	.266	.000	.705	.950
	N	29	29	29	29	29	29	29	29	29	29	29	29	24	30	30	30	30	30	30	30	30	30	30	30	30	13
Fe soil	Pearson Correlation	-.129	-.078	-.069	-.068	-.103	-.043	-.145	.001	-.081	.364	-.231	.020	-.008	-.393	.147	.135	.177	.218	.074	.149	.359	.210	1.000	.190	-.162	-.006
	Sig. (2-tailed)	.506	.689	.723	.726	.596	.827	.454	.997	.677	.052	.227	.918	.971	.031	.437	.478	.349	.247	.699	.430	.051	.266	.	.315	.392	.983
	N	29	29	29	29	29	29	29	29	29	29	29	29	24	30	30	30	30	30	30	30	30	30	30	30	30	13
Zn soil	Pearson Correlation	.075	-.086	-.098	-.142	-.098	-.097	-.188	-.188	-.088	-.128	-.020	-.077	-.111	-.014	.460	.448	.022	-.065	-.036	-.201	.452	.919	.190	1.000	.069	-.046
	Sig. (2-tailed)	.698	.659	.614	.462	.614	.618	.329	.329	.651	.510	.918	.690	.607	.943	.010	.013	.906	.731	.850	.286	.012	.000	.315	.	.719	.882
	N	29	29	29	29	29	29	29	29	29	29	29	29	24	30	30	30	30	30	30	30	30	30	30	30	30	13
Na % soil	Pearson Correlation	.135	.108	.108	.192	-.025	.004	-.025	.006	-.048	-.111	-.145	.034	-.207	.048	-.162	-.132	-.174	.392	.197	.113	.037	.072	-.162	.069	1.000	.351
	Sig. (2-tailed)	.485	.575	.577	.318	.896	.982	.896	.977	.804	.566	.452	.859	.331	.800	.392	.488	.359	.032	.296	.551	.847	.705	.392	.719	.	.239
	N	29	29	29	29	29	29	29	29	29	29	29	29	24	30	30	30	30	30	30	30	30	30	30	30	30	13
Ec mS/cm soil	Pearson Correlation	.368	.012	.009	-.120	-.073	-.033	-.218	-.089	-.307	-.195	-.115	-.014	.034	-.132	.213	.217	.042	-.166	.727	.613	-.033	-.019	-.006	-.046	.351	1.000
	Sig. (2-tailed)	.215	.968	.977	.695	.812	.915	.475	.773	.308	.524	.708	.963	.917	.668	.485	.477	.892	.588	.005	.026	.914	.950	.983	.882	.239	.
	N	13	13	13	13	13	13	13	13	13	13	13	13	12	13	13	13	13	13	13	13	13	13	13	13	13	13

ANNEX 4.2

Table 4.2.1A: Wet seasons phosphate concentrations

	TRP	THP	TP
MUHURU BAY	1.06	nd	2.22
SORI	2.27	nd	2.95
MBITA MAIN LAKE	1.21	nd	3.75
W. GULF	1.58	nd	3.09
HOMABAY LAKE	2.05	nd	1.62
KENDUBAY	2.27	0.97	1.41
KUSA	3.17	nd	2.80
DUNGA BEACH	1.51	nd	4.37
HIPPO POINT	1.05	0.25	7.00
CAR WASH	1.39	0.80	5.34
LUANDA	1.49	nd	1.52
MISORI	0.90	0.58	4.52
USENGE	1.41	0.25	3.40
PORT VICTORIA	1.26	0.67	5.86
SIO PORT	1.19	0.83	4.88
R. KUJA	1.32	0.43	2.95
R. AWACH	1.70	nd	1.52
R. SONDU MIRIU	1.73	0.26	0.45
R. NYANDO	2.05	nd	3.13
R. NYAMASARIA	1.85	nd	1.59
R. KISIAN	1.05	nd	6.51
R. MUGRUK	0.92	1.96	4.52
R. AWACH SEME	2.10	1.79	2.42
R. YALA	1.64	nd	6.12
R. NZOIA	1.01	0.56	6.44
R. SIO	1.14	1.97	5.33
HOMABAY SEWAGE	18.14	3.37	21.51
HOMABAY DISCHARGE A	2.44	nd	1.59
NYALENDA	1.14	2.27	5.43
KWASCO	1.39	0.45	8.08
KISATI	5.24	0.14	10.10
SAKA	1.73	0.02	5.24

Table 4.2.2A: Phosphorus concentration in dry season II

	TRP	THP	TP
MUHURU BAY	nd	0.74	0.95
SORI	0.20	0.87	1.27
MBITA MAIN LAKE	nd	1.02	1.08
W. GULF	nd	0.87	1.00
HOMABAY LAKE	0.57	0.33	1.44
KENDUBAY	0.17	0.80	1.72
KUSA	0.47	0.68	1.42
DUNGA BEACH	0.41	0.55	1.34
HIPPO POINT	0.41	0.48	1.34
CAR WASH	0.75	0.40	1.67
LUANDA	0.37	0.60	1.51
MISORI	0.47	0.49	1.28
USENGE	0.67	0.18	1.34
PORT VICTORIA	0.81	0.22	1.33
SIO PORT	0.62	0.36	1.62
R. KUJA	0.13	0.58	0.89
R. AWACH	0.09	0.84	1.22
R. SONDU MIRIU	0.52	0.37	1.89
R. NYANDO	0.88	0.49	1.78
R. NYAMASARIA	nd	1.06	0.78
R. KISIAN	0.45	0.29	1.25
R. MUGRUK	0.75	0.10	1.59
R. AWACH SEME	0.15	0.59	1.17
R. YALA	0.78	0.30	1.40
R. NZOIA	0.25	0.68	1.17
R. SIO	0.18	0.66	1.17
HOMABAY SEWAGE	15.48	3.83	21.37
HOMABAY DISCHARGE A	1.26	0.31	2.32
NYALENDA	nd	1.02	1.16
KWASCO	0.37	0.60	1.99
KISATI	7.69	2.45	12.40
SAKA	3.80	-0.08	4.62

Table 4.2.3A: Phosphorus Concentration in Short rain season

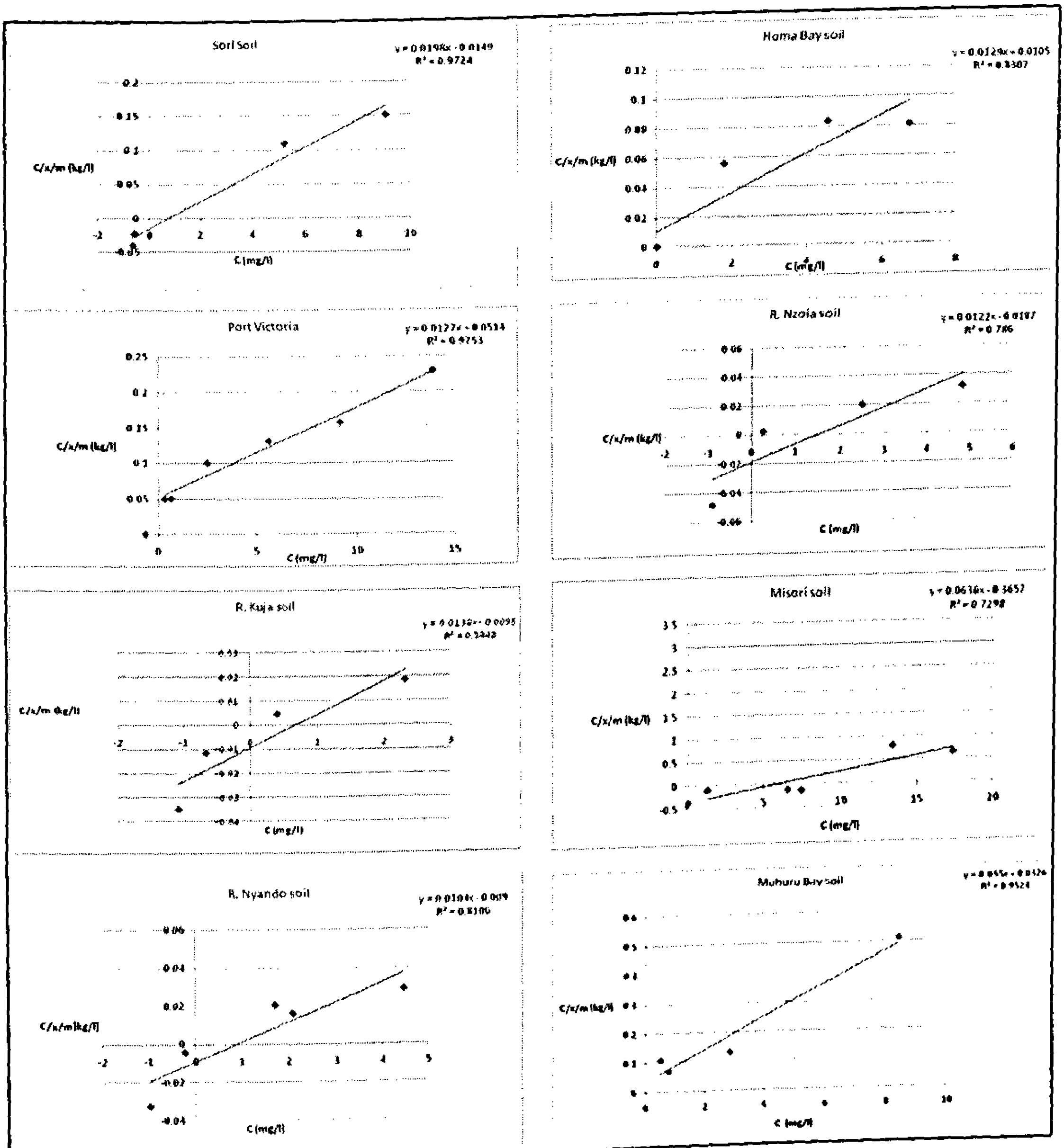
	TRP	THP	TP
MUHURU BAY	1.40	0.18	1.35
SORI	1.80	0.39	2.69
MBITA MAIN LAKE	1.99	nd	2.03
MBITA W. GULF	1.58	0.38	4.66
HOMABAY LAKE	1.95	0.63	2.36
KENDUBAY	1.54	nd	2.74
KUSA	1.65	0.41	2.20
DUNGA BEACH	1.27	0.11	1.97
HIPPO POINT	1.06	0.12	1.66
CAR WASH	1.20	0.04	2.12
LUANDA	1.80	0.52	2.36
MISORI	1.73	nd	2.69
USENGE	0.99	nd	1.51
PORT VICTORIA	1.08	0.16	1.35
SIO PORT	0.94	nd	1.51
R. KUJA	1.33	nd	1.51
R. AWACH	1.58	0.08	4.49
R. SONDU MIRIU	2.21	0.88	2.36
R. NYANDO	2.21	0.77	3.02
R. NYAMASARIA	0.99	nd	1.51
R. KISIAN	0.91	nd	2.43
R. MUGRUK	1.73	nd	2.69
R. AWACH SEME	1.73	nd	2.36
R. YALA	0.84	nd	1.51
R. NZOIA	0.89	nd	1.51
R. SIO	0.84	nd	1.35
HOMABAY SEWAGE	20.04	7.71	33.03
HOMABAY DISCHARGE A	2.11	0.63	3.02
NYALENDA	1.06	nd	1.82
KWASCO	0.84	nd	1.97
KISATI	3.18	nd	6.28
SAKA	4.77	nd	5.66

Table 4.2.4A: Phosphorus concentration in dry season I

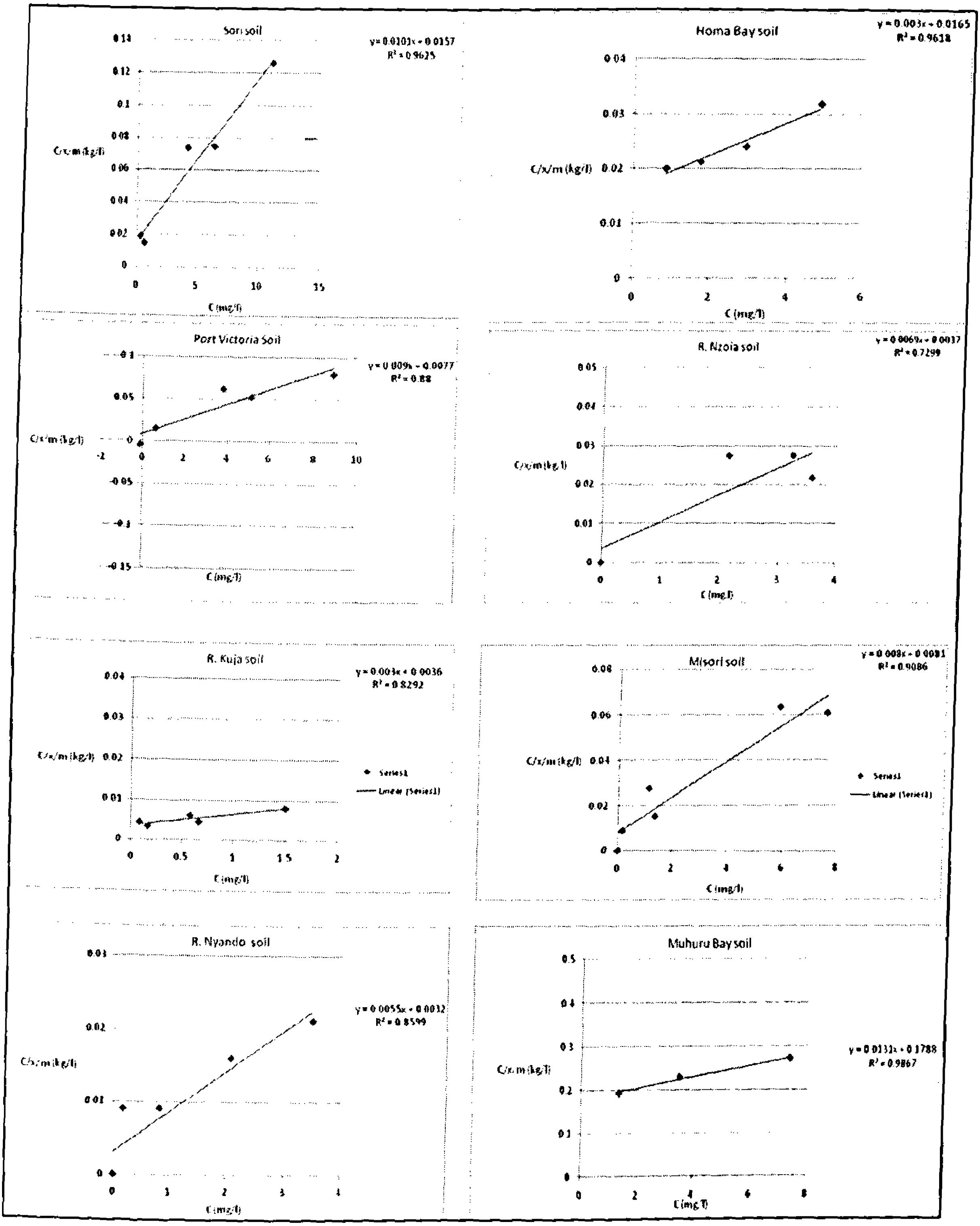
	TRP	THP	TP
MUHURU BAY	1.02	nd	1.27
SORI	1.02	nd	1.37
MBITA MAIN LAKE	0.93	0.88	1.30
MBITA W. GULF	0.78	0.04	1.65
HOMABAY LAKE	1.07	0.05	1.58
KENDUBAY	1.07	0.00	2.02
KUSA	1.07	nd	1.37
DUNGA BEACH	0.93	0.19	1.30
HIPPO POINT	0.78	0.19	1.30
CAR WASH	1.22	0.11	1.74
LUANDA	0.88	0.04	1.27
MISORI	0.88	nd	1.18
USENGE	1.07	nd	1.13
PORT VICTORIA	0.83	nd	1.08
SIO PORT	0.93	nd	0.94
R. KUJA	0.78	0.29	1.46
R. AWACH	0.86	nd	1.08
R. SONDU MIRIU	1.07	0.55	1.15
R. NYANDO	1.07	nd	1.69
R. NYAMASARIA	1.07	0.12	1.30
R. KISIAN	0.78	0.11	1.15
R. MUGRUK	0.78	nd	1.23
R. AWACH SEME	1.94	nd	1.97
R. YALA	0.98	nd	1.04
R. NZOIA	0.73	nd	1.08
R. SIO	0.83	nd	1.41
HOMABAY SEWAGE	19.62	nd	20.28
HOMABAY DISCHARGE A	1.07	5.48	11.88
NYALENDA	1.02	nd	1.41
KWASCO	1.51	0.60	2.99
KISATI	1.14	0.28	0.94
SAKA	0.71	0.03	1.30

ANNEX 4.3

PHOSPHORUS ADSORPTION ISOTHERMS



Fugure 4.3.1A: Langmuir phosphorus adsorption isotherms for non-amended soils



Fugure 4.3.2A: Langmuir phosphorus adsorption isotherms for amended soils

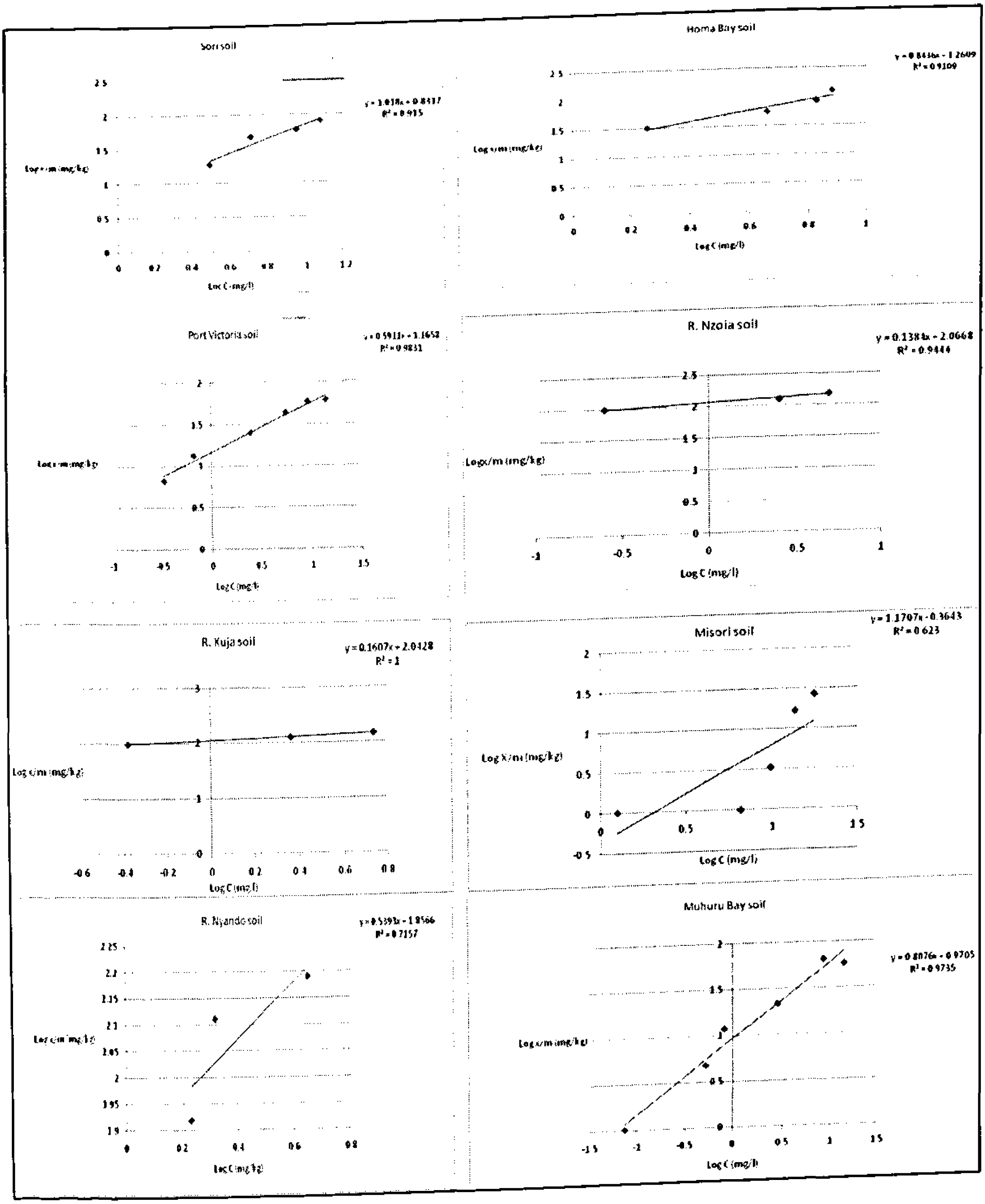


Figure 4.3.3A: Freundlich phosphorus adsorption isotherms for non-amended soils

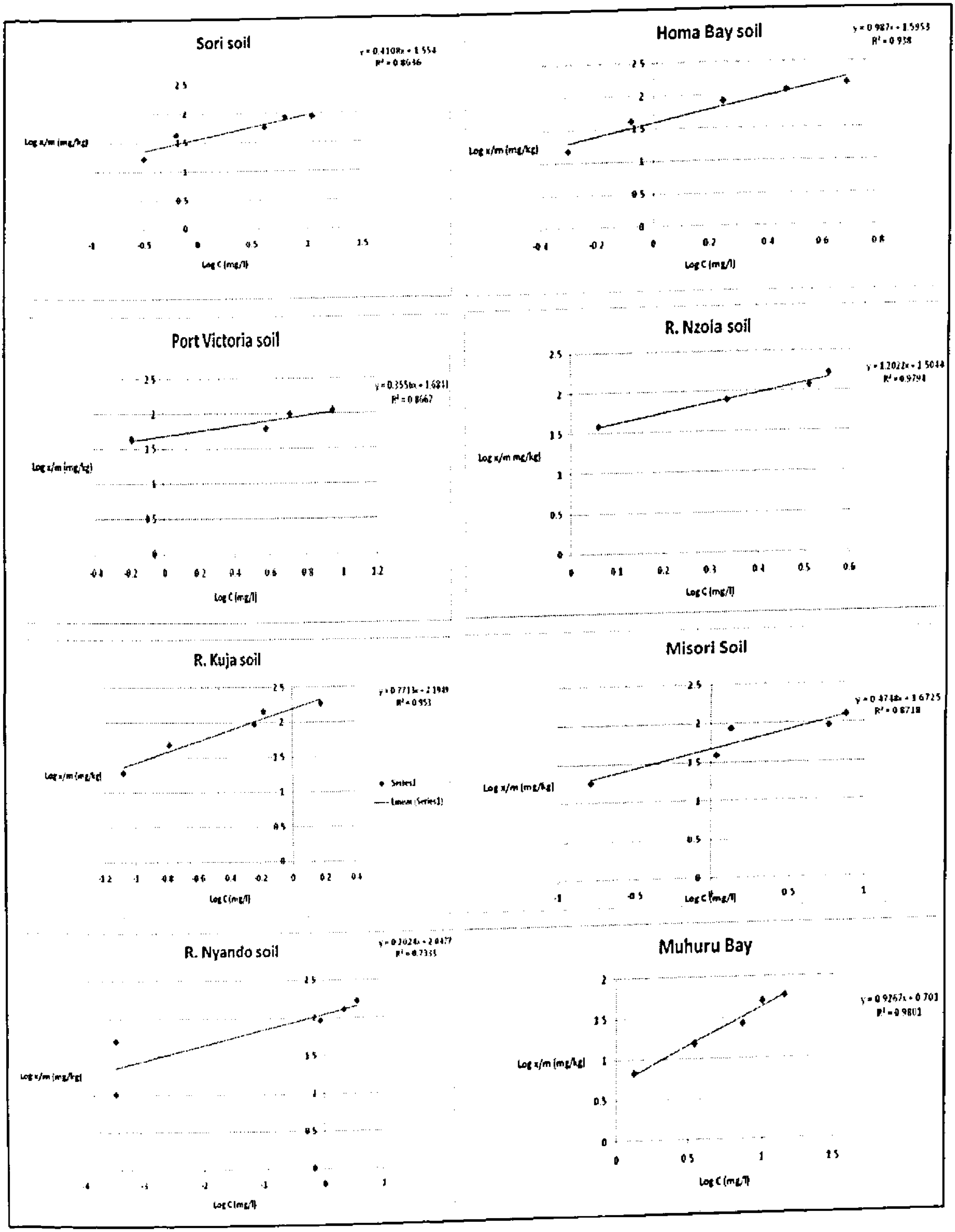


Figure 4.3.4A: Freundlich phosphorus adsorption isotherms for compost amended soils

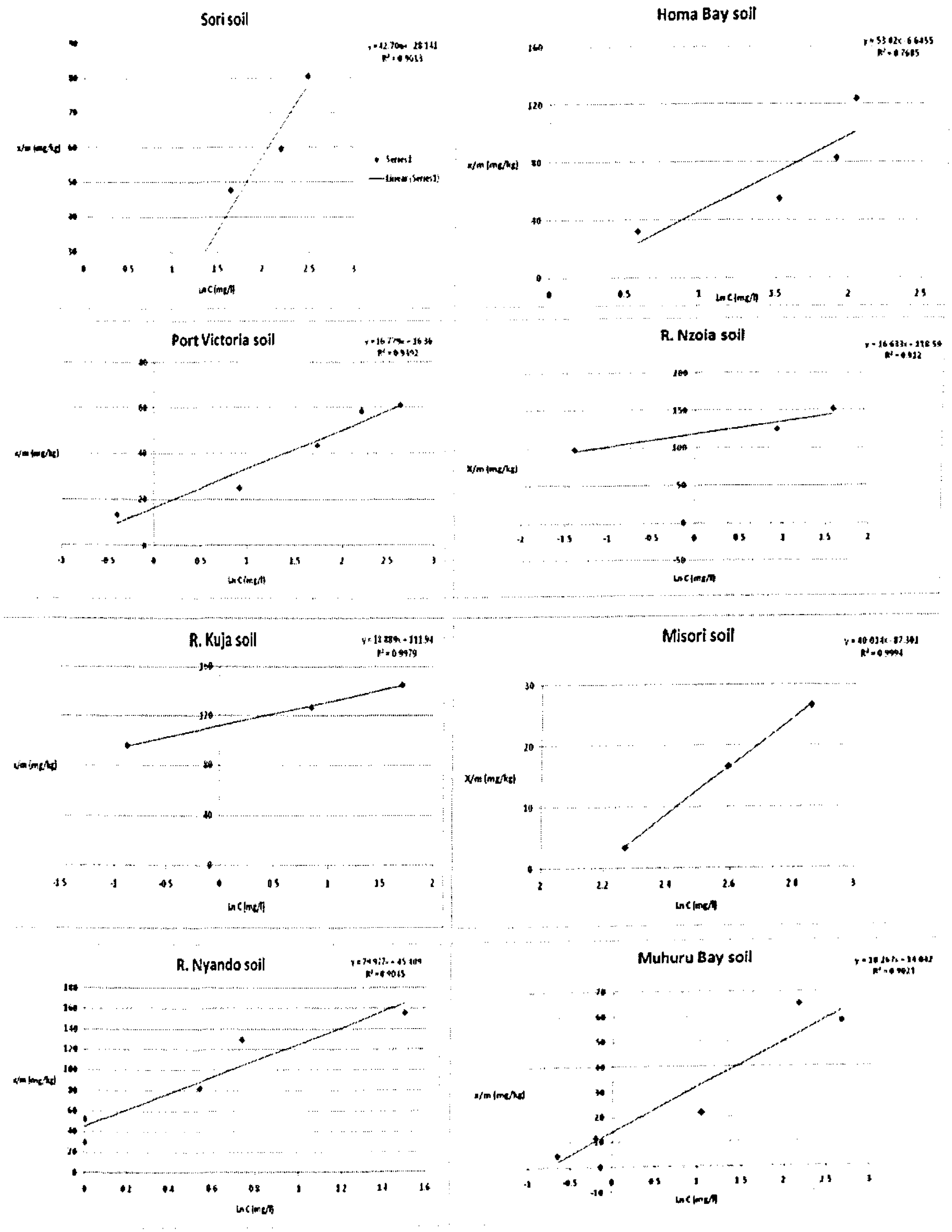


Figure 4.3.5A: Temkin phosphorus adsorption isotherms for non-amended soils

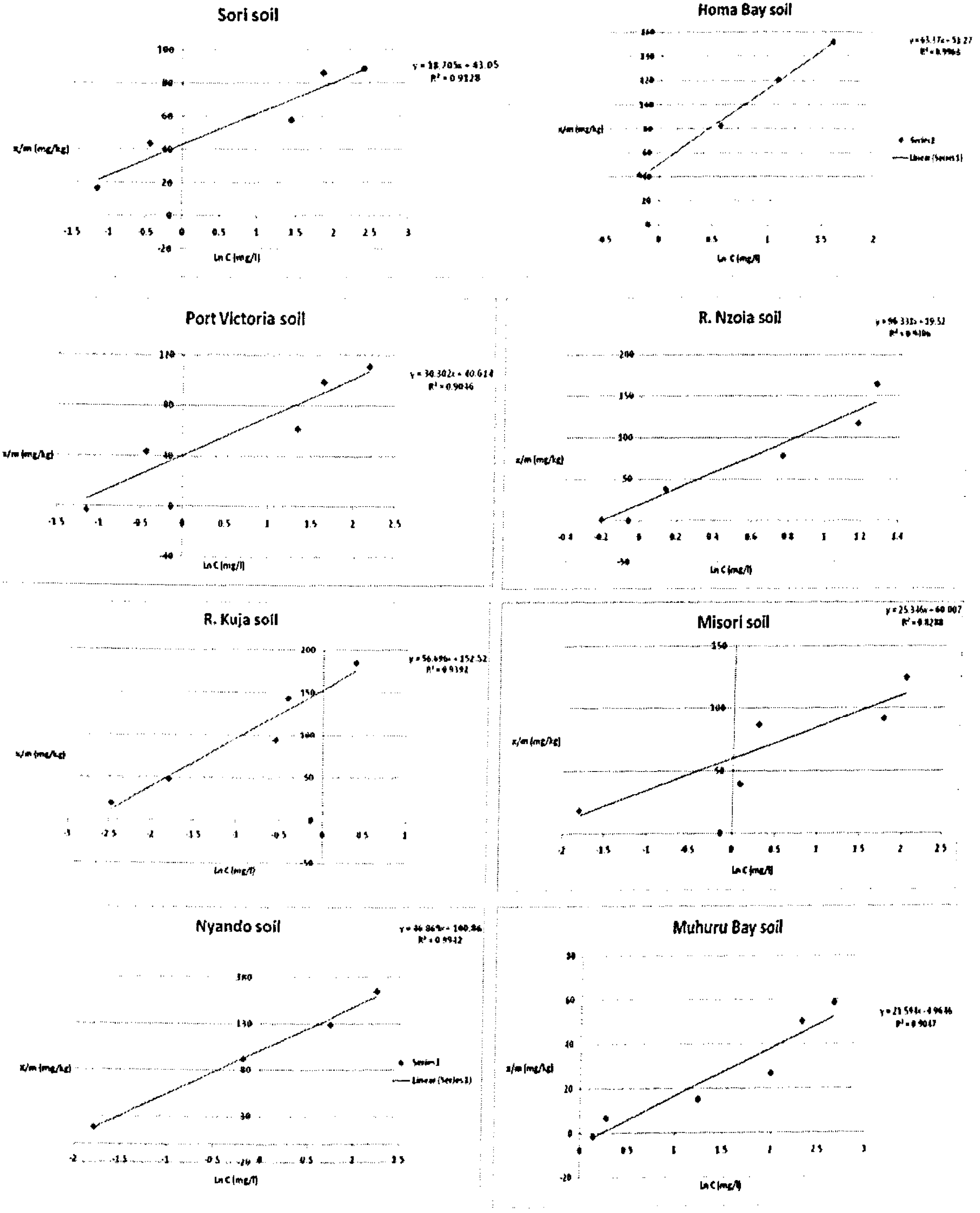


Figure 4.3.6A: Temkin phosphorus adsorption isotherms for compost amended soils

Table 4.3.1A: Pearson correlation coefficient between the Langmuir, Freundlich and Temkin constants for non-amended soils

Correlations

		LB	LK	FK	FB	TK	KB
LB	Pearson Correlation	1	-.273	.602	-.661	.076	.301
	Sig. (2-tailed)		.514	.115	.074	.858	.469
	N	8	8	8	8	8	8
LK	Pearson Correlation	-.273	1	-.290	.121	-.354	-.332
	Sig. (2-tailed)	.514		.486	.775	.389	.422
	N	8	8	8	8	8	8
FK	Pearson Correlation	.602	-.290	1	-.925**	.741*	-.111
	Sig. (2-tailed)	.115	.486		.001	.035	.793
	N	8	8	8	8	8	8
FB	Pearson Correlation	-.661	.121	-.925**	1	-.547	.313
	Sig. (2-tailed)	.074	.775	.001		.161	.451
	N	8	8	8	8	8	8
TK	Pearson Correlation	.076	-.354	.741*	-.547	1	-.263
	Sig. (2-tailed)	.858	.389	.035	.161		.529
	N	8	8	8	8	8	8
KB	Pearson Correlation	.301	-.332	-.111	.313	-.263	1
	Sig. (2-tailed)	.469	.422	.793	.451	.529	
	N	8	8	8	8	8	8

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 4.3.2A : Pearson correlation coefficient between the Langmuir, Freundlich and Temkin constants for amended soils

Correlations							
		LB	LK	FK	FB	TK	KB
LB	Pearson Correlation	1	.019	.815*	.182	.839**	.481
	Sig. (2-tailed)		.965	.014	.667	.009	.227
	N	8	8	8	8	8	8
LK	Pearson Correlation	.019	1	.317	-.225	.216	.474
	Sig. (2-tailed)	.965		.444	.592	.607	.235
	N	8	8	8	8	8	8
FK	Pearson Correlation	.815*	.317	1	-.309	.977**	.190
	Sig. (2-tailed)	.014	.444		.456	.000	.651
	N	8	8	8	8	8	8
FB	Pearson Correlation	.182	-.225	-.309	1	-.335	.642
	Sig. (2-tailed)	.667	.592	.456		.418	.086
	N	8	8	8	8	8	8
TK	Pearson Correlation	.839**	.216	.977**	-.335	1	.128
	Sig. (2-tailed)	.009	.607	.000	.418		.762
	N	8	8	8	8	8	8
KB	Pearson Correlation	.481	.474	.190	.642	.128	1
	Sig. (2-tailed)	.227	.235	.651	.086	.762	
	N	8	8	8	8	8	8

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

ANNEX 4.4

PESTICIDE RESIDUES IN WATER, SOIL AND SEDIMENTS

Table 4.4.1A: Mean pesticide concentrations in water from Lake Victoria Basin (ng/l)

Dieldrin	Dry season 1	±sd	Wet seaon	±sd	Dry season 2	±sd	Short rain	±sd	max	min	mean	median	sum
MUHURUBAY	2.43	0.23	4.72	0.06	3.57	0.56	3.87	0.05	4.72	2.43	3.65	3.72	14.59
SORI	3.29	0.43	6.64	0.83	3.60	0.82	1.09	0.00	6.64	1.09	3.65	3.44	14.61
MBITA LHSD	3.79	0.99	2.38	0.07	4.98	0.04	4.55	0.47	4.98	2.38	3.93	4.17	15.70
MBITA WG	3.12	0.84	4.50	0.24	4.13	0.46	2.62	0.36	4.50	2.62	3.59	3.63	14.38
HOMABAY	2.44	0.35	6.81	0.04	2.62	0.08	5.44	0.77	6.81	2.44	4.33	4.03	17.30
KENDUBAY	2.98	0.45	13.92	0.04	3.55	1.11	2.64	0.06	13.92	2.64	5.77	3.27	23.09
KUSA	2.44	0.03	4.55	0.14	5.87	0.43	2.76	0.16	5.87	2.44	3.91	3.66	15.63
DUNGA BEACH	2.15	0.47	3.34	1.01	3.17	0.32	2.38	0.26	3.34	2.15	2.76	2.77	11.03
HIPPOPOINT	2.56	0.39	17.20	0.11	2.92	0.05	2.63	0.18	17.20	2.56	6.33	2.78	25.32
RAILWAYS	2.84	0.17	5.82	0.05	4.13	0.44	4.33	0.29	5.82	2.84	4.28	4.23	17.13
LUANDA	3.05	0.57	5.21	0.03	4.22	0.11	2.38	0.10	5.21	2.38	3.72	3.64	14.87
MISORI	2.58	0.39	2.76	0.67	2.96	0.59	2.41	0.06	2.96	2.41	2.68	2.67	10.71
USENGE	3.44	0.68	6.59	0.22	4.61	0.48	3.00	0.35	6.59	3.00	4.41	4.02	17.64
PORT VICTORIA	2.70	0.91	5.48	0.04	3.90	0.77	4.04	0.82	5.48	2.70	4.03	3.97	16.12
SIO PORT	4.47	0.79	3.39	0.81	3.23	0.62	3.08	0.67	4.47	3.08	3.54	3.31	14.17
R. KUJA	3.52	0.21	5.32	0.91	3.51	0.51	5.33	0.81	5.33	3.51	4.42	4.42	17.68
R. AWACH	5.59	0.71	5.18	0.11	4.14	0.66	3.21	0.95	5.59	3.21	4.53	4.66	18.12
R. SONDU	2.15	0.26	3.84	0.57	4.52	0.80	2.56	0.68	4.52	2.15	3.27	3.20	13.08
R. NYANDO	2.08	0.53	7.03	0.03	4.80	0.29	3.47	0.03	7.03	2.08	4.34	4.14	17.38
R. NYAMASARIA	3.07	0.18	3.74	0.91	3.34	0.48	2.84	0.48	3.74	2.84	3.25	3.21	12.99
R. KISIAN	4.69	0.30	5.11	0.98	4.16	0.74	2.91	0.32	5.11	2.91	4.22	4.42	16.86
R. MUGRUK	4.19	0.63	4.34	0.16	3.08	0.34	4.60	0.72	4.60	3.08	4.06	4.27	16.22

R. AWACH SEME	3.11	0.71	11.77	0.31	3.06	0.53	3.81	0.82	11.77	3.06	5.44	3.46	21.74
R. YALA	3.38	1.61	4.50	0.10	2.08	0.53	2.62	0.31	4.50	2.08	3.14	3.00	12.57
R. NZOIA	3.49	0.49	4.55	0.02	3.55	0.62	2.94	0.09	4.55	2.94	3.63	3.52	14.52
R. SIO	4.01	1.27	7.55	0.02	3.27	0.45	2.34	0.10	7.55	2.34	4.29	3.64	17.18
HOMABAY S.E.	0.00	0.00	12.57	0.43	5.57	0.73	2.17	0.10	12.57	0.00	5.08	3.87	20.32
HOMA BAY DISCHARGE	2.83	0.55	9.50	0.09	3.24	0.18	4.97	0.17	9.50	2.83	5.13	4.10	20.54
NYALENDA	4.32	0.47	3.05	0.08	4.03	0.35	2.54	0.21	4.32	2.54	3.49	3.54	13.94
KWASCO	2.90	0.27	7.64	0.20	4.98	0.13	2.81	0.09	7.64	2.81	4.58	3.94	18.34
KISATI	2.34	0.38	8.34	0.61	2.06	0.05	3.25	0.07	8.34	2.06	4.00	2.79	15.98
SAKA	2.33	0.71	3.83	0.55	3.43	0.01	7.65	0.79	7.65	2.33	4.31	3.63	17.25
MAX	5.59	1.61	17.20	1.01	5.87	1.11	7.65	0.95					
MIN	0.00	0.00	2.38	0.02	2.06	0.01	1.09	0.00					
MEAN	3.07	0.53	6.29	0.33	3.76	0.45	3.35	0.35					
MEDIAN	3.02	0.47	5.19	0.15	3.56	0.47	2.92	0.28					
SUM	98.29	16.96	201.16	10.44	120.29	14.27	107.29	11.35					

***p,p'*-DDE**

	Dry Season 1		Wet Season	std	Dry season 2	std	Short rain	Std	max	min	mean	median	sum
MUHURUBAY	3.73	0.85	0.00	0.00	3.20	0.29	0.08	0.02	3.73	0.00	1.75	1.64	7.01
SORI	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.01	0.00	0.03
MBITA LHSD	3.50	0.06	1.04	0.06	0.00	0.00	0.76	0.25	3.50	0.00	1.32	0.90	5.29
MBITA WG	3.03	0.13	0.00	0.00	1.42	0.11	0.96	0.15	3.03	0.00	1.35	1.19	5.41
HOMABAY	0.00	0.00	0.00	0.00	0.00	0.00	3.03	0.08	3.03	0.00	0.76	0.00	3.03
KENDUBAY	5.14	0.19	0.66	0.00	0.00	0.00	1.80	0.42	5.14	0.00	1.90	1.23	7.60
KUSA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DUNGA BEACH	0.08	0.01	0.00	0.00	0.01	0.00	6.61	0.53	6.61	0.00	1.68	0.05	6.71
HIPPOPOINT	4.35	0.30	0.00	0.00	0.00	0.00	6.05	0.89	6.05	0.00	2.60	2.18	10.41
RAILWAYS	0.71	0.83	0.00	0.00	0.62	0.11	0.00	0.00	0.71	0.00	0.33	0.31	1.33
LUANDA	63.36	4.75	0.00	0.00	0.00	0.00	0.00	0.00	63.36	0.00	15.84	0.00	63.36
MISORI	6.22	0.31	18.64	0.42	0.56	0.16	0.00	0.00	18.64	0.00	6.35	3.39	25.42
USENGE	0.30	0.36	0.00	0.00	0.21	0.06	1.89	0.19	1.89	0.00	0.60	0.26	2.41
PORT VICTORIA	2.66	0.15	0.94	0.05	4.01	0.32	5.20	0.15	5.20	0.94	3.20	3.34	12.82
SIO PORT	4.85	0.03	0.00	0.00	0.47	0.05	3.71	0.57	4.85	0.00	2.26	2.09	9.02
R. KUJA	9.27	0.21	0.00	0.00	0.47	0.14	0.00	0.00	9.27	0.00	2.43	0.23	9.74

R. AWACH	0.00	0.00	0.00	0.00	2.00	0.13	0.00	0.00	**2.00**	**0.00**	**0.50**	**0.00**	**2.00**
R. SONDU	5.34	0.11	0.17	0.16	0.92	0.09	0.15	0.03	**5.34**	**0.15**	**1.65**	**0.55**	**6.59**
R. NYANDO	10.11	0.62	6.57	0.04	4.20	0.78	2.50	0.10	**10.11**	**2.50**	**5.85**	**5.39**	**23.39**
R. NYAMASARIA	0.08	0.01	0.00	0.00	1.17	0.03	2.43	0.03	**2.43**	**0.00**	**0.92**	**0.62**	**3.68**
R. KISIAN	4.27	0.53	0.57	0.01	0.81	0.07	0.00	0.00	**4.27**	**0.00**	**1.41**	**0.69**	**5.66**
R. MUGRUK	4.02	0.09	0.00	0.00	3.87	0.32	0.00	0.00	**4.02**	**0.00**	**1.97**	**1.94**	**7.89**
R. AWACH SEME	1.80	0.13	0.00	0.00	0.73	0.05	4.32	0.05	**4.32**	**0.00**	**1.71**	**1.26**	**6.84**
R. YALA	10.05	0.24	0.00	0.00	0.36	0.29	3.62	0.06	**10.05**	**0.00**	**3.50**	**1.99**	**14.02**
R. NZOIA	0.00	0.00	0.00	0.00	1.49	0.10	0.00	0.00	**1.49**	**0.00**	**0.37**	**0.00**	**1.49**
R. SIO	1.70	0.89	0.00	0.00	3.31	0.36	3.81	0.13	**3.81**	**0.00**	**2.20**	**2.50**	**8.82**
HOMABAY S.E.	11.61	1.17	13.33	1.87	15.32	0.63	4.94	0.87	**15.32**	**4.94**	**11.30**	**12.47**	**45.19**
HOMA BAY DISCHARGE	0.00	0.00	0.00	0.00	3.16	0.11	0.80	0.13	**3.16**	**0.00**	**0.99**	**0.40**	**3.96**
NYALENDA	3.22	0.03	7.62	6.62	4.01	0.15	0.00	0.00	**7.62**	**0.00**	**3.71**	**3.62**	**14.85**
KWASCO	0.00	0.00	0.00	0.00	0.16	0.10	0.24	0.09	**0.24**	**0.00**	**0.10**	**0.08**	**0.40**
KISATI	3.84	0.09	0.00	0.00	0.53	0.05	4.49	0.84	**4.49**	**0.00**	**2.21**	**2.18**	**8.85**
SAKA	3.38	0.10	0.00	0.00	0.91	0.13	1.37	0.79	**3.38**	**0.00**	**1.42**	**1.14**	**5.66**
MAX	63.36	4.75	18.64	6.62	15.32	0.78	6.61	0.89					
MIN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
MEAN	5.21	0.38	1.55	0.29	1.69	0.14	1.84	0.20					
MEDIAN	3.30	0.12	0.00	0.00	0.67	0.10	0.88	0.07					
SUM	166.65	12.19	49.55	9.22	53.93	4.63	58.74	6.37					

Endosulphan 1													
	Dry Season 1		Wet Season	std	Dry season 2	std	Short rain	Std	**max**	**min**	**mean**	**median**	**sum**
MUHURUBAY	3.16	0.66	0.00	0.00	1.16	0.32	2.17	0.37	**3.16**	**0.00**	**1.62**	**1.67**	**6.49**
SORI	1.05	0.12	1.00	0.04	1.34	0.27	0.55	0.14	**1.34**	**0.55**	**0.98**	**1.02**	**3.93**
MBITA LHSD	3.88	0.34	1.01	0.14	2.18	0.08	1.53	0.50	**3.88**	**1.01**	**2.15**	**1.85**	**8.59**
MBITA WG	2.27	0.58	1.51	0.67	1.21	0.20	1.32	0.62	**2.27**	**1.21**	**1.58**	**1.41**	**6.32**
HOMABAY	0.96	0.11	1.57	0.07	1.14	0.14	5.56	0.03	**5.56**	**0.96**	**2.31**	**1.35**	**9.22**
KENDUBAY	5.54	0.16	1.29	0.46	1.88	0.34	1.89	0.81	**5.54**	**1.29**	**2.65**	**1.89**	**10.61**
KUSA	1.12	0.26	0.00	0.00	1.59	0.50	0.00	0.00	**1.59**	**0.00**	**0.68**	**0.56**	**2.70**
DUNGA BEACH	0.90	0.27	1.27	0.55	1.22	0.21	0.88	0.19	**1.27**	**0.88**	**1.07**	**1.06**	**4.27**
HIPPOPOINT	2.98	0.13	0.98	0.04	1.73	0.98	1.31	0.42	**2.98**	**0.98**	**1.75**	**1.52**	**7.00**

RAILWAYS	0.96	0.06	0.90	0.13	1.34	0.05	5.42	0.73	**5.42**	**0.90**	**2.15**	**1.15**	**8.61**
LUANDA	0.98	0.07	0.99	0.16	1.54	0.16	0.98	0.29	**1.54**	**0.98**	**1.12**	**0.99**	**4.49**
MISORI	0.96	0.22	3.58	0.18	1.07	0.33	1.11	0.18	**3.58**	**0.96**	**1.68**	**1.09**	**6.72**
USENGE	1.18	0.24	1.10	0.32	1.62	0.12	1.89	0.95	**1.89**	**1.10**	**1.45**	**1.40**	**5.79**
PORT VICTORIA	0.91	0.18	1.20	0.10	1.58	0.43	1.94	0.54	**1.94**	**0.91**	**1.41**	**1.39**	**5.63**
SIO PORT	4.23	0.19	0.87	0.14	1.18	0.17	11.02	1.01	**11.02**	**0.87**	**4.32**	**2.70**	**17.29**
R. KUJA	4.46	0.37	1.03	0.24	1.67	0.43	0.88	0.02	**4.46**	**0.88**	**2.01**	**1.35**	**8.04**
R. AWACH	1.39	0.21	6.11	0.76	1.07	0.96	0.63	0.63	**6.11**	**0.63**	**2.30**	**1.23**	**9.19**
R. SONDU	0.84	0.15	1.11	0.16	1.71	0.55	1.02	0.33	**1.71**	**0.84**	**1.17**	**1.06**	**4.68**
R. NYANDO	0.83	0.15	1.09	0.15	1.64	0.49	1.03	0.81	**1.64**	**0.83**	**1.15**	**1.06**	**4.60**
R. NYAMASARIA	0.99	0.20	1.19	0.18	1.91	1.04	1.01	0.37	**1.91**	**0.99**	**1.28**	**1.10**	**5.10**
R. KISIAN	2.37	0.02	1.75	0.14	1.43	0.00	1.09	0.16	**2.37**	**1.09**	**1.66**	**1.59**	**6.64**
R. MUGRUK	6.01	0.28	1.60	0.07	1.47	0.94	1.24	0.18	**6.01**	**1.24**	**2.58**	**1.54**	**10.32**
R. AWACH SEME	2.14	0.09	1.31	0.16	1.21	0.22	1.01	0.19	**2.14**	**1.01**	**1.42**	**1.26**	**5.67**
R. YALA	9.87	0.32	1.59	0.82	0.86	0.33	2.35	1.31	**9.87**	**0.86**	**3.67**	**1.97**	**14.67**
R. NZOIA	1.13	0.17	0.81	0.50	1.45	0.02	2.06	0.18	**2.06**	**0.81**	**1.36**	**1.29**	**5.45**
R. SIO	1.82	0.68	1.48	0.56	1.18	0.17	1.24	0.76	**1.82**	**1.18**	**1.43**	**1.36**	**5.73**
HOMABAY S.E.	7.49	0.85	5.89	0.29	1.54	0.77	15.46	0.99	**15.46**	**1.54**	**7.60**	**6.69**	**30.39**
HOMA BAY DISCHARGE	0.95	0.01	1.40	0.04	0.95	0.11	2.21	0.03	**2.21**	**0.95**	**1.38**	**1.17**	**5.51**
NYALENDA	2.74	0.12	1.16	0.11	2.00	0.94	1.00	0.07	**2.74**	**1.00**	**1.72**	**1.58**	**6.89**
KWASCO	1.11	0.11	3.18	0.17	2.21	0.35	10.96	0.44	**10.96**	**1.11**	**4.36**	**2.69**	**17.45**
KISATI	2.99	0.16	5.64	0.93	0.80	0.10	1.33	0.13	**5.64**	**0.80**	**2.69**	**2.16**	**10.76**
SAKA	0.85	0.20	1.12	0.08	1.34	0.17	1.08	0.34	**1.34**	**0.85**	**1.10**	**1.10**	**4.39**
MAX	9.87	0.85	6.11	0.93	2.21	1.04	15.46	1.31					
MIN	0.83	0.01	0.00	0.00	0.80	0.00	0.00	0.00					
MEAN	2.47	0.24	1.71	0.26	1.44	0.37	2.60	0.43					
MEDIAN	1.28	0.19	1.20	0.16	1.44	0.29	1.28	0.36					
SUM	79.06	7.65	54.71	8.35	46.20	11.89	83.18	13.73					
***p,p'*-DDD**													
	Dry Season 1		Wet Season	std	Dry season 2	std	Short rain	Std	**max**	**min**	**mean**	**median**	**sum**
MUHURUBAY	13.77	1.37	0.00	0.00	0.38	0.14	1.20	1.39	**13.77**	**0.00**	**3.84**	**0.79**	**15.35**
SORI	6.92	1.87	0.00	0.00	0.00	0.00	0.00	0.00	**6.92**	**0.00**	**1.73**	**0.00**	**6.92**

MBITA LHSD	12.71	4.35	0.00	0.00	0.00	0.00	0.09	0.02	**12.71**	**0.00**	**3.20**	**0.04**	**12.79**
MBITA WG	0.05	0.02	0.07	0.01	0.72	0.12	0.10	0.03	**0.72**	**0.05**	**0.24**	**0.09**	**0.94**
HOMABAY	9.42	1.26	0.00	0.00	0.00	0.00	2.52	1.70	**9.42**	**0.00**	**2.99**	**1.26**	**11.94**
KENDUBAY	12.42	0.88	0.00	0.00	0.00	0.00	9.84	0.55	**12.42**	**0.00**	**5.56**	**4.92**	**22.26**
KUSA	0.00	0.00	0.00	0.00	0.11	0.02	0.00	0.00	**0.11**	**0.00**	**0.03**	**0.00**	**0.11**
DUNGA BEACH	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
HIPPOPOINT	5.56	0.82	0.00	0.00	0.00	0.00	1.62	0.04	**5.56**	**0.00**	**1.80**	**0.81**	**7.18**
RAILWAYS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
LUANDA	4.33	0.17	0.00	0.00	0.00	0.00	0.00	0.00	**4.33**	**0.00**	**1.08**	**0.00**	**4.33**
MISORI	7.98	0.11	0.00	0.00	0.00	0.00	0.00	0.00	**7.98**	**0.00**	**1.99**	**0.00**	**7.98**
USENGE	8.28	0.52	1.36	0.17	0.14	0.00	0.00	0.00	**8.28**	**0.00**	**2.45**	**0.75**	**9.78**
PORT VICTORIA	2.24	0.59	0.00	0.00	0.00	0.00	3.39	0.13	**3.39**	**0.00**	**1.41**	**1.12**	**5.63**
SIO PORT	0.00	0.00	0.61	0.10	0.00	0.00	0.00	0.00	**0.61**	**0.00**	**0.15**	**0.00**	**0.61**
R. KUJA	0.00	0.00	0.00	0.00	0.29	0.01	27.31	1.55	**27.31**	**0.00**	**6.90**	**0.15**	**27.60**
R. AWACH	0.00	0.00	0.00	0.00	0.30	0.00	1.37	1.49	**1.37**	**0.00**	**0.42**	**0.15**	**1.66**
R. SONDU	4.66	0.61	0.00	0.00	0.00	0.00	0.00	0.00	**4.66**	**0.00**	**1.17**	**0.00**	**4.66**
R. NYANDO	0.00	0.00	15.25	0.23	0.00	0.00	0.00	0.00	**15.25**	**0.00**	**3.81**	**0.00**	**15.25**
R. NYAMASARIA	3.25	0.00	0.00	0.00	1.15	0.12	0.90	0.29	**3.25**	**0.00**	**1.32**	**1.02**	**5.30**
R. KISIAN	5.05	0.07	0.00	0.00	0.00	0.00	0.00	0.00	**5.05**	**0.00**	**1.26**	**0.00**	**5.05**
R. MUGRUK	4.51	0.04	0.21	0.10	0.12	0.01	0.00	0.00	**4.51**	**0.00**	**1.21**	**0.16**	**4.84**
R. AWACH SEME	1.30	0.74	0.00	0.00	0.54	0.16	0.00	0.00	**1.30**	**0.00**	**0.46**	**0.27**	**1.84**
R. YALA	0.00	0.00	14.34	0.67	0.04	0.01	1.00	0.96	**14.34**	**0.00**	**3.84**	**0.52**	**15.38**
R. NZOIA	3.39	0.21	0.00	0.00	0.00	0.00	0.00	0.00	**3.39**	**0.00**	**0.85**	**0.00**	**3.39**
R. SIO	7.57	0.00	0.00	0.00	0.11	0.01	1.01	0.00	**7.57**	**0.00**	**2.17**	**0.56**	**8.69**
HOMABAY S.E.	8.05	0.54	0.00	0.00	17.42	0.95	6.66	2.26	**17.42**	**0.00**	**8.03**	**7.36**	**32.13**
HOMA BAY DISCHARGE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
NYALENDA	5.57	0.17	2.70	0.27	0.00	0.00	0.02	0.34					
KWASCO	0.00	0.00	0.00	0.00	0.74	0.17	25.98	22.77	**5.57**	**0.00**	**2.07**	**1.36**	**8.29**
KISATI	0.74	0.20	0.00	0.00	0.00	0.00	0.00	0.00	**25.98**	**0.00**	**6.68**	**0.37**	**26.73**
SAKA	0.47	0.27	0.00	0.00	0.00	0.00	0.00	0.00	**0.74**	**0.00**	**0.19**	**0.00**	**0.74**
									0.47	**0.00**	**0.12**	**0.00**	**0.47**
MAX	13.77	4.35	15.25	0.67	17.42	0.95	27.31	22.77					
MIN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
MEAN	4.01	0.46	1.08	0.05	0.69	0.05	2.59	1.05					
MEDIAN	3.32	0.14	0.00	0.00	0.00	0.00	0.00	0.00					

SUM	128.24	14.81	34.55	1.55	22.06	1.72	83.00	33.52					
p,p'-DDT													
	Dry Season 1		Wet Season	std	Dry season 2	std	Short rain	Std	**max**	**min**	**mean**	**median**	**sum**
MUHURUBAY	0.00	0.00	0.00	0.00	0.00	0.00	2.57	1.39	**2.57**	**0.00**	**0.64**	**0.00**	**2.57**
SORI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
MBITA LHSD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
MBITA WG	0.00	0.00	0.00	0.00	0.00	0.00	4.95	0.08	**4.95**	**0.00**	**1.24**	**0.00**	**4.95**
HOMABAY	0.50	0.58	0.00	0.00	0.00	0.00	1.10	0.14	**1.10**	**0.00**	**0.40**	**0.25**	**1.60**
KENDUBAY	0.00	0.00	11.69	1.13	0.00	0.00	0.00	0.00	**11.69**	**0.00**	**2.92**	**0.00**	**11.69**
KUSA	0.00	0.00	0.00	0.00	4.09	1.00	0.00	0.00	**4.09**	**0.00**	**1.02**	**0.00**	**4.09**
DUNGA BEACH	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
HIPPOPOINT	0.00	0.00	0.00	0.00	0.00	0.00	0.48	0.06	**0.48**	**0.00**	**0.12**	**0.00**	**0.48**
RAILWAYS	2.51	0.05	0.00	0.00	0.00	0.00	0.00	0.00	**2.51**	**0.00**	**0.63**	**0.00**	**2.51**
LUANDA	0.00	0.00	3.27	0.90	0.00	0.00	0.00	0.00	**3.27**	**0.00**	**0.82**	**0.00**	**3.27**
MISORI	0.00	0.00	1.40	0.14	0.00	0.00	0.00	0.00	**1.40**	**0.00**	**0.35**	**0.00**	**1.40**
USENGE	0.00	0.00	2.04	0.09	0.00	0.00	0.00	0.00	**2.04**	**0.00**	**0.51**	**0.00**	**2.04**
PORT VICTORIA	1.71	0.03	1.04	0.36	7.76	0.38	41.88	3.43	**41.88**	**1.04**	**13.09**	**4.73**	**52.38**
SIO PORT	2.64	0.17	3.99	0.15	0.00	0.00	0.00	0.00	**3.99**	**0.00**	**1.66**	**1.32**	**6.64**
R. KUJA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
R. AWACH	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
R. SONDU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
R. NYANDO	0.00	0.00	103.68	5.21	0.00	0.00	0.00	0.00	**103.68**	**0.00**	**25.92**	**0.00**	**103.68**
R. NYAMASARIA	9.64	0.28	0.00	0.00	0.00	0.00	0.57	0.06	**9.64**	**0.00**	**2.55**	**0.28**	**10.21**
R. KISIAN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
R. MUGRUK	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
R. AWACH SEME	0.00	0.00	0.26	0.02	0.00	0.00	0.00	0.00	**0.26**	**0.00**	**0.07**	**0.00**	**0.26**
R. YALA	0.49	0.16	0.00	0.00	0.00	0.00	0.00	0.00	**0.49**	**0.00**	**0.12**	**0.00**	**0.49**
R. NZOIA	0.00	0.00	3.92	0.25	0.00	0.00	0.00	0.00	**3.92**	**0.00**	**0.98**	**0.00**	**3.92**
R. SIO	1.82	0.20	1.86	0.22	0.00	0.00	0.00	0.00	**1.86**	**0.00**	**0.92**	**0.91**	**3.69**
HOMABAY S.E.	0.00	0.00	0.00	0.00	0.00	0.00	1.02	0.14	**1.02**	**0.00**	**0.26**	**0.00**	**1.02**
HOMA BAY DISCHARGE	0.00	0.00	2.65	0.20	0.00	0.00	0.00	0.00	**2.65**	**0.00**	**0.66**	**0.00**	**2.65**
NYALENDA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
KWASCO	0.00	0.00	244.86	63.44	0.00	0.00	308.45	11.96	**308.45**	**0.00**	**138.33**	**122.43**	**553.31**

KISATI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
SAKA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
MAX	9.64	0.58	244.86	63.44	7.76	1.00	308.45	11.96					
MIN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
MEAN	0.60	0.05	11.90	2.25	0.37	0.04	11.28	0.54					
MEDIAN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
SUM	19.30	1.48	380.67	72.10	11.85	1.38	361.04	17.25					
Endrin													
	Dry Season 1		Wet Season	std	Dry season 2	std	Short rain	Std	**max**	**min**	**mean**	**median**	**sum**
MUHURUBAY	2.39	0.13	0.00	0.00	0.00	0.00	0.19	0.03	**2.39**	**0.00**	**0.65**	**0.10**	**2.58**
SORI	7.40	0.98	0.00	0.00	0.00	0.00	3.05	0.07	**7.40**	**0.00**	**2.61**	**1.52**	**10.45**
MBITA LHSD	2.49	0.13	1.45	0.35	0.00	0.00	0.17	0.05	**2.49**	**0.00**	**1.03**	**0.81**	**4.12**
MBITA WG	1.34	0.09	0.00	0.00	0.00	0.00	0.44	0.11	**1.34**	**0.00**	**0.45**	**0.22**	**1.78**
HOMABAY	0.04	0.01	0.00	0.00	0.00	0.00	2.81	0.62	**2.81**	**0.00**	**0.71**	**0.02**	**2.85**
KENDUBAY	2.97	0.18	0.00	0.00	0.00	0.00	1.13	0.14	**2.97**	**0.00**	**1.03**	**0.57**	**4.10**
KUSA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
DUNGA BEACH	1.11	0.14	0.00	0.00	0.00	0.00	2.89	0.30	**2.89**	**0.00**	**1.00**	**0.55**	**4.00**
HIPPOPOINT	3.09	0.31	0.00	0.00	0.09	0.02	0.03	0.01	**3.09**	**0.00**	**0.80**	**0.06**	**3.21**
RAILWAYS	0.00	0.00	1.05	0.23	0.00	0.00	0.34	0.40	**1.05**	**0.00**	**0.35**	**0.17**	**1.39**
LUANDA	0.00	0.00	0.00	0.00	0.00	0.00	0.57	0.06	**0.57**	**0.00**	**0.14**	**0.00**	**0.57**
MISORI	3.56	0.77	16.01	0.24	0.00	0.00	0.00	0.00	**16.01**	**0.00**	**4.89**	**1.78**	**19.56**
USENGE	0.02	0.00	1.62	0.11	0.00	0.00	1.05	0.71	**1.62**	**0.00**	**0.67**	**0.53**	**2.69**
PORT VICTORIA	2.00	0.15	0.00	0.00	0.08	0.01	3.40	0.28	**3.40**	**0.00**	**1.37**	**1.04**	**5.48**
SIO PORT	3.58	0.16	0.74	0.21	0.00	0.00	2.79	0.34	**3.58**	**0.00**	**1.78**	**1.76**	**7.11**
R. KUJA	2.80	0.71	0.92	0.25	0.00	0.00	40.72	2.45	**40.72**	**0.00**	**11.11**	**1.86**	**44.43**
R. AWACH	0.00	0.00	1.49	0.03	0.00	0.00	0.00	0.00	**1.49**	**0.00**	**0.37**	**0.00**	**1.49**
R. SONDU	2.73	0.98	0.23	0.13	0.34	0.08	0.00	0.00	**2.73**	**0.00**	**0.82**	**0.28**	**3.30**
R. NYANDO	1.88	0.32	11.81	0.52	0.00	0.00	1.12	0.23	**11.81**	**0.00**	**3.70**	**1.50**	**14.82**
R. NYAMASARIA	2.57	0.08	0.29	0.08	0.00	0.00	1.95	0.33	**2.57**	**0.00**	**1.20**	**1.12**	**4.81**
R. KISIAN	2.23	0.30	0.00	0.00	0.00	0.00	0.00	0.00	**2.23**	**0.00**	**0.56**	**0.00**	**2.23**
R. MUGRUK	2.36	0.29	0.00	0.00	0.00	0.00	0.00	0.00	**2.36**	**0.00**	**0.59**	**0.00**	**2.36**
R. AWACH SEME	1.31	0.13	3.45	0.17	0.00	0.00	4.05	0.34	**4.05**	**0.00**	**2.20**	**2.38**	**8.81**
R. YALA	3.85	0.35	1.51	0.03	0.00	0.00	0.00	0.00	**3.85**	**0.00**	**1.34**	**0.76**	**5.36**

	Dry Season 1	std	Wet Season	std	Dry season 2	std	Short rain	Std	max	min	mean	median	sum
R. NZOIA	0.00	0.00	2.00	0.42	0.22	0.17	0.00	0.00	**2.00**	**0.00**	**0.56**	**0.11**	**2.22**
R. SIO	2.26	0.21	4.04	0.23	0.77	0.18	2.56	5.19	**4.04**	**0.77**	**2.41**	**2.41**	**9.63**
HOMABAY S.E.	0.00	0.00	0.00	0.00	0.00	0.00	1.36	0.20	**1.36**	**0.00**	**0.34**	**0.00**	**1.36**
HOMA BAY DISCHARGE	1.03	0.09	1.13	0.10	0.00	0.00	0.00	0.00	**1.13**	**0.00**	**0.54**	**0.51**	**2.16**
NYALENDA	1.98	0.19	0.00	0.00	5.76	0.76	0.00	0.00	**5.76**	**0.00**	**1.93**	**0.99**	**7.73**
KWASCO	0.21	0.03	3.49	0.77	0.00	0.00	9.50	2.00	**9.50**	**0.00**	**3.30**	**1.85**	**13.21**
KISATI	3.50	0.05	0.00	0.00	0.00	0.00	0.00	0.00	**3.50**	**0.00**	**0.87**	**0.00**	**3.50**
SAKA	0.00	0.00	2.71	0.48	0.00	0.00	0.26	0.07	**2.71**	**0.00**	**0.74**	**0.13**	**2.97**
MAX	7.40	0.98	16.01	0.77	5.76	0.76	40.72	5.19					
MEAN	1.83	0.21	1.69	0.14	0.23	0.04	2.51	0.43					
MEDIAN	1.99	0.13	0.26	0.03	0.00	0.00	0.39	0.07					
SUM	58.70	6.76	53.95	4.34	7.26	1.23	80.38	13.92					
Endosulphan II													
	Dry Season 1		Wet Season	std	Dry season 2	std	Short rain	Std	**max**	**min**	**mean**	**median**	**sum**
MUHURUBAY	11.69	2.06	0.00	0.00	0.00	0.00	1.50	0.71	**11.69**	**0.00**	**3.30**	**0.75**	**13.19**
SORI	9.21	1.34	14.30	2.04	0.30	0.02	0.00	0.00	**14.30**	**0.00**	**5.95**	**4.76**	**23.81**
MBITA LHSD	8.35	2.35	0.82	0.98	0.00	0.00	0.00	0.00	**8.35**	**0.00**	**2.29**	**0.41**	**9.17**
MBITA WG	0.00	0.00	0.98	0.17	0.00	0.00	0.00	0.00	**0.98**	**0.00**	**0.24**	**0.00**	**0.98**
HOMABAY	2.16	0.24	0.00	0.00	0.00	0.00	24.03	1.50	**24.03**	**0.00**	**6.55**	**1.08**	**26.19**
KENDUBAY	13.03	1.39	1.12	0.13	0.00	0.00	2.88	0.46	**13.03**	**0.00**	**4.26**	**2.00**	**17.03**
KUSA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
DUNGA BEACH	0.00	0.00	1.57	0.07	0.00	0.00	0.00	0.00	**1.57**	**0.00**	**0.39**	**0.00**	**1.57**
HIPPOPOINT	8.92	1.02	1.35	0.10	1.15	0.19	0.41	0.15	**8.92**	**0.41**	**2.96**	**1.25**	**11.82**
RAILWAYS	0.00	0.00	0.00	0.00	1.95	0.11	0.00	0.00	**1.95**	**0.00**	**0.49**	**0.00**	**1.95**
LUANDA	5.25	1.43	0.00	0.00	0.00	0.00	0.00	0.00	**5.25**	**0.00**	**1.31**	**0.00**	**5.25**
MISORI	0.00	0.00	0.00	0.00	0.39	0.23	0.77	0.07	**0.77**	**0.00**	**0.29**	**0.19**	**1.15**
USENGE	4.60	0.25	12.90	0.98	0.00	0.00	9.01	1.43	**12.90**	**0.00**	**6.63**	**6.81**	**26.52**
PORT VICTORIA	3.68	0.17	0.00	0.00	173.81	4.47	0.96	0.19	**173.81**	**0.00**	**44.61**	**2.32**	**178.45**
SIO PORT	0.00	0.00	13.72	0.79	9.16	1.04	0.00	0.00	**13.72**	**0.00**	**5.72**	**4.58**	**22.88**
R. KUJA	0.94	0.23	7.64	0.82	0.00	0.00	0.00	0.00	**7.64**	**0.00**	**2.14**	**0.47**	**8.57**
R. AWACH	0.00	0.00	86.00	7.43	0.00	0.00	2.70	0.24	**86.00**	**0.00**	**22.18**	**1.35**	**88.70**
R. SONDU	1.26	0.79	0.49	0.08	0.00	0.00	4.03	0.09	**4.03**	**0.00**	**1.45**	**0.88**	**5.78**
R. NYANDO	7.70	1.27	57.94	1.46	0.00	0.00	6.68	0.91	**57.94**	**0.00**	**18.08**	**7.19**	**72.32**
R.	5.15	0.53	6.35	0.34	0.00	0.00	8.00	0.13	**8.00**	**0.00**	**4.87**	**5.75**	**19.50**

NYAMASARIA													
R. KISIAN	5.22	0.37	0.00	0.00	0.00	0.00	0.70	0.00	**5.22**	**0.00**	**1.48**	**0.35**	**5.92**
R. MUGRUK	2.56	0.35	0.00	0.00	0.00	0.00	0.00	0.00	**2.56**	**0.00**	**0.64**	**0.00**	**2.56**
R. AWACH SEME	0.39	0.10	0.00	0.00	4.80	0.42	19.23	1.61	**19.23**	**0.00**	**6.10**	**2.59**	**24.41**
R. YALA	1.89	0.28	43.80	2.84	0.00	0.00	0.00	0.00	**43.80**	**0.00**	**11.42**	**0.94**	**45.69**
R. NZOIA	5.03	0.77	0.00	0.00	1.26	0.34	0.00	0.00	**5.03**	**0.00**	**1.57**	**0.63**	**6.29**
R. SIO	0.00	0.00	0.00	0.00	0.00	0.00	18.07	1.41	**18.07**	**0.00**	**4.52**	**0.00**	**18.07**
HOMABAY S.E.	12.98	1.99	0.00	0.00	0.00	0.00	29.11	1.54	**29.11**	**0.00**	**10.52**	**6.49**	**42.09**
HOMA BAY DISCHARGE	0.21	0.14	0.00	0.00	0.00	0.00	7.97	0.19	**7.97**	**0.00**	**2.05**	**0.11**	**8.19**
NYALENDA	3.05	0.74	0.00	0.00	66.10	1.43	0.00	0.00	**66.10**	**0.00**	**17.29**	**1.52**	**69.15**
KWASCO	0.48	0.13	0.00	0.00	0.00	0.00	37.83	0.26	**37.83**	**0.00**	**9.58**	**0.24**	**38.31**
KISATI	4.93	0.21	0.00	0.00	0.00	0.00	0.00	0.00	**4.93**	**0.00**	**1.23**	**0.00**	**4.93**
SAKA	0.00	0.00	5.97	0.17	0.00	0.00	0.00	0.00	**5.97**	**0.00**	**1.49**	**0.00**	**5.97**
MAX	13.03	2.35	86.00	7.43	173.81	4.47	37.83	1.61					
MIN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
MEAN	3.71	0.57	7.97	0.57	8.09	0.26	5.43	0.34					
MEDIAN	2.36	0.24	0.00	0.00	0.00	0.00	0.56	0.04					
SUM	118.68	18.15	254.94	18.39	258.91	8.26	173.89	10.90					

Endrin													
	Dry Season 1		Wet Season	std	Dry season 2	std	Short rain	Std	**max**	**min**	**mean**	**median**	**sum**
MUHURUBAY	8.72	3.71	0.00	0.00	52.88	5.70	2.25	0.25	**52.88**	**0.00**	**15.96**	**5.48**	**63.84**
SORI	0.16	0.02	74.91	0.43	50.09	4.01	0.00	0.00	**74.91**	**0.00**	**31.29**	**25.13**	**125.16**
MBITA LHSD	89.12	12.78	0.08	0.01	72.99	3.02	64.90	1.14	**89.12**	**0.08**	**56.77**	**68.95**	**227.10**
MBITA WG	18.18	2.67	72.04	0.28	42.97	3.91	0.38	0.08	**72.04**	**0.38**	**33.39**	**30.58**	**133.57**
HOMABAY	1.88	0.30	0.46	0.05	0.00	0.00	70.35	0.58	**70.35**	**0.00**	**18.17**	**1.17**	**72.69**
KENDUBAY	91.12	7.23	58.70	2.13	0.00	0.00	3.61	0.22	**91.12**	**0.00**	**38.36**	**31.16**	**153.44**
KUSA	0.15	0.02	0.00	0.00	69.66	7.88	0.00	0.00	**69.66**	**0.00**	**17.45**	**0.07**	**69.81**
DUNGA BEACH	0.17	0.02	0.21	0.01	48.50	5.13	1.44	0.50	**48.50**	**0.17**	**12.58**	**0.82**	**50.31**
HIPPOPOINT	14.87	0.48	0.14	0.02	5.54	2.05	0.02	0.01	**14.87**	**0.02**	**5.14**	**2.84**	**20.57**
RAILWAYS	1.44	0.11	0.49	0.11	34.83	30.22	0.24	0.00	**34.83**	**0.24**	**9.25**	**0.96**	**37.00**
LUANDA	0.86	1.35	0.43	0.06	13.37	0.74	0.00	0.00	**13.37**	**0.00**	**3.66**	**0.64**	**14.65**
MISORI	38.93	2.76	10.95	0.29	47.44	3.96	0.04	0.00	**47.44**	**0.04**	**24.34**	**24.94**	**97.36**
USENGE	3.66	0.30	0.44	0.05	52.50	6.28	2.83	0.37	**52.50**	**0.44**	**14.86**	**3.25**	**59.43**

PORT VICTORIA	1.48	0.01	8.75	0.92	116.43	22.32	0.75	0.17	**116.43**	**0.75**	**31.85**	**5.11**	**127.41**
SIO PORT	157.77	3.19	0.19	0.02	50.96	9.98	3.54	0.46	**157.77**	**0.19**	**53.12**	**27.25**	**212.46**
R. KUJA	62.60	3.63	0.46	0.12	57.48	1.96	0.00	0.00	**62.60**	**0.00**	**30.14**	**28.97**	**120.54**
R. AWACH	0.02	0.01	0.56	0.07	54.56	9.15	0.19	0.06	**54.56**	**0.02**	**13.83**	**0.37**	**55.32**
R. SONDU	1.71	0.41	1.04	0.07	72.96	20.64	0.82	0.39	**72.96**	**0.82**	**19.13**	**1.38**	**76.54**
R. NYANDO	0.11	0.07	0.98	0.45	48.78	2.85	0.19	0.02	**48.78**	**0.11**	**12.52**	**0.58**	**50.06**
R. NYAMASARIA	3.48	0.23	0.25	0.28	13.26	1.65	15.90	0.98	**15.90**	**0.25**	**8.22**	**8.37**	**32.88**
R. KISIAN	58.42	13.80	69.29	1.88	23.39	2.88	0.10	0.04	**69.29**	**0.10**	**37.80**	**40.90**	**151.19**
R. MUGRUK	0.43	0.06	49.45	0.89	57.84	3.88	0.41	0.14	**57.84**	**0.41**	**27.03**	**24.94**	**108.13**
R. AWACH SEME	70.04	1.10	0.83	0.08	40.20	3.02	1.14	0.10	**70.04**	**0.83**	**28.06**	**20.67**	**112.22**
R. YALA	9.60	0.95	1.62	0.36	10.34	3.43	0.04	0.01	**10.34**	**0.04**	**5.40**	**5.61**	**21.59**
R. NZOIA	3.37	0.28	0.61	0.11	16.30	1.86	0.00	0.00	**16.30**	**0.00**	**5.07**	**1.99**	**20.28**
R. SIO	20.34	2.90	0.69	0.39	0.08	0.04	4.81	0.45	**20.34**	**0.08**	**6.48**	**2.75**	**25.92**
HOMABAY S.E.	50.22	8.44	0.00	0.00	84.71	4.73	0.00	0.00	**84.71**	**0.00**	**33.73**	**25.11**	**134.92**
HOMA BAY DISCHARGE	0.24	0.07	1.09	0.20	49.05	2.92	0.00	0.00	**49.05**	**0.00**	**12.59**	**0.66**	**50.38**
NYALENDA	40.19	1.71	0.20	0.04	46.21	1.74	0.00	0.00	**46.21**	**0.00**	**21.65**	**20.20**	**86.60**
KWASCO	0.25	0.10	1.01	0.29	0.00	0.00	1.40	0.19	**1.40**	**0.00**	**0.66**	**0.63**	**2.66**
KISATI	58.39	2.08	0.00	0.00	0.00	0.00	0.09	0.04	**58.39**	**0.00**	**14.62**	**0.04**	**58.48**
SAKA	0.00	0.00	0.31	0.10	26.52	22.98	0.00	0.00	**26.52**	**0.00**	**6.71**	**0.16**	**26.83**
MAX	157.77	13.80	74.91	2.13	116.43	30.22	70.35	1.14					
MIN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
MEAN	25.25	2.21	11.13	0.30	39.37	5.90	5.48	0.19					
MEDIAN	3.57	0.45	0.52	0.10	46.83	3.23	0.22	0.05					
SUM	807.90	70.79	356.18	9.69	1,259.84	188.90	175.43	6.20					
α-HCH													
	Dry Season 1		Wet Season	std	Dry season 2	std	Short rain	Std	**max**	**min**	**mean**	**median**	**sum**
MUHURUBAY	3.01	0.48	0.00	0.00	3.48	0.94	3.82	0.26	**3.82**	**0.00**	**2.58**	**3.24**	**10.30**
SORI	3.39	0.37	3.05	0.18	3.94	0.55	1.57	0.04	**3.94**	**1.57**	**2.99**	**3.22**	**11.95**
MBITA LHSD	2.87	0.80	3.11	0.45	10.22	0.61	8.84	0.91	**10.22**	**2.87**	**6.26**	**5.98**	**25.04**
MBITA WG	1.97	0.24	3.76	0.76	3.47	0.36	3.17	0.57	**3.76**	**1.97**	**3.09**	**3.32**	**12.38**
HOMABAY	3.57	0.21	4.50	0.08	3.07	0.02	3.90	0.63	**4.50**	**3.07**	**3.76**	**3.74**	**12.38**
KENDUBAY	3.58	0.93	3.21	0.29	3.62	0.55	3.60	0.15	**3.62**	**3.21**	**3.50**	**3.59**	**14.01**

KUSA	3.25	0.23	0.00	0.00	3.80	0.92	0.00	0.00	**3.80**	**0.00**	**1.76**	**1.62**	**7.05**
DUNGA BEACH	3.03	0.76	3.92	1.20	3.74	0.58	2.73	0.16	**3.92**	**2.73**	**3.35**	**3.38**	**13.42**
HIPPOPOINT	11.05	1.34	3.08	0.17	3.11	0.04	3.12	0.16	**11.05**	**3.08**	**5.09**	**3.11**	**20.35**
RAILWAYS	3.21	0.52	2.76	0.40	4.04	0.11	4.33	0.04	**4.33**	**2.76**	**3.58**	**3.63**	**14.34**
LUANDA	3.06	0.09	3.53	0.63	8.87	0.78	2.44	0.12	**8.87**	**2.44**	**4.47**	**3.29**	**17.90**
MISORI	3.06	0.58	2.77	0.05	2.90	0.51	3.31	0.09	**3.31**	**2.77**	**3.01**	**2.98**	**12.04**
USENGE	3.72	0.45	3.98	0.93	4.22	0.64	3.24	0.43	**4.22**	**3.24**	**3.79**	**3.85**	**15.16**
PORT VICTORIA	3.09	0.63	3.85	0.82	4.38	0.86	3.34	0.16	**4.38**	**3.09**	**3.66**	**3.60**	**14.65**
SIO PORT	4.56	0.93	2.53	0.65	3.51	0.50	3.52	0.88	**4.56**	**2.53**	**3.53**	**3.52**	**14.12**
R. KUJA	2.93	0.53	3.33	0.94	3.77	0.40	2.84	0.20	**3.77**	**2.84**	**3.22**	**3.13**	**12.86**
R. AWACH	4.19	0.16	15.03	2.89	4.31	0.11	2.87	1.00	**15.03**	**2.87**	**6.60**	**4.25**	**26.40**
R. SONDU	2.97	0.55	3.32	0.11	4.15	0.72	3.21	0.89	**4.15**	**2.97**	**3.41**	**3.26**	**13.65**
R. NYANDO	2.67	0.59	3.00	0.14	3.61	0.13	3.35	0.08	**3.61**	**2.67**	**3.16**	**3.17**	**12.62**
R. NYAMASARIA	3.84	0.15	3.36	0.20	3.92	0.67	2.46	0.73	**3.92**	**2.46**	**3.40**	**3.60**	**13.58**
R. KISIAN	2.54	0.25	6.23	0.94	4.20	0.48	4.13	0.54	**6.23**	**2.54**	**4.28**	**4.17**	**17.10**
R. MUGRUK	2.64	0.52	3.19	0.10	2.99	0.43	3.60	0.51	**3.60**	**2.64**	**3.11**	**3.09**	**12.42**
R. AWACH SEME	2.55	0.95	3.90	0.27	3.60	0.53	3.27	0.81	**3.90**	**2.55**	**3.33**	**3.43**	**13.31**
R. YALA	2.51	0.25	2.93	0.07	2.39	0.79	3.35	0.35	**3.35**	**2.39**	**2.79**	**2.72**	**11.17**
R. NZOIA	3.92	0.55	3.28	0.78	3.95	0.73	3.33	0.06	**3.95**	**3.28**	**3.62**	**3.62**	**14.47**
R. SIO	4.07	0.56	3.02	0.31	4.42	0.27	5.27	0.88	**5.27**	**3.02**	**4.19**	**4.24**	**16.77**
HOMABAY S.E.	10.04	2.75	6.26	0.75	3.44	0.70	50.59	0.86	**50.59**	**3.44**	**17.58**	**8.15**	**70.33**
HOMA BAY DISCHARGE	2.94	0.02	3.68	0.16	2.76	0.16	6.12	0.74	**6.12**	**2.76**	**3.88**	**3.31**	**15.51**
NYALENDA	2.43	0.14	2.99	0.14	4.57	0.20	4.88	0.49	**4.88**	**2.43**	**3.72**	**3.78**	**14.88**
KWASCO	5.09	2.72	4.34	0.34	6.01	0.19	72.14	3.18	**72.14**	**4.34**	**21.89**	**5.55**	**87.57**
KISATI	2.87	0.55	0.00	0.00	2.41	0.19	4.28	0.09	**4.28**	**0.00**	**2.39**	**2.64**	**9.55**
SAKA	3.06	0.22	3.50	0.99	3.62	0.36	2.81	0.99	**3.62**	**2.81**	**3.25**	**3.28**	**12.99**
MAX	11.05	2.75	15.03	2.89	10.22	0.94	72.14	3.18					
MIN	1.97	0.02	0.00	0.00	2.39	0.02	0.00	0.00					
MEAN	3.68	0.63	3.61	0.49	4.08	0.47	7.17	0.53					
MEDIAN	3.06	0.53	3.30	0.30	3.75	0.50	3.35	0.46					
SUM	117.65	20.04	115.41	15.72	130.48	15.03	229.42	16.99					
δ-HCH													
	Dry Season 1		Wet	std	Dry	std	Short	Std	**max**	**min**	**mean**	**median**	**sum**

			Season		season 2		rain						
MUHURUBAY	0.50	0.11	0.00	0.00	1.29	0.07	1.51	0.53	**1.51**	**0.00**	**0.82**	**0.89**	**3.30**
SORI	1.30	0.66	0.68	0.09	0.90	0.06	0.87	0.01	**1.30**	**0.68**	**0.94**	**0.89**	**3.75**
MBITA LHSD	2.43	0.53	0.74	0.21	1.04	0.08	0.85	0.17	**2.43**	**0.74**	**1.27**	**0.94**	**5.06**
MBITA WG	0.33	0.12	0.84	0.17	0.74	0.07	0.66	0.09	**0.84**	**0.33**	**0.64**	**0.70**	**2.56**
HOMABAY	2.86	0.34	4.68	0.29	1.94	0.11	12.35	0.38	**12.35**	**1.94**	**5.46**	**3.77**	**21.84**
KENDUBAY	0.54	0.01	4.95	0.17	1.33	0.66	2.92	0.68	**4.95**	**0.54**	**2.43**	**2.12**	**9.74**
KUSA	2.36	0.46	0.00	0.00	2.06	0.18	0.00	0.00	**2.36**	**0.00**	**1.11**	**1.03**	**4.42**
DUNGA BEACH	4.56	0.06	1.11	0.33	0.90	0.20	1.18	0.70	**4.56**	**0.90**	**1.94**	**1.15**	**7.76**
HIPPOPOINT	1.18	0.32	1.07	0.03	1.28	0.87	6.71	0.13	**6.71**	**1.07**	**2.56**	**1.23**	**10.24**
RAILWAYS	0.47	0.04	4.22	0.03	0.86	0.03	6.18	0.50	**6.18**	**0.47**	**2.93**	**2.54**	**11.73**
LUANDA	2.17	0.34	7.20	0.83	0.93	0.00	0.64	0.04	**7.20**	**0.64**	**2.74**	**1.55**	**10.94**
MISORI	1.22	0.57	4.00	0.98	0.69	0.18	2.23	0.03	**4.00**	**0.69**	**2.03**	**1.72**	**8.13**
USENGE	2.66	0.19	3.78	0.33	0.92	0.13	1.04	0.27	**3.78**	**0.92**	**2.10**	**1.85**	**8.40**
PORT VICTORIA	0.50	0.10	4.56	0.29	1.63	1.00	5.19	0.19	**5.19**	**0.50**	**2.97**	**3.10**	**11.88**
SIO PORT	0.74	0.24	3.36	0.78	1.18	0.83	1.59	0.29	**3.36**	**0.74**	**1.71**	**1.38**	**6.86**
R. KUJA	1.05	0.46	4.80	0.42	0.84	0.05	0.57	0.02	**4.80**	**0.57**	**1.82**	**0.95**	**7.26**
R. AWACH	3.00	0.22	4.86	0.33	0.89	0.01	6.54	0.19	**6.54**	**0.89**	**3.82**	**3.93**	**15.29**
R. SONDU	0.37	0.10	3.47	0.10	1.03	0.17	4.18	0.12	**4.18**	**0.37**	**2.26**	**2.25**	**9.05**
R. NYANDO	0.34	0.11	4.27	0.12	1.44	0.29	2.69	0.42	**4.27**	**0.34**	**2.19**	**2.07**	**8.75**
R. NYAMASARIA	2.66	0.14	3.47	0.07	1.38	0.93	0.71	0.11	**3.47**	**0.71**	**2.05**	**2.02**	**8.21**
R. KISIAN	0.44	0.07	5.83	0.38	1.07	0.19	4.12	0.13	**5.83**	**0.44**	**2.86**	**2.60**	**11.45**
R. MUGRUK	1.72	0.06	0.00	0.00	1.36	0.47	3.04	0.01	**3.04**	**0.00**	**1.53**	**1.54**	**6.12**
R. AWACH SEME	2.04	0.06	9.97	0.08	4.97	0.17	1.26	0.26	**9.97**	**1.26**	**4.56**	**3.50**	**18.24**
R. YALA	0.41	0.07	2.25	0.59	0.63	0.00	1.39	0.24	**2.25**	**0.41**	**1.17**	**1.01**	**4.68**
R. NZOIA	1.87	0.69	10.32	0.34	1.49	0.41	1.24	0.05	**10.32**	**1.24**	**3.73**	**1.68**	**14.92**
R. SIO	0.43	0.13	15.34	1.86	0.81	0.19	1.97	0.28	**15.34**	**0.43**	**4.64**	**1.39**	**18.55**
HOMABAY S.E.	0.00	0.00	9.09	1.41	0.74	0.17	0.90	0.05	**9.09**	**0.00**	**2.68**	**0.82**	**10.72**
HOMA BAY DISCHARGE	0.42	0.00	7.85	0.28	0.56	0.02	5.84	0.23	**7.85**	**0.42**	**3.67**	**3.20**	**14.66**
NYALENDA	0.38	0.05	2.45	0.16	1.18	0.30	0.70	0.09	**2.45**	**0.38**	**1.18**	**0.94**	**4.71**
KWASCO	2.90	0.53	8.56	0.11	1.57	0.09	0.56	0.08	**8.56**	**0.56**	**3.40**	**2.23**	**13.59**
KISATI	2.16	0.05	0.00	0.00	0.57	0.06	3.33	0.06	**3.33**	**0.00**	**1.51**	**1.36**	**6.05**
SAKA	1.56	0.07	1.94	0.20	0.70	0.03	0.91	0.11	**1.94**	**0.70**	**1.28**	**1.24**	**5.12**
MAX	4.56	0.69	15.34	1.86	4.97	1.00	12.35	0.70					

MIN	0.00	0.00	0.00	0.00	0.56	0.00	0.00	0.00					
MEAN	1.42	0.22	4.24	0.34	1.22	0.25	2.62	0.20					
MEDIAN	1.20	0.12	3.89	0.21	1.03	0.17	1.45	0.13					
SUM	45.56	6.90	135.67	11.00	38.93	8.06	83.85	6.44					
β-BHC													
	Dry Season 1		Wet Season	std	Dry season 2	std	Short rain	Std	**max**	**min**	**mean**	**median**	**sum**
MUHURUBAY	4.98	1.26	0.00	0.00	1.77	0.18	6.89	0.23	**6.89**	**0.00**	**3.41**	**3.37**	**13.64**
SORI	5.70	0.24	8.11	0.13	6.99	0.14	2.40	0.04	**8.11**	**2.40**	**5.80**	**6.35**	**23.21**
MBITA LHSD	7.10	0.50	10.24	0.05	5.79	0.98	2.44	0.61	**10.24**	**2.44**	**6.39**	**6.44**	**25.57**
MBITA WG	3.85	0.97	11.97	3.26	8.02	0.10	2.40	0.18	**11.97**	**2.40**	**6.56**	**5.94**	**26.24**
HOMABAY	5.92	0.34	3.02	0.12	2.05	0.07	2.45	0.56	**5.92**	**2.05**	**3.36**	**2.73**	**13.44**
KENDUBAY	3.60	0.75	2.02	0.19	5.32	0.77	6.22	0.18	**6.22**	**2.02**	**4.29**	**4.46**	**17.17**
KUSA	8.45	0.83	0.00	0.00	4.25	0.97	0.00	0.00	**8.45**	**0.00**	**3.18**	**2.12**	**12.70**
DUNGA BEACH	15.95	0.15	3.05	0.92	2.28	0.10	2.29	0.67	**15.95**	**2.28**	**5.89**	**2.67**	**23.56**
HIPPOPOINT	5.04	0.00	2.75	0.04	2.03	0.09	14.89	0.91	**14.89**	**2.03**	**6.18**	**3.90**	**24.72**
RAILWAYS	1.28	0.12	1.67	0.08	2.59	0.12	2.49	0.09	**2.59**	**1.28**	**2.01**	**2.08**	**8.03**
LUANDA	5.28	0.34	1.79	0.22	2.93	0.23	3.18	0.08	**5.28**	**1.79**	**3.30**	**3.06**	**13.18**
MISORI	2.94	0.66	1.78	0.01	1.90	0.27	5.72	0.07	**5.72**	**1.78**	**3.09**	**2.42**	**12.34**
USENGE	6.32	0.12	4.68	0.64	8.40	1.34	3.03	0.69	**8.40**	**3.03**	**5.61**	**5.50**	**22.44**
PORT VICTORIA	5.43	0.90	2.17	0.09	3.99	0.89	8.72	1.90	**8.72**	**2.17**	**5.08**	**4.71**	**20.30**
SIO PORT	6.50	0.47	1.62	0.38	2.98	0.89	3.35	0.13	**6.50**	**1.62**	**3.61**	**3.16**	**14.45**
R. KUJA	1.61	0.36	3.03	0.19	7.84	1.36	1.73	0.06	**7.84**	**1.61**	**3.55**	**2.38**	**14.21**
R. AWACH	1.61	0.01	10.81	0.80	2.62	0.07	1.31	0.31	**10.81**	**1.31**	**4.09**	**2.11**	**16.34**
R. SONDU	4.76	0.30	3.90	0.28	16.07	0.62	17.86	0.33	**17.86**	**3.90**	**10.65**	**10.42**	**42.59**
R. NYANDO	1.01	0.33	1.92	0.13	9.93	1.53	5.25	0.81	**9.93**	**1.01**	**4.53**	**3.58**	**18.11**
R. NYAMASARIA	1.18	0.17	6.22	0.64	15.16	2.44	3.52	0.87	**15.16**	**1.18**	**6.52**	**4.87**	**26.07**
R. KISIAN	2.15	0.59	2.41	0.19	2.83	0.03	7.22	0.18	**7.22**	**2.15**	**3.65**	**2.62**	**14.62**
R. MUGRUK	1.56	0.01	2.04	0.03	2.07	0.07	5.01	0.03	**5.01**	**1.56**	**2.67**	**2.05**	**10.68**
R. AWACH SEME	4.48	0.77	2.39	0.06	4.71	0.81	7.10	0.01	**7.10**	**2.39**	**4.67**	**4.60**	**18.67**
R. YALA	3.04	0.00	2.57	1.00	1.64	0.54	6.36	0.49	**6.36**	**1.64**	**3.40**	**2.80**	**13.61**
R. NZOIA	5.12	1.50	2.08	0.47	2.50	0.45	6.44	0.08	**6.44**	**2.08**	**4.03**	**3.81**	**16.14**
R. SIO	10.10	0.40	1.90	0.19	2.45	0.32	8.21	0.70	**10.10**	**1.90**	**5.67**	**5.33**	**22.67**
HOMABAY S.E.	7.92	0.46	11.63	0.01	4.59	2.03	18.74	1.86	**18.74**	**4.59**	**10.72**	**9.78**	**42.89**
HOMA BAY	1.24	0.01	2.39	0.05	1.95	0.22	13.75	0.92	**13.75**	**1.24**	**4.83**	**2.17**	**19.33**

DISCHARGE													
NYALENDA	1.07	0.03	2.07	0.16	9.23	1.25	5.67	0.03	**9.23**	**1.07**	**4.51**	**3.87**	**18.04**
KWASCO	9.02	0.46	9.32	0.14	13.08	1.12	15.25	0.38	**15.25**	**9.02**	**11.67**	**11.20**	**46.68**
KISATI	16.84	3.67	0.00	0.00	1.48	0.06	80.67	0.64	**80.67**	**0.00**	**24.75**	**9.16**	**98.99**
SAKA	11.67	2.38	5.99	0.53	2.38	0.20	4.42	0.84	**11.67**	**2.38**	**6.12**	**5.21**	**24.47**
MAX	16.84	3.67	11.97	3.26	16.07	2.44	80.67	1.90					
MIN	1.01	0.00	0.00	0.00	1.48	0.03	0.00	0.00					
MEAN	5.40	0.60	3.92	0.34	5.06	0.63	8.59	0.46					
MEDIAN	5.01	0.38	2.40	0.15	2.95	0.38	5.46	0.32					
SUM	172.76	19.10	125.55	10.99	161.82	20.24	274.99	14.86					
Heptachlor													
	Dry Season 1		Wet Season	std	Dry season 2	std	Short rain	Std	**max**	**min**	**mean**	**median**	**sum**
MUHURUBAY	9.61	1.30	0.00	0.00	12.13	3.10	15.81	1.66	**15.81**	**0.00**	**9.39**	**10.87**	**37.55**
SORI	14.48	0.86	10.04	0.60	13.10	1.56	15.22	0.34	**15.22**	**10.04**	**13.21**	**13.79**	**52.84**
MBITA LHSD	13.61	2.16	10.70	0.82	14.57	0.68	12.70	3.20	**14.57**	**10.70**	**12.89**	**13.15**	**51.58**
MBITA WG	6.26	0.40	12.38	2.48	11.82	0.65	9.96	1.30	**12.38**	**6.26**	**10.10**	**10.89**	**40.42**
HOMABAY	13.69	1.41	26.85	1.23	10.39	0.24	15.17	0.15	**26.85**	**10.39**	**16.53**	**14.43**	**66.10**
KENDUBAY	12.96	0.27	10.59	1.06	12.01	1.67	14.03	2.71	**14.03**	**10.59**	**12.40**	**12.49**	**49.60**
KUSA	29.37	0.62	0.00	0.00	12.81	2.44	0.00	0.00	**29.37**	**0.00**	**10.55**	**6.41**	**42.18**
DUNGA BEACH	15.32	1.73	15.02	2.76	12.21	1.96	8.43	1.15	**15.32**	**8.43**	**12.74**	**13.61**	**50.97**
HIPPOPOINT	10.29	1.38	10.29	0.75	10.39	0.05	21.74	1.57	**21.74**	**10.29**	**13.18**	**10.34**	**52.71**
RAILWAYS	15.32	0.10	7.99	0.36	13.37	0.24	13.22	0.56	**15.32**	**7.99**	**12.48**	**13.30**	**49.90**
LUANDA	9.96	0.79	9.32	1.14	13.67	0.97	8.61	0.52	**13.67**	**8.61**	**10.39**	**9.64**	**41.57**
MISORI	10.97	0.48	16.96	1.22	9.57	1.72	9.58	0.03	**16.96**	**9.57**	**11.77**	**10.27**	**47.08**
USENGE	15.05	1.22	9.42	0.96	13.99	2.10	11.97	1.80	**15.05**	**9.42**	**12.61**	**12.98**	**50.43**
PORT VICTORIA	10.46	2.47	23.57	0.89	14.62	2.99	11.37	0.99	**23.57**	**10.46**	**15.00**	**12.99**	**60.02**
SIO PORT	9.35	1.20	6.95	0.20	11.65	1.70	13.47	0.85	**13.47**	**6.95**	**10.36**	**10.50**	**41.42**
R. KUJA	10.76	1.30	8.92	0.24	12.46	1.26	9.40	0.94	**12.46**	**8.92**	**10.39**	**10.08**	**41.55**
R. AWACH	15.00	0.16	19.79	0.33	13.72	0.39	8.78	2.98	**19.79**	**8.78**	**14.32**	**14.36**	**57.30**
R. SONDU	10.68	1.02	12.59	2.83	13.66	2.37	13.26	3.93	**13.66**	**10.68**	**12.55**	**12.92**	**50.18**
R. NYANDO	10.85	2.50	9.90	0.55	13.88	3.51	11.04	0.04	**13.88**	**9.90**	**11.42**	**10.94**	**45.67**
R. NYAMASARIA	14.22	2.20	13.43	3.92	12.85	2.10	9.51	2.96	**14.22**	**9.51**	**12.50**	**13.14**	**50.02**
R. KISIAN	9.99	0.00	12.45	1.20	13.66	1.31	12.48	0.28	**13.66**	**9.99**	**12.15**	**12.46**	**48.58**
R. MUGRUK	10.15	2.73	11.27	0.78	9.71	2.14	13.42	2.36	**13.42**	**9.71**	**11.13**	**10.71**	**44.54**

R. AWACH SEME	11.58	2.20	11.84	1.45	11.88	1.81	12.54	2.11	**12.54**	**11.58**	**11.96**	**11.86**	**47.83**
R. YALA	9.54	0.90	17.92	0.77	7.82	2.63	10.62	0.67	**17.92**	**7.82**	**11.48**	**10.08**	**45.90**
R. NZOIA	14.12	1.64	9.91	1.35	13.53	2.97	13.15	0.35	**14.12**	**9.91**	**12.68**	**13.34**	**50.71**
R. SIO	18.32	2.00	10.95	2.51	11.89	1.83	6.90	1.06	**18.32**	**6.90**	**12.01**	**11.42**	**48.05**
HOMABAY S.E.	13.96	1.61	26.54	2.20	11.46	2.33	15.73	0.90	**26.54**	**11.46**	**16.92**	**14.84**	**67.68**
HOMA BAY DISCHARGE	9.66	0.07	12.27	0.26	9.79	1.46	21.48	0.71	**21.48**	**9.66**	**13.30**	**11.03**	**53.21**
NYALENDA	8.18	0.13	10.50	0.46	15.02	0.65	13.91	1.50	**15.02**	**8.18**	**11.90**	**12.20**	**47.60**
KWASCO	10.13	0.05	21.47	0.90	20.00	0.03	8.62	1.12	**21.47**	**8.62**	**15.05**	**15.06**	**60.21**
KISATI	12.60	0.49	0.00	0.00	7.63	0.26	12.35	0.36	**12.60**	**0.00**	**8.14**	**9.99**	**32.58**
SAKA	10.66	0.81	10.84	1.64	10.58	0.69	19.07	1.38	**19.07**	**10.58**	**12.79**	**10.75**	**51.15**
MAX	29.37	2.73	26.85	3.92	20.00	3.51	21.74	3.93					
MIN	6.26	0.00	0.00	0.00	7.63	0.03	0.00	0.00					
MEAN	12.41	1.13	12.21	1.12	12.37	1.56	12.30	1.26					
MEDIAN	10.91	1.11	10.90	0.89	12.33	1.69	12.51	1.02					
SUM	397.11	36.23	390.67	35.86	395.85	49.81	393.52	40.46					
Aldrin													
	Dry Season I		Wet Season	std	Dry season 2	std	Short rain	Std	**max**	**min**	**mean**	**median**	**sum**
MUHURUBAY	4.24	0.80	0.00	0.00	4.91	0.15	3.77	0.17	**4.91**	**0.00**	**3.23**	**4.00**	**12.92**
SORI	194.06	5.71	0.58	0.11	0.00	0.00	3.59	0.04	**194.06**	**0.00**	**49.56**	**2.08**	**198.22**
MBITA LHSD	1.75	0.40	0.00	0.00	0.00	0.00	0.00	0.00	**1.75**	**0.00**	**0.44**	**0.00**	**1.75**
MBITA WG	0.00	0.00	2.78	0.15	0.00	0.00	10.34	0.19	**10.34**	**0.00**	**3.28**	**1.39**	**13.11**
HOMABAY	1.49	0.18	0.83	0.08	0.00	0.00	8.39	0.24	**8.39**	**0.00**	**2.68**	**1.16**	**10.72**
KENDUBAY	0.03	0.01	0.00	0.00	0.00	0.00	5.30	0.14	**5.30**	**0.00**	**1.33**	**0.01**	**5.33**
KUSA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
DUNGA BEACH	2.96	0.09	29.65	0.64	0.00	0.00	0.00	0.00	**29.65**	**0.00**	**8.15**	**1.48**	**32.61**
HIPPOPOINT	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.06	**0.47**	**0.00**	**0.12**	**0.00**	**0.47**
RAILWAYS	89.93	2.59	0.00	0.00	1.51	0.01	0.00	0.00	**89.93**	**0.00**	**22.86**	**0.75**	**91.44**
LUANDA	0.00	0.00	2.59	0.11	0.00	0.00	4.48	0.12	**4.48**	**0.00**	**1.77**	**1.30**	**7.07**
MISORI	1.44	0.02	2.94	0.11	0.00	0.00	0.00	0.00	**2.94**	**0.00**	**1.10**	**0.72**	**4.39**
USENGE	0.00	0.00	0.00	0.00	0.71	0.05	4.26	0.04	**4.26**	**0.00**	**1.24**	**0.35**	**4.97**
PORT VICTORIA	6.48	0.06	0.80	0.13	3.11	0.26	0.00	0.00	**6.48**	**0.00**	**2.60**	**1.95**	**10.38**
SIO PORT	2.73	0.20	1.12	0.34	0.00	0.00	2.37	0.28	**2.73**	**0.00**	**1.55**	**1.74**	**6.22**
R. KUJA	0.00	0.00	0.57	0.06	0.00	0.00	0.00	0.00	**0.57**	**0.00**	**0.14**	**0.00**	**0.57**

R. AWACH	0.00	0.00	2.28	0.26	0.00	0.00	0.00	0.00	**2.28**	**0.00**	**0.57**	**0.00**	**2.28**
R. SONDU	0.38	0.11	6.16	5.67	2.46	0.14	0.00	0.00	**6.16**	**0.00**	**2.25**	**1.42**	**9.00**
R. NYANDO	0.00	0.00	41.11	54.34	13.23	0.46	0.00	0.00	**41.11**	**0.00**	**13.58**	**6.61**	**54.33**
R. NYAMASARIA	21.40	1.95	0.00	0.00	0.00	0.00	0.00	0.00	**21.40**	**0.00**	**5.35**	**0.00**	**21.40**
R. KISIAN	5.73	0.29	1.65	0.63	0.00	0.00	13.34	0.78	**13.34**	**0.00**	**5.18**	**3.69**	**20.71**
R. MUGRUK	6.04	0.08	0.00	0.00	2.29	0.22	7.01	0.12	**7.01**	**0.00**	**3.83**	**4.17**	**15.34**
R. AWACH SEME	0.00	0.00	0.00	0.00	3.98	0.16	6.06	0.22	**6.06**	**0.00**	**2.51**	**1.99**	**10.04**
R. YALA	1.08	0.17	6.43	0.68	0.00	0.00	2.37	0.74	**6.43**	**0.00**	**2.47**	**1.72**	**9.87**
R. NZOIA	0.00	0.00	0.47	0.63	0.00	0.00	0.00	0.00	**0.47**	**0.00**	**0.12**	**0.00**	**0.47**
R. SIO	3.80	0.41	4.69	0.18	0.00	0.00	0.00	0.00	**4.69**	**0.00**	**2.12**	**1.90**	**8.49**
HOMABAY S.E.	0.00	0.00	7.50	0.41	0.00	0.00	9.50	0.83	**9.50**	**0.00**	**4.25**	**3.75**	**17.00**
HOMA BAY DISCHARGE	0.00	0.00	0.49	0.10	0.05	0.02	9.91	1.41	**9.91**	**0.00**	**2.61**	**0.27**	**10.45**
NYALENDA	0.00	0.00	0.00	0.00	170.73	2.60	4.08	1.38	**170.73**	**0.00**	**43.70**	**2.04**	**174.81**
KWASCO	0.90	0.02	0.00	0.00	0.00	0.00	15.58	0.69	**15.58**	**0.00**	**4.12**	**0.45**	**16.48**
KISATI	4.99	0.15	0.00	0.00	0.00	0.00	0.00	0.00	**4.99**	**0.00**	**1.25**	**0.00**	**4.99**
SAKA	0.46	0.14	0.00	0.00	0.00	0.00	0.00	0.00	**0.46**	**0.00**	**0.11**	**0.00**	**0.46**
MAX	194.06	5.71	41.11	54.34	170.73	2.60	15.58	1.41					
MIN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
MEAN	10.93	0.42	3.52	2.02	6.34	0.13	3.46	0.23					
MEDIAN	0.68	0.04	0.53	0.09	0.00	0.00	1.42	0.04					
SUM	349.87	13.39	112.63	64.62	202.97	4.07	110.82	7.45					
Heptachlor epoxide													
	Dry Season 1		Wet Season	std	Dry season 2	std	Short rain	Std	**max**	**min**	**mean**	**median**	**sum**
MUHURUBAY	0.49	0.03	0.00	0.00	14.91	0.26	0.53	0.05	**14.91**	**0.00**	**3.98**	**0.51**	**15.93**
SORI	3.99	0.15	10.37	0.06	7.97	0.18	0.96	0.09	**10.37**	**0.96**	**5.82**	**5.98**	**23.29**
MBITA LHSD	3.23	0.09	0.00	0.00	0.00	0.00	0.00	0.00	**3.23**	**0.00**	**0.81**	**0.00**	**3.23**
MBITA WG	0.31	0.04	0.00	0.00	0.75	0.10	0.05	0.01	**0.75**	**0.00**	**0.28**	**0.18**	**1.11**
HOMABAY	2.59	0.06	0.00	0.00	0.00	0.00	129.98	2.67	**129.98**	**0.00**	**33.14**	**1.29**	**132.57**
KENDUBAY	2.39	0.09	0.00	0.00	1.96	0.18	18.41	26.04	**18.41**	**0.00**	**5.69**	**2.18**	**22.76**
KUSA	0.00	0.00	0.00	0.00	1.04	0.08	0.00	0.00	**1.04**	**0.00**	**0.26**	**0.00**	**1.04**
DUNGA BEACH	6.96	0.19	0.00	0.00	1.09	0.28	2.00	0.13	**6.96**	**0.00**	**2.51**	**1.54**	**10.04**

HIPPOPOINT	4.43	0.65	0.00	0.00	7.91	0.26	49.16	1.32	**49.16**	**0.00**	**15.37**	**6.17**	**61.50**
RAILWAYS	0.00	0.00	0.00	0.00	17.20	0.44	0.00	0.00	**17.20**	**0.00**	**4.30**	**0.00**	**17.20**
LUANDA	1.99	0.27	0.00	0.00	0.00	0.00	81.08	0.65	**81.08**	**0.00**	**20.77**	**1.00**	**83.08**
MISORI	41.15	0.18	0.00	0.00	6.60	0.38	0.00	0.00	**41.15**	**0.00**	**11.94**	**3.30**	**47.75**
USENGE	0.00	0.00	0.00	0.00	8.52	0.09	2.23	0.19	**8.52**	**0.00**	**2.69**	**1.11**	**10.74**
PORT VICTORIA	2.46	0.52	0.00	0.00	39.97	0.17	74.59	4.94	**74.59**	**0.00**	**29.26**	**21.22**	**117.02**
SIO PORT	45.28	0.42	0.13	0.03	8.56	1.26	1.52	0.06	**45.28**	**0.13**	**13.87**	**5.04**	**55.49**
R. KUJA	33.51	0.82	1.85	0.34	0.00	0.00	9.92	0.16	**33.51**	**0.00**	**11.32**	**5.89**	**45.28**
R. AWACH	0.00	0.00	0.02	0.00	9.78	0.34	2.97	0.18	**9.78**	**0.00**	**3.19**	**1.50**	**12.77**
R. SONDU	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.08	**0.40**	**0.00**	**0.10**	**0.00**	**0.40**
R. NYANDO	0.16	0.07	2.20	2.23	14.86	0.33	1.35	0.25	**14.86**	**0.16**	**4.64**	**1.77**	**18.56**
R. NYAMASARIA	0.00	0.00	0.75	0.18	12.49	0.57	70.91	0.26	**70.91**	**0.00**	**21.04**	**6.62**	**84.14**
R. KISIAN	40.37	0.72	0.96	0.19	1.48	0.06	0.00	0.00	**40.37**	**0.00**	**10.70**	**1.22**	**42.80**
R. MUGRUK	19.48	0.86	0.00	0.00	1.62	0.07	0.51	0.03	**19.48**	**0.00**	**5.40**	**1.07**	**21.62**
R. AWACH SEME	10.22	0.10	0.00	0.00	0.00	0.00	114.32	3.15	**114.32**	**0.00**	**31.14**	**5.11**	**124.54**
R. YALA	11.69	0.21	0.78	0.33	2.26	1.97	0.04	0.03	**11.69**	**0.04**	**3.69**	**1.52**	**14.76**
R. NZOIA	0.00	0.00	0.29	0.01	3.01	0.12	0.32	0.36	**3.01**	**0.00**	**0.90**	**0.31**	**3.62**
R. SIO	20.23	0.17	2.50	0.02	0.09	0.01	0.34	0.03	**20.23**	**0.09**	**5.79**	**1.42**	**23.16**
HOMABAY S.E.	21.04	0.08	0.00	0.00	0.73	0.14	56.48	6.21	**56.48**	**0.00**	**19.56**	**10.88**	**78.25**
HOMA BAY DISCHARGE	0.00	0.00	6.72	0.24	0.00	0.00	0.76	0.08	**6.72**	**0.00**	**1.87**	**0.38**	**7.49**
NYALENDA	21.94	1.01	0.09	0.00	10.00	0.13	1.88	0.23	**21.94**	**0.09**	**8.48**	**5.94**	**33.91**
KWASCO	0.06	0.07	0.95	0.20	0.00	0.00	58.60	2.11	**58.60**	**0.00**	**14.90**	**0.51**	**59.61**
KISATI	32.89	1.12	0.00	0.00	2.59	0.05	0.00	0.00	**32.89**	**0.00**	**8.87**	**1.30**	**35.48**
SAKA	0.00	0.00	0.09	0.09	4.49	0.11	0.40	0.01	**4.49**	**0.00**	**1.24**	**0.24**	**4.97**
MAX	45.28	1.12	10.37	2.23	39.97	1.97	129.98	26.04					
MIN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
MEAN	10.21	0.25	0.87	0.12	5.62	0.24	21.24	1.54					
MEDIAN	2.52	0.09	0.00	0.00	2.11	0.11	1.16	0.11					
SUM	326.86	7.90	27.71	3.91	179.87	7.58	679.70	49.32					
Endosulphan sulphate													
	Dry Season 1		Wet Season	std	Dry season 2	std	Short rain	Std	**max**	**min**	**mean**	**median**	**sum**

MUHURUBAY	6.03	0.26	0.00	0.00	3.97	0.24	2.95	0.43	**6.03**	**0.00**	**3.24**	**3.46**	**12.95**
SORI	3.18	0.57	5.09	0.58	3.10	0.41	1.38	0.26	**5.09**	**1.38**	**3.19**	**3.14**	**12.75**
MBITA LHSD	4.33	0.85	3.25	0.15	4.19	0.12	3.89	0.52	**4.33**	**3.25**	**3.92**	**4.04**	**15.66**
MBITA WG	4.41	0.80	3.60	0.72	3.59	0.89	3.28	0.37	**4.41**	**3.28**	**3.72**	**3.60**	**14.89**
HOMABAY	2.69	0.46	3.94	0.21	2.80	0.31	4.17	0.20	**4.17**	**2.69**	**3.40**	**3.37**	**13.60**
KENDUBAY	4.89	0.76	3.53	0.98	3.32	0.58	4.35	0.25	**4.89**	**3.32**	**4.02**	**3.94**	**16.08**
KUSA	5.09	0.01	0.00	0.00	3.49	0.79	0.00	0.00	**5.09**	**0.00**	**2.14**	**1.75**	**8.58**
DUNGA BEACH	2.34	0.74	4.77	1.11	3.27	0.76	2.29	0.41	**4.77**	**2.29**	**3.17**	**2.81**	**12.67**
HIPPOPOINT	4.98	0.62	3.17	0.09	3.01	0.27	2.76	0.15	**4.98**	**2.76**	**3.48**	**3.09**	**13.92**
RAILWAYS	3.59	0.95	4.62	0.24	3.49	0.25	6.20	0.05	**6.20**	**3.49**	**4.47**	**4.10**	**17.89**
LUANDA	3.73	0.69	6.42	0.25	4.13	0.00	2.60	0.11	**6.42**	**2.60**	**4.22**	**3.93**	**16.86**
MISORI	2.77	0.49	4.57	2.20	2.38	0.64	2.51	0.07	**4.57**	**2.38**	**3.06**	**2.64**	**12.23**
USENGE	3.14	0.63	4.43	1.04	4.02	0.60	2.96	0.56	**4.43**	**2.96**	**3.64**	**3.58**	**14.56**
PORT VICTORIA	2.90	0.23	5.19	1.90	4.27	0.05	3.25	0.44	**5.19**	**2.90**	**3.90**	**3.76**	**15.61**
SIO PORT	5.59	0.70	4.53	0.39	4.58	0.97	2.93	0.76	**5.59**	**2.93**	**4.41**	**4.56**	**17.63**
R. KUJA	6.00	0.76	5.37	0.22	4.34	0.82	2.24	0.09	**6.00**	**2.24**	**4.49**	**4.86**	**17.96**
R. AWACH	3.17	0.11	4.03	0.05	3.79	0.11	2.48	0.89	**4.03**	**2.48**	**3.37**	**3.48**	**13.47**
R. SONDU	2.41	0.43	5.38	0.68	4.68	0.57	3.84	0.96	**5.38**	**2.41**	**4.08**	**4.26**	**16.30**
R. NYANDO	2.80	0.97	7.17	0.06	5.66	0.72	3.05	0.46	**7.17**	**2.80**	**4.67**	**4.36**	**18.68**
R. NYAMASARIA	4.55	0.97	3.24	0.52	5.06	0.77	2.70	0.81	**5.06**	**2.70**	**3.89**	**3.90**	**15.55**
R. KISIAN	5.07	0.87	4.97	0.11	3.62	0.12	3.58	0.63	**5.07**	**3.58**	**4.31**	**4.30**	**17.24**
R. MUGRUK	4.48	0.82	3.05	0.09	2.88	0.16	2.71	0.25	**4.48**	**2.71**	**3.28**	**2.97**	**13.12**
R. AWACH SEME	3.07	0.10	13.26	0.55	4.11	0.72	4.53	0.13	**13.26**	**3.07**	**6.24**	**4.32**	**24.97**
R. YALA	8.56	0.66	2.72	0.21	2.65	1.00	4.13	0.55	**8.56**	**2.65**	**4.52**	**3.42**	**18.06**
R. NZOIA	3.49	0.84	2.92	0.73	3.50	0.84	3.92	0.12	**3.92**	**2.92**	**3.46**	**3.50**	**13.83**
R. SIO	2.94	0.06	6.12	0.64	3.45	0.67	3.12	2.41	**6.12**	**2.94**	**3.91**	**3.29**	**15.63**
HOMABAY S.E.	7.27	0.57	11.76	0.95	12.27	0.25	2.65	0.11	**12.27**	**2.65**	**8.49**	**9.51**	**33.95**
HOMA BAY DISCHARGE	2.70	0.35	8.51	0.55	2.39	0.02	12.33	0.34	**12.33**	**2.39**	**6.48**	**5.60**	**25.93**
NYALENDA	4.76	0.47	3.59	0.12	3.56	0.52	3.22	0.87	**4.76**	**3.22**	**3.78**	**3.58**	**15.14**
KWASCO	7.20	0.42	4.01	0.12	5.56	0.06	3.57	0.07	**7.20**	**3.57**	**5.09**	**4.78**	**20.34**
KISATI	5.21	0.73	0.00	0.00	2.10	0.01	3.36	0.20	**5.21**	**0.00**	**2.67**	**2.73**	**10.67**
SAKA	12.90	0.87	2.69	0.18	3.08	0.02	14.87	2.55	**14.87**	**2.69**	**8.38**	**7.99**	**33.53**
MAX	12.90	0.97	13.26	2.20	12.27	1.00	14.87	2.55					
MIN	2.34	0.01	0.00	0.00	2.10	0.00	0.00	0.00					

MEAN	4.57	0.59	4.56	0.49	3.95	0.45	3.81	0.50					
MEDIAN	4.37	0.64	4.23	0.24	3.58	0.47	3.17	0.35					
SUM	146.27	18.75	145.86	15.64	126.30	14.26	121.82	16.02					
Methoxychlor													
	Dry Season 1		Wet Season	std	Dry season 2	std	Short rain	Std	**max**	**min**	**mean**	**median**	**sum**
MUHURUBAY	0.05	0.01	0.00	0.00	1.30	0.22	0.14	0.05	**1.30**	**0.00**	**0.37**	**0.09**	**1.48**
SORI	0.19	0.19	1.65	0.64	1.17	0.05	0.28	0.08	**1.65**	**0.19**	**0.82**	**0.73**	**3.29**
MBITA LHSD	0.17	0.19	0.06	0.01	1.35	0.09	128.94	16.40	**128.94**	**0.06**	**32.63**	**0.76**	**130.53**
MBITA WG	5.57	0.68	86.17	7.34	0.77	0.12	0.08	0.04	**86.17**	**0.08**	**23.15**	**3.17**	**92.59**
HOMABAY	0.70	0.76	0.16	0.03	0.05	0.06	130.93	5.59	**130.93**	**0.05**	**32.96**	**0.43**	**131.84**
KENDUBAY	0.06	0.02	1.83	0.26	0.87	0.01	1.30	0.37	**1.83**	**0.06**	**1.01**	**1.08**	**4.05**
KUSA	0.10	0.00	0.00	0.00	1.51	0.04	0.00	0.00	**1.51**	**0.00**	**0.40**	**0.05**	**1.61**
DUNGA BEACH	0.12	0.11	0.07	0.03	1.04	0.02	0.05	0.01	**1.04**	**0.05**	**0.32**	**0.10**	**1.28**
HIPPOPOINT	1.91	0.14	0.07	0.02	0.26	0.01	0.06	0.01	**1.91**	**0.06**	**0.58**	**0.16**	**2.30**
RAILWAYS	0.23	0.21	10.41	0.30	0.79	0.06	2.51	0.28	**10.41**	**0.23**	**3.48**	**1.65**	**13.94**
LUANDA	0.54	0.52	1.51	0.70	0.69	0.24	0.07	0.03	**1.51**	**0.07**	**0.70**	**0.62**	**2.81**
MISORI	0.06	0.01	0.32	0.14	0.74	0.07	0.98	0.16	**0.98**	**0.06**	**0.53**	**0.53**	**2.10**
USENGE	0.18	0.11	0.10	0.01	0.61	0.01	0.10	0.06	**0.61**	**0.10**	**0.25**	**0.14**	**1.00**
PORT VICTORIA	0.25	0.29	1.75	0.38	0.48	0.11	0.06	0.00	**1.75**	**0.06**	**0.64**	**0.37**	**2.54**
SIO PORT	0.10	0.07	9.91	0.95	43.48	60.27	0.08	0.00	**43.48**	**0.08**	**13.39**	**5.00**	**53.56**
R. KUJA	0.07	0.03	9.50	1.27	1.06	0.06	0.05	0.00	**9.50**	**0.05**	**2.67**	**0.57**	**10.68**
R. AWACH	0.19	0.03	8.49	1.09	0.59	0.04	31.38	1.83	**31.38**	**0.19**	**10.16**	**4.54**	**40.66**
R. SONDU	1.11	0.23	1.00	0.18	0.74	0.06	3.86	0.21	**3.86**	**0.74**	**1.68**	**1.06**	**6.71**
R. NYANDO	3.95	0.21	1.26	0.06	0.99	0.04	0.09	0.01	**3.95**	**0.09**	**1.57**	**1.12**	**6.29**
R. NYAMASARIA	0.27	0.21	0.18	0.09	0.47	0.03	0.04	0.01	**0.47**	**0.04**	**0.24**	**0.23**	**0.96**
R. KISIAN	0.05	0.00	1.32	0.10	0.50	0.08	0.64	0.81	**1.32**	**0.05**	**0.63**	**0.57**	**2.51**
R. MUGRUK	0.36	0.21	87.03	8.87	0.58	0.03	0.12	0.04	**87.03**	**0.12**	**22.02**	**0.47**	**88.10**
R. AWACH SEME	0.06	0.03	4.55	0.14	0.54	0.01	0.06	0.01	**4.55**	**0.06**	**1.30**	**0.30**	**5.21**
R. YALA	1.32	0.17	19.04	4.17	0.24	0.09	0.09	0.04	**19.04**	**0.09**	**5.18**	**0.78**	**20.70**
R. NZOIA	0.67	0.51	0.64	0.32	0.52	0.06	0.08	0.02	**0.67**	**0.08**	**0.48**	**0.58**	**1.92**
R. SIO	0.53	0.70	19.27	4.30	29.89	41.29	0.08	0.04	**29.89**	**0.08**	**12.45**	**9.90**	**49.78**
HOMABAY S.E.	0.00	0.00	16.59	2.12	2.24	0.61	0.05	0.01	**16.59**	**0.00**	**4.72**	**1.15**	**18.89**
HOMA BAY DISCHARGE	2.67	0.16	2.05	0.08	0.65	0.13	1.27	0.10	**2.67**	**0.65**	**1.66**	**1.66**	**6.64**

NYALENDA	0.05	0.00	0.73	0.20	0.73	0.13	0.22	0.05	**0.73**	**0.05**	**0.43**	**0.47**	**1.73**
KWASCO	5.70	0.55	2.48	0.05	0.10	0.14	12.37	0.65	**12.37**	**0.10**	**5.16**	**4.09**	**20.66**
KISATI	3.23	0.29	0.00	0.00	0.28	0.40	24.04	2.75	**24.04**	**0.00**	**6.89**	**1.75**	**27.55**
SAKA	1.02	0.00	9.39	0.90	0.68	0.01	0.21	0.07	**9.39**	**0.21**	**2.83**	**0.85**	**11.31**
MAX	5.70	0.76	87.03	8.87	43.48	60.27	130.93	16.40					
MIN	0.00	0.00	0.00	0.00	0.05	0.01	0.00	0.00					
MEAN	0.98	0.21	9.30	1.09	3.00	3.27	10.63	0.93					
MEDIAN	0.24	0.17	1.58	0.19	0.71	0.06	0.11	0.05					
SUM	31.49	6.65	297.56	34.73	95.92	104.60	340.24	29.73					
γ-HCH	Dry Season 1		Wet Season	std	Dry season 2	std	Short rain	std	**max**	**min**	**mean**	**median**	**sum**
MUHURUBAY	14.08	0.29	4.72	0.06	4.11	0.02	0.00	0.00	**14.08**	**0.00**	**5.73**	**4.42**	**22.91**
SORI	1.36	0.73	4.95	0.86	1.34	0.10	4.54	0.19	**4.95**	**1.34**	**3.05**	**2.95**	**12.19**
MBITA LHSD	39.52	4.51	2.42	0.02	0.00	0.00	42.32	1.22	**42.32**	**0.00**	**21.06**	**20.97**	**84.26**
MBITA WG	0.59	0.19	18.33	1.89	0.00	0.00	0.00	0.00	**18.33**	**0.00**	**4.73**	**0.30**	**18.92**
HOMABAY	3.96	0.50	6.94	0.22	0.00	0.00	19.82	0.39	**19.82**	**0.00**	**7.68**	**5.45**	**30.72**
KENDUBAY	0.00	0.00	13.99	0.14	0.00	0.00	6.28	0.24	**13.99**	**0.00**	**5.07**	**3.14**	**20.27**
KUSA	3.12	0.78	4.55	0.14	5.02	0.10	0.00	0.00	**5.02**	**0.00**	**3.18**	**3.84**	**12.70**
DUNGA BEACH	6.34	0.83	3.38	0.10	0.00	0.00	7.13	2.90	**7.13**	**0.00**	**4.21**	**4.86**	**16.85**
HIPPOPOINT	124.39	6.35	17.01	0.16	5.26	0.72	49.27	1.51	**124.39**	**5.26**	**48.98**	**33.14**	**195.93**
RAILWAYS	18.62	2.75	5.11	0.96	9.60	0.57	26.58	0.84	**26.58**	**5.11**	**14.98**	**14.11**	**59.91**
LUANDA	1.08	0.67	17.22	1.59	4.40	0.15	59.44	1.56	**59.44**	**1.08**	**20.53**	**10.81**	**82.14**
MISORI	0.00	0.00	2.10	1.05	4.49	0.57	2.43	0.80	**4.49**	**0.00**	**2.25**	**2.26**	**9.02**
USENGE	11.26	1.18	49.84	2.76	0.00	0.00	6.90	0.62	**49.84**	**0.00**	**17.00**	**9.08**	**67.99**
PORT VICTORIA	7.63	0.66	48.81	1.80	15.76	0.94	60.07	13.75	**60.07**	**7.63**	**33.07**	**32.29**	**132.27**
SIO PORT	0.00	0.00	3.73	0.24	16.20	3.83	11.13	1.21	**16.20**	**0.00**	**7.76**	**7.43**	**31.06**
R. KUJA	76.73	4.76	11.71	3.26	13.98	0.16	17.71	1.19	**76.73**	**11.71**	**30.03**	**15.84**	**120.13**
R. AWACH	0.00	0.00	5.63	0.57	0.00	0.00	17.19	1.28	**17.19**	**0.00**	**5.70**	**2.81**	**22.82**
R. SONDU	0.67	0.95	24.64	2.19	9.04	1.72	12.39	0.85	**24.64**	**0.67**	**11.68**	**10.71**	**46.74**
R. NYANDO	4.05	1.47	1.97	0.18	0.00	0.00	8.82	0.74	**8.82**	**0.00**	**3.71**	**3.01**	**14.83**
R. NYAMASARIA	3.65	0.63	24.06	1.46	4.08	0.61	0.00	0.00	**24.06**	**0.00**	**7.95**	**3.87**	**31.79**
R. KISIAN	39.92	0.24	5.38	1.01	4.56	0.76	6.20	0.20	**39.92**	**4.56**	**14.02**	**5.79**	**56.06**
R. MUGRUK	6.76	0.47	19.43	0.94	0.00	0.00	39.19	1.29	**39.19**	**0.00**	**16.34**	**13.09**	**65.38**
R. AWACH SEME	23.19	0.13	11.82	0.39	19.53	0.79	124.91	0.26	**124.91**	**11.82**	**44.86**	**21.36**	**179.45**

R. YALA	8.96	0.18	6.49	2.73	0.00	0.00	28.65	2.05	**28.65**	**0.00**	**11.03**	**7.73**	**44.10**
R. NZOIA	15.01	0.13	4.34	0.31	3.29	0.47	2.94	0.22	**15.01**	**2.94**	**6.39**	**3.82**	**25.58**
R. SIO	41.50	0.57	7.76	0.32	0.00	0.00	8.62	9.96	**41.50**	**0.00**	**14.47**	**8.19**	**57.88**
HOMABAY S.E.	0.00	0.00	12.57	0.43	0.00	0.00	60.35	0.92	**60.35**	**0.00**	**18.23**	**6.29**	**72.92**
HOMA BAY DISCHARGE	0.00	0.00	23.16	1.51	3.16	0.07	11.11	0.35	**23.16**	**0.00**	**9.36**	**7.14**	**37.43**
NYALENDA	4.87	0.31	19.25	1.64	0.00	0.00	0.00	0.00	**19.25**	**0.00**	**6.03**	**2.44**	**24.12**
KWASCO	16.42	2.36	6.60	0.71	5.00	0.14	161.53	10.51	**161.53**	**5.00**	**47.39**	**11.51**	**189.54**
KISATI	81.79	1.11	8.34	0.61	2.12	0.14	51.08	1.40	**81.79**	**2.12**	**35.83**	**29.71**	**143.33**
SAKA	67.69	2.49	3.22	0.92	3.49	0.09	6.03	0.66	**67.69**	**3.22**	**20.11**	**4.76**	**80.44**
MAX	124.39	6.35	49.84	3.26	19.53	3.83	161.53	13.75	**161.53**	**19.53**	**88.82**	**87.11**	**355.28**
MIN	0.00	0.00	1.97	0.02	0.00	0.00	0.00	0.00	**1.97**	**0.00**	**0.49**	**0.00**	**1.97**
MEAN	19.47	1.10	12.48	0.97	4.20	0.37	26.64	1.78	**26.64**	**4.20**	**15.70**	**15.98**	**62.80**
MEDIAN	6.55	0.60	7.35	0.78	3.23	0.10	11.12	0.82	**11.12**	**3.23**	**7.06**	**6.95**	**28.25**
SUM	623.15	35.25	399.45	31.15	134.43	11.95	852.63	57.11	**852.63**	**134.43**	**502.42**	**511.30**	**2,009.67**

Table 4.4.2A: Pesticide residues in sediments (ng/kg)

ALDRIN	Dry season 1	±sd	Wet seaon	±sd	Dry season 2	±sd	Short rain	±sd	MEAN	MAX	MIN	SUM
MUHURUBAY	668.02	56.38	0.00	0.00	231.58	48.73	0.00	0.00	224.90	668.02	0.00	899.60
SORI	0.00	0.00	80.67	24.55	112.32	10.13	0.00	0.00	48.25	112.32	0.00	192.99
MBITA LHSD	0.00	0.00	538.39	31.39	290.26	7.86	0.00	0.00	207.16	538.39	0.00	828.65
MBITA WG	0.00	0.00	401.35	19.42	8,975.86	59.29	0.00	0.00	2,344.30	8,975.86	0.00	9,377.21
HOMABAY	120.41	2.33	276.38	3.94	358.23	16.13	256.44	5.65	252.86	358.23	120.41	1,011.46
KENDUBAY	3,953.05	66.01	19,501.38	591.11	1,996.61	87.76	216.71	15.11	6,416.94	19,501.38	216.71	25,667.76
KUSA	384.09	16.29	243.74	6.23	106.31	16.16	0.00	0.00	183.53	384.09	0.00	734.14
DUNGA BEACH	349.41	37.68	44.22	5.66	2,801.22	68.55	45.86	3.07	810.18	2,801.22	44.22	3,240.70
HIPPOPOINT	0.00	0.00	269.28	6.59	308.07	18.67	139.25	9.83	179.15	308.07	0.00	716.59
RAILWAYS	143.97	8.18	554.98	45.33	719.74	136.04	0.00	0.00	354.67	719.74	0.00	1,418.70
LUANDA	1,113.87	37.90	308.87	41.20	327.32	29.27	0.00	0.00	437.52	1,113.87	0.00	1,750.06
MISORI	496.67	44.52	302.15	11.94	187.18	5.01	0.00	0.00	246.50	496.67	0.00	986.00
USENGE	0.00	0.00	579.65	15.87	578.26	64.42	49.38	3.75	301.82	579.65	0.00	1,207.30
PORT VICTORIA	658.32	145.02	397.77	52.01	2,988.55	96.72	135.16	13.41	1,044.95	2,988.55	135.16	4,179.80
SIO PORT	826.29	163.21	314.13	69.29	227.54	56.07	250.40	9.94	404.59	826.29	227.54	1,618.35
R. KUJA	201.08	1.02	732.91	42.91	430.24	27.85	2,086.61	233.00	862.71	2,086.61	201.08	3,450.84
R. AWACH	0.00	0.00	40.18	1.96	241.14	29.55	0.00	0.00	70.33	241.14	0.00	281.32
R. SONDU	778.07	28.33	277.21	66.50	159.50	50.58	193.88	77.12	352.17	778.07	159.50	1,408.67
R. NYANDO	490.32	28.21	425.30	32.82	578.34	39.80	499.87	21.22	498.46	578.34	425.30	1,993.84
R. NYAMASARIA	747.84	22.61	558.90	42.92	1,633.86	66.30	3,248.39	201.77	1,547.25	3,248.39	558.90	6,188.98
R. KISIAN	586.33	47.91	329.95	22.54	418.74	16.60	348.34	36.16	420.84	586.33	329.95	1,683.36
R. MUGRUK	166.31	14.99	307.02	12.79	2,070.72	55.21	53.06	17.76	649.28	2,070.72	53.06	2,597.12
R. AWACH SEME	943.62	43.18	57.31	20.36	50.94	6.87	822.89	52.74	468.69	943.62	50.94	1,874.77
R. YALA	173.80	10.82	199.52	20.12	2,540.33	67.94	53.85	7.92	741.88	2,540.33	53.85	2,967.50
R. NZOIA	252.45	10.56	828.60	30.76	514.68	39.31	204.84	12.02	450.14	828.60	204.84	1,800.57
R. SIO	953.43	65.49	65.06	15.17	283.87	26.55	1,046.87	97.96	587.31	1,046.87	65.06	2,349.24
NYALENDA	100.79	11.71	291.12	27.41	21,815.71	706.84	0.00	0.00	5,551.90	21,815.71	0.00	22,207.62
KWASCO	0.00	0.00	0.00	0.00	646.01	77.89	290.59	11.18	234.15	646.01	0.00	936.60
KISATI	2,099.64	106.58	53.84	11.64	6,425.59	486.02	277.25	39.58	2,214.08	6,425.59	53.84	8,856.32
SAKA	587.05	20.07	87.12	15.64	1,881.23	71.69	0.00	0.00	638.85	1,881.23	0.00	2,555.41

									#DIV/0!	0.00	0.00	0.00
MEAN	**559.83**	**32.97**	**935.57**	**42.94**	**1,996.66**	**82.99**	**340.65**	**28.97**	958.18	1,996.66	340.65	3,832.72
MAX	**3,953.05**	**163.21**	**19,501.38**	**591.11**	**21,815.71**	**706.84**	**3,248.39**	**233.00**	12,129.63	21,815.71	3,248.39	48,518.52
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**50.94**	**5.01**	**0.00**	**0.00**	12.74	50.94	0.00	50.94
MEDIAN	**366.75**	**18.18**	**296.64**	**20.24**	**472.46**	**49.65**	**94.51**	**8.87**	307.59	472.46	94.51	1,230.35
SUM	**16,794.85**	**989.00**	**28,067.01**	**1,288.07**	**59,899.94**	**2,489.78**	**10,219.65**	**869.17**	28,745.36	59,899.94	10,219.65	114,981.45
DIELDRIN	Dry season 1	±sd	Wet seaon	±sd	Dry season 2	±sd	Short rain	±sd				
MUHURUBAY	10,421.74	624.39	0.00	0.00	5,903.83	170.17	0.00	0.00	4,081.39	10,421.74	0.00	16,325.57
SORI	0.00	0.00	0.00	0.00	1,393.49	14.88	0.00	0.00	348.37	1,393.49	0.00	1,393.49
MBITA LHSD	0.00	0.00	404.52	261.90	131.63	17.05	0.00	0.00	134.04	404.52	0.00	536.15
MBITA WG	0.00	0.00	423.32	22.32	41,432.67	611.60	0.00	0.00	10,464.00	41,432.67	0.00	41,855.99
HOMABAY	3,491.70	29.92	382.59	18.49	42.59	18.45	0.00	0.00	979.22	3,491.70	0.00	3,916.89
KENDUBAY	6,365.85	568.92	414.31	24.94	0.00	0.00	211.29	8.26	1,747.86	6,365.85	0.00	6,991.45
KUSA	392.87	32.08	304.75	8.02	948.99	117.50	0.00	0.00	411.65	948.99	0.00	1,646.61
DUNGA BEACH	0.00	0.00	0.00	0.00	2,448.61	80.25	0.00	0.00	612.15	2,448.61	0.00	2,448.61
HIPPOPOINT	0.00	0.00	3,433.37	61.22	310.71	42.10	538.18	55.12	1,070.57	3,433.37	0.00	4,282.26
RAILWAYS	0.00	0.00	403.47	17.36	5,381.54	350.40	0.00	0.00	1,446.25	5,381.54	0.00	5,785.01
LUANDA	0.00	0.00	0.00	0.00	395.75	53.47	0.00	0.00	98.94	395.75	0.00	395.75
MISORI	141.00	15.28	407.69	41.42	0.00	0.00	0.00	0.00	137.17	407.69	0.00	548.69
USENGE	0.00	0.00	3,010.94	140.75	1,390.82	44.70	284.40	14.81	1,171.54	3,010.94	0.00	4,686.16
PORT VICTORIA	1,365.40	100.77	378.64	5.00	458.92	143.09	922.44	72.39	781.35	1,365.40	378.64	3,125.41
SIO PORT	1,047.39	698.80	508.31	4.72	725.75	68.17	7,723.93	498.06	2,501.34	7,723.93	508.31	10,005.37
R. KUJA	0.00	0.00	382.08	17.96	0.00	0.00	0.00	0.00	95.52	382.08	0.00	382.08
R. AWACH	0.00	0.00	0.00	0.00	361.94	47.23	0.00	0.00	90.48	361.94	0.00	361.94
R. SONDU	59.06	30.83	406.84	37.52	2,590.34	128.36	1,004.59	22.19	1,015.21	2,590.34	59.06	4,060.83
R. NYANDO	4,682.97	169.99	423.80	25.52	1,079.40	30.58	0.00	0.00	1,546.54	4,682.97	0.00	6,186.18
R. NYAMASARIA	873.92	28.37	458.39	47.45	2,824.19	26.73	50.33	19.13	1,051.71	2,824.19	50.33	4,206.83
R. KISIAN	1,559.03	84.61	504.75	124.62	2,877.67	129.36	368.08	33.60	1,327.38	2,877.67	368.08	5,309.53
R. MUGRUK	3,138.69	58.26	0.00	0.00	3,028.70	148.75	0.00	0.00	1,541.85	3,138.69	0.00	6,167.39
R. AWACH SEME	60,150.17	589.71	0.00	0.00	0.00	0.00	0.00	0.00	15,037.54	60,150.17	0.00	60,150.17
R. YALA	2,979.11	46.95	1,866.92	149.40	1,994.28	2,631.75	0.00	0.00	1,710.08	2,979.11	0.00	6,840.31
R. NZOIA	9,616.71	54.89	0.00	0.00	1,507.63	15.32	295.35	6.29	2,854.92	9,616.71	0.00	11,419.69
R. SIO	1,706.86	26.12	0.00	0.00	1,521.86	74.56	3,931.71	110.66	1,790.11	3,931.71	0.00	7,160.42

NYALENDA	0.00	0.00	0.00	0.00	50,731.57	1,176.42	0.00	0.00	12,682.89	50,731.57	0.00	50,731.57
KWASCO	0.00	0.00	0.00	0.00	7,673.74	838.76	571.47	36.34	2,061.30	7,673.74	0.00	8,245.21
KISATI	7,530.83	396.57	0.00	0.00	1,088.39	28.89	381.81	35.64	2,250.26	7,530.83	0.00	9,001.03
SAKA	0.00	0.00	2,950.02	79.03	6,217.09	254.57	0.00	0.00	2,291.78	6,217.09	0.00	9,167.11
MEAN	**3,850.78**	**118.55**	**568.82**	**36.25**	**4,815.40**	**242.10**	**542.79**	**30.42**	2,444.45	4,815.40	542.79	9,777.79
MAX	**60,150.17**	**698.80**	**3,433.37**	**261.90**	**50,731.57**	**2,631.75**	**7,723.93**	**498.06**	30,509.76	60,150.17	3,433.37	122,039.04
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.00	0.00	0.00	0.00
MEDIAN	**266.94**	**27.25**	**382.34**	**12.69**	**1,392.16**	**60.82**	**0.00**	**0.00**	510.36	1,392.16	0.00	2,041.43
SUM	**115,523.30**	**3,556.43**	**17,064.69**	**1,087.64**	**144,462.12**	**7,263.11**	**16,283.58**	**912.51**	73,333.42	144,462.12	16,283.58	293,333.69
***p,p'*-DDT**	Dry season 1	±sd	Wet seaon	±sd	Dry season 2	±sd	Short rain	±sd				
MUHURUBAY	290,003.28	6,614.45	0.00	0.00	30,522.95	1,018.68	0.00	0.00	80,131.56	290,003.28	0.00	320,526.23
SORI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MBITA LHSD	0.00	0.00	12,347.70	1,494.03	10,440.98	403.47	0.00	0.00	5,697.17	12,347.70	0.00	22,788.68
MBITA WG	0.00	0.00	6,058.97	642.59	71,481.98	707.11	0.00	0.00	19,385.24	71,481.98	0.00	77,540.95
HOMABAY	49,217.04	2,140.53	5,433.07	360.19	2,073.36	48.18	0.00	0.00	14,180.87	49,217.04	0.00	56,723.47
KENDUBAY	0.00	0.00	2,552.87	54.33	79.70	24.34	0.00	0.00	658.14	2,552.87	0.00	2,632.57
KUSA	8,225.06	310.01	16,753.89	682.96	53,533.87	2,539.48	0.00	0.00	19,628.21	53,533.87	0.00	78,512.82
DUNGA BEACH	0.00	0.00	0.00	0.00	22,816.38	2,387.84	0.00	0.00	5,704.09	22,816.38	0.00	22,816.38
HIPPOPOINT	0.00	0.00	33,615.66	5,175.78	5,283.77	1,965.63	33,114.13	948.49	18,003.39	33,615.66	0.00	72,013.56
RAILWAYS	0.00	0.00	29,722.74	469.17	28,758.29	2,351.75	0.00	0.00	14,620.26	29,722.74	0.00	58,481.03
LUANDA	420,409.30	599.35	0.00	0.00	36,520.76	1,398.24	0.00	0.00	114,232.51	420,409.30	0.00	456,930.06
MISORI	13,100.03	109.91	8,711.27	308.42	150.34	2.10	0.00	0.00	5,490.41	13,100.03	0.00	21,961.64
USENGE	0.00	0.00	43,446.06	1,428.21	12,400.59	924.86	86.30	32.40	13,983.24	43,446.06	0.00	55,932.95
PORT VICTORIA	10,977.54	758.49	9,716.88	899.44	10,106.54	399.81	7,621.03	479.89	9,605.50	10,977.54	7,621.03	38,421.98
SIO PORT	265,802.67	7,554.89	19,699.25	1,244.25	699.46	56.85	4,396.78	175.65	72,649.54	265,802.67	699.46	290,598.15
R. KUJA	5,860.27	217.67	15,408.66	541.96	0.00	0.00	14,681.82	425.91	8,987.69	15,408.66	0.00	35,950.75
R. AWACH	0.00	0.00	0.00	0.00	24,773.35	864.74	0.00	0.00	6,193.34	24,773.35	0.00	24,773.35
R. SONDU	0.00	0.00	3,841.59	279.00	12,872.29	254.17	0.00	0.00	4,178.47	12,872.29	0.00	16,713.89
R. NYANDO	45,775.79	598.96	5,942.00	781.04	24,736.58	1,693.05	4,707.73	339.00	20,290.53	45,775.79	4,707.73	81,162.10
R. NYAMASARIA	11,118.32	478.84	15,442.09	1,362.17	8,083.95	89.59	18,201.57	1,104.94	13,211.48	18,201.57	8,083.95	52,845.91
R. KISIAN	4,958.18	149.63	12,704.84	911.95	126,381.69	4,939.14	71,800.96	3,133.95	53,961.42	126,381.69	4,958.18	215,845.67
R. MUGRUK	65,005.86	2,853.95	0.00	0.00	40,833.02	1,084.10	0.00	0.00	26,459.72	65,005.86	0.00	105,838.88

R. AWACH SEME	182.60	20.15	0.00	0.00	0.00	0.00	128.73	1.18	77.83	182.60	0.00	311.33
R. YALA	0.00	0.00	2,932.26	82.86	2,404.21	272.90	0.00	0.00	1,334.12	2,932.26	0.00	5,336.47
R. NZOIA	1,145.75	145.46	0.00	0.00	9,771.02	1,009.90	11,805.31	875.14	5,680.52	11,805.31	0.00	22,722.08
R. SIO	12,938.81	885.72	0.00	0.00	1,089.39	112.11	46,125.79	1,172.40	15,038.50	46,125.79	0.00	60,153.98
NYALENDA	102,213.23	705.59	7,227.93	12,519.14	70,398.55	721.28	0.00	0.00	44,959.93	102,213.23	0.00	179,839.71
KWASCO	0.00	0.00	0.00	0.00	27,887.65	689.95	0.00	0.00	6,971.91	27,887.65	0.00	27,887.65
KISATI	312,074.26	1,022.48	0.00	0.00	27,700.13	581.55	2,895.78	125.22	85,667.54	312,074.26	0.00	342,670.18
SAKA	136,603.42	1,456.27	781.60	30.32	80,042.42	60,423.66	0.00	0.00	54,356.86	136,603.42	0.00	217,427.44
MEAN	**58,520.38**	**887.41**	**8,411.31**	**975.59**	**24,728.11**	**2,898.82**	**7,185.53**	**293.81**	24,711.33	58,520.38	7,185.53	98,845.33
MAX	**420,409.30**	**7,554.89**	**43,446.06**	**12,519.14**	**126,381.69**	**60,423.66**	**71,800.96**	**3,133.95**	165,509.50	420,409.30	43,446.06	662,038.01
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.00	0.00	0.00	0.00
MEDIAN	**5,409.22**	**147.54**	**4,637.33**	**293.71**	**12,636.44**	**698.53**	**0.00**	**0.00**	5,670.75	12,636.44	0.00	22,683.00
SUM	**1,755,611.40**	**26,622.33**	**252,339.32**	**29,267.82**	**741,843.23**	**86,964.47**	**215,565.91**	**8,814.19**	741,339.97	1,755,611.40	215,565.91	2,965,359.86
***p,p'*-DDE**	Dry season 1	±sd	Wet seaon	±sd	Dry season 2	±sd	Short rain	±sd				
MUHURUBAY	1,076.11	25.32	0.00	0.00	180.89	21.40	0.00	0.00	314.25	1,076.11	0.00	1,257.00
SORI	0.00	0.00	195.72	7.20	0.00	0.00	0.00	0.00	48.93	195.72	0.00	195.72
MBITA LHSD	0.00	0.00	1,021.17	96.63	185.14	25.51	0.00	0.00	301.58	1,021.17	0.00	1,206.31
MBITA WG	0.00	0.00	574.44	75.05	8,902.99	233.03	0.00	0.00	2,369.36	8,902.99	0.00	9,477.43
HOMABAY	301.73	10.33	509.62	38.64	217.45	16.66	349.89	6.43	344.68	509.62	217.45	1,378.70
KENDUBAY	5,766.35	225.50	887.54	25.86	2,088.31	58.23	104.32	6.39	2,211.63	5,766.35	104.32	8,846.53
KUSA	645.87	47.62	330.96	26.65	247.48	21.68	0.00	0.00	306.08	645.87	0.00	1,224.31
DUNGA BEACH	303.75	8.10	148.78	2.20	280.50	25.00	160.21	10.71	223.31	303.75	148.78	893.24
HIPPOPOINT	0.00	0.00	383.26	33.11	470.06	73.09	2,960.66	68.12	953.50	2,960.66	0.00	3,813.99
RAILWAYS	304.41	3.12	401.83	54.93	782.50	163.38	0.00	0.00	372.19	782.50	0.00	1,488.75
LUANDA	2,980.59	43.96	158.34	3.44	281.26	27.08	0.00	0.00	855.05	2,980.59	0.00	3,420.19
MISORI	480.57	25.82	3,959.28	76.37	0.00	0.00	0.00	0.00	1,109.96	3,959.28	0.00	4,439.85
USENGE	0.00	0.00	3,580.63	157.45	25,962.44	838.49	181.86	21.17	7,431.23	25,962.44	0.00	29,724.93
PORT VICTORIA	247.21	57.40	319.24	37.68	3,155.65	127.06	360.81	13.36	1,020.73	3,155.65	247.21	4,082.91
SIO PORT	735.90	27.74	597.24	11.05	163.38	16.78	311.14	27.32	451.92	735.90	163.38	1,807.66
R. KUJA	280.18	7.78	385.59	18.67	0.00	0.00	151.62	10.98	204.35	385.59	0.00	817.39
R. AWACH	0.00	0.00	132.99	17.45	503.67	32.15	0.00	0.00	159.16	503.67	0.00	636.66
R. SONDU	173.14	9.75	770.19	85.73	445.79	118.26	0.00	0.00	347.28	770.19	0.00	1,389.12

R. NYANDO	4,461.74	53.95	761.98	26.55	183.83	12.23	0.00	0.00	1,351.89	4,461.74	0.00	5,407.55
R. NYAMASARIA	488.07	62.92	455.40	40.60	410.05	61.58	0.00	0.00	338.38	488.07	0.00	1,353.51
R. KISIAN	437.79	129.11	578.39	50.58	0.00	0.00	735.45	30.52	437.91	735.45	0.00	1,751.63
R. MUGRUK	208.20	48.89	0.00	0.00	175.86	22.47	0.00	0.00	96.02	208.20	0.00	384.06
R. AWACH SEME	187.57	9.20	155.15	4.81	186.26	22.31	72.13	23.32	150.28	187.57	72.13	601.11
R. YALA	192.99	19.94	989.26	100.36	1,149.94	131.03	165.55	9.40	624.44	1,149.94	165.55	2,497.74
R. NZOIA	317.02	27.19	5,939.28	132.10	329.19	36.16	334.93	35.70	1,730.10	5,939.28	317.02	6,920.42
R. SIO	1,492.95	34.25	201.58	6.89	0.00	0.00	746.77	53.39	610.33	1,492.95	0.00	2,441.31
NYALENDA	170.08	15.62	479.20	31.26	3,869.59	130.56	0.00	0.00	1,129.72	3,869.59	0.00	4,518.87
KWASCO	0.00	0.00	0.00	0.00	942.63	95.49	0.00	0.00	235.66	942.63	0.00	942.63
KISATI	4,589.02	196.99	149.60	1.14	542.90	9.99	329.23	59.98	1,402.69	4,589.02	149.60	5,610.76
SAKA	1,042.00	57.18	2,210.93	200.55	248.51	17.71	0.00	0.00	875.36	2,210.93	0.00	3,501.44
MEAN	**896.11**	**38.26**	**875.92**	**45.43**	**1,730.21**	**77.91**	**232.15**	**12.56**	933.60	1,730.21	232.15	3,734.39
MAX	**5,766.35**	**225.50**	**5,939.28**	**200.55**	**25,962.44**	**838.49**	**2,960.66**	**68.12**	10,157.18	25,962.44	2,960.66	40,628.73
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.00	0.00	0.00	0.00
MEDIAN	**302.74**	**22.63**	**428.62**	**28.96**	**280.88**	**25.26**	**0.00**	**0.00**	253.06	428.62	0.00	1,012.24
SUM	**26,883.24**	**1,147.69**	**26,277.61**	**1,362.97**	**51,906.29**	**2,337.34**	**6,964.59**	**376.80**	28,007.93	51,906.29	6,964.59	112,031.73
***p,p'*-DDD**	**Dry season 1**	**±sd**	**Wet seaon**	**±sd**	**Dry season 2**	**±sd**	**Short rain**	**±sd**				
MUHURUBAY	202.78	5.27	0.00	0.00	225.47	48.58	0.00	0.00	107.06	225.47	0.00	428.25
SORI	0.00	0.00	274.59	27.08	198.30	14.66	0.00	0.00	118.22	274.59	0.00	472.89
MBITA LHSD	0.00	0.00	341.73	18.34	290.62	11.25	0.00	0.00	158.09	341.73	0.00	632.35
MBITA WG	0.00	0.00	354.84	5.83	28,708.52	1,537.48	0.00	0.00	7,265.84	28,708.52	0.00	29,063.36
HOMABAY	214.95	-	137.28	55.72	317.29	30.01	147.11	8.25	204.16	317.29	137.28	816.64
KENDUBAY	205.63	11.81	303.74	34.04	99.22	23.45	293.41	81.57	225.50	303.74	99.22	902.01
KUSA	399.50	96.29	0.00	0.00	356.41	141.24	0.00	0.00	188.98	399.50	0.00	755.92
DUNGA BEACH	397.73	4.23	196.05	11.19	473.77	44.05	209.93	12.82	319.37	473.77	196.05	1,277.48
HIPPOPOINT	0.00	0.00	185.11	46.32	237.59	31.32	5,964.40	317.75	1,596.77	5,964.40	0.00	6,387.10
RAILWAYS	451.65	50.28	147.95	36.28	437.46	62.94	0.00	0.00	259.26	451.65	0.00	1,037.05
LUANDA	11,121.68	987.08	207.92	6.96	191.67	24.54	0.00	0.00	2,880.32	11,121.68	0.00	11,521.28
MISORI	511.90	24.86	64.22	37.12	203.51	15.93	0.00	0.00	194.91	511.90	0.00	779.63
USENGE	0.00	0.00	3,507.10	161.10	196.62	33.41	260.95	49.92	991.17	3,507.10	0.00	3,964.67
PORT VICTORIA	249.01	19.43	274.62	31.08	511.52	100.81	4,246.25	231.91	1,320.35	4,246.25	249.01	5,281.41

SIO PORT	2,347.26	242.73	331.24	29.47	192.00	19.94	229.43	34.18	774.98	2,347.26	192.00	3,099.92
R. KUJA	329.46	55.17	138.05	14.41	479.72	62.57	207.40	7.91	288.66	479.72	138.05	1,154.64
R. AWACH	0.00	0.00	193.08	17.15	582.80	149.45	0.00	0.00	193.97	582.80	0.00	775.88
R. SONDU	286.45	13.28	185.16	24.40	1,635.34	1,227.39	217.48	15.49	581.11	1,635.34	185.16	2,324.42
R. NYANDO	358.22	131.42	975.42	49.41	1,508.97	86.49	429.20	38.93	817.95	1,508.97	358.22	3,271.80
R. NYAMASARIA	323.28	25.62	428.77	54.63	454.24	22.68	458.75	65.93	416.26	458.75	323.28	1,665.04
R. KISIAN	2,633.29	142.36	388.25	29.66	205.95	11.48	201.38	17.89	857.22	2,633.29	201.38	3,428.88
R. MUGRUK	1,140.02	96.51	0.00	0.00	1,681.14	68.48	189.93	16.48	752.77	1,681.14	0.00	3,011.09
R. AWACH SEME	255.26	24.51	229.38	29.79	219.30	5.37	116.97	7.26	205.23	255.26	116.97	820.91
R. YALA	958.82	58.16	1,130.34	101.18	550.65	87.14	232.55	21.53	718.09	1,130.34	232.55	2,872.37
R. NZOIA	212.11	3.46	8,654.72	313.14	267.25	79.27	329.74	34.90	2,365.96	8,654.72	212.11	9,463.82
R. SIO	1,372.85	47.82	290.72	27.90	384.91	15.97	2,020.50	22.19	1,017.24	2,020.50	290.72	4,068.98
NYALENDA	308.42	19.27	0.00	0.00	1,607.67	70.95	0.00	0.00	479.02	1,607.67	0.00	1,916.09
KWASCO	0.00	0.00	0.00	0.00	236.15	57.71	715.56	103.92	237.93	715.56	0.00	951.71
KISATI	11,330.43	921.80	206.96	11.40	247.47	48.03	221.59	26.08	3,001.61	11,330.43	206.96	12,006.44
SAKA	207.80	2.91	911.49	37.57	504.36	39.70	0.00	0.00	405.91	911.49	0.00	1,623.66
									#DIV/0!	0.00	0.00	0.00
MEAN	**1,193.95**	-	**668.62**	**40.37**	**1,440.20**	**139.08**	**556.42**	**37.16**	964.80	1,440.20	556.42	3,859.19
MAX	**11,330.43**	-	**8,654.72**	**313.14**	**28,708.52**	**1,537.48**	**5,964.40**	**317.75**	13,664.52	28,708.52	5,964.40	54,658.07
MIN	**0.00**	-	**0.00**	**0.00**	**99.22**	**5.37**	**0.00**	**0.00**	24.81	99.22	0.00	99.22
MEDIAN	**297.44**	-	**218.65**	**28.68**	**336.85**	**46.04**	**204.39**	**14.15**	264.33	336.85	204.39	1,057.33
SUM	**35,818.52**	-	**20,058.71**	**1,211.18**	**43,205.92**	**4,172.29**	**16,692.53**	**1,114.91**	28,943.92	43,205.92	16,692.53	115,775.68
ENDOSULPHAN I												
	Dry season 1	±sd	Wet seaon	±sd	Dry season 2	±sd	Short rain	±sd				
MUHURUBAY	3,651.90	163.54	0.00	0.00	496.08	24.39	0.00	0.00	1,036.99	3,651.90	0.00	4,147.98
SORI	0.00	0.00	118.31	18.03	85.86	13.11	0.00	0.00	51.04	118.31	0.00	204.17
MBITA LHSD	0.00	0.00	495.88	23.31	836.57	134.64	0.00	0.00	333.11	836.57	0.00	1,332.45
MBITA WG	0.00	0.00	526.98	137.54	7,615.53	370.55	0.00	0.00	2,035.63	7,615.53	0.00	8,142.51
HOMABAY	252.78	47.21	436.35	18.87	1,859.87	39.85	292.19	5.79	710.30	1,859.87	252.78	2,841.19
KENDUBAY	5,294.47	210.15	311.80	10.22	47,883.64	960.41	699.07	24.43	13,547.24	47,883.64	311.80	54,188.98
KUSA	281.67	16.81	0.00	0.00	452.66	41.79	0.00	0.00	183.58	452.66	0.00	734.33
DUNGA BEACH	2,973.97	59.80	528.16	31.68	480.41	32.95	83.39	5.57	1,016.49	2,973.97	83.39	4,065.94
HIPPOPOINT	0.00	0.00	759.38	5.98	5,909.21	773.94	4,186.12	236.06	2,713.68	5,909.21	0.00	10,854.72

RAILWAYS	1,018.14	68.38	375.92	30.00	1,106.35	73.18	0.00	0.00	625.10	1,106.35	0.00	2,500.41
LUANDA	4,887.21	30.16	88.75	10.46	198.72	82.16	0.00	0.00	1,293.67	4,887.21	0.00	5,174.68
MISORI	253.76	42.40	354.23	10.46	240.22	16.79	0.00	0.00	212.05	354.23	0.00	848.22
USENGE	0.00	0.00	3,479.83	31.50	1,569.04	98.45	102.86	22.66	1,287.93	3,479.83	0.00	5,151.72
PORT VICTORIA	4,170.15	312.97	332.45	16.66	481.13	29.26	791.38	140.96	1,443.78	4,170.15	332.45	5,775.12
SIO PORT	956.77	131.18	485.98	69.74	1,019.38	19.04	101.87	19.32	641.00	1,019.38	101.87	2,564.00
R. KUJA	151.82	10.65	462.13	60.45	399.64	14.23	301.19	11.32	328.69	462.13	151.82	1,314.78
R. AWACH	0.00	0.00	75.53	5.65	888.16	485.23	0.00	0.00	240.92	888.16	0.00	963.69
R. SONDU	334.61	41.11	619.58	42.77	262.32	26.23	273.13	73.37	372.41	619.58	262.32	1,489.65
R. NYANDO	2,457.64	1,798.85	352.77	11.85	96.06	11.29	2,910.59	117.48	1,454.26	2,910.59	96.06	5,817.06
R. NYAMASARIA	98.25	20.11	623.75	87.54	777.60	21.26	542.28	55.91	510.47	777.60	98.25	2,041.88
R. KISIAN	10,560.94	1,949.18	687.74	33.23	7,476.73	48.60	292.30	6.49	4,754.43	10,560.94	292.30	19,017.70
R. MUGRUK	320.46	26.45	0.00	0.00	2,129.10	74.22	83.96	15.60	633.38	2,129.10	0.00	2,533.52
R. AWACH SEME	89.93	18.79	92.05	11.45	414.59	53.10	0.00	0.00	149.14	414.59	0.00	596.57
R. YALA	424.82	24.95	345.86	5.04	8,834.41	224.20	478.41	-	2,520.88	8,834.41	345.86	10,083.50
R. NZOIA	485.47	3.90	0.00	0.00	213.21	69.38	254.11	28.14	238.20	485.47	0.00	952.80
R. SIO	179.93	30.45	135.72	31.22	303.39	6.40	493.52	22.53	278.14	493.52	135.72	1,112.57
NYALENDA	679.58	34.64	910.18	147.38	2,110.73	83.93	0.00	0.00	925.12	2,110.73	0.00	3,700.49
KWASCO	0.00	0.00	0.00	0.00	989.97	198.82	298.07	9.92	322.01	989.97	0.00	1,288.04
KISATI	93.02	9.29	85.66	11.19	91.13	8.63	540.92	82.88	202.68	540.92	85.66	810.72
SAKA	88.71	9.46	395.29	11.49	394.98	12.45	0.00	0.00	219.75	395.29	0.00	878.98
MEAN	**1,323.53**	**168.68**	**436.01**	**29.12**	**3,187.22**	**134.95**	**424.18**	-	1,342.74	3,187.22	424.18	5,370.95
MAX	**10,560.94**	**1,949.18**	**3,479.83**	**147.38**	**47,883.64**	**960.41**	**4,186.12**	-	16,527.63	47,883.64	3,479.83	66,110.53
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**85.86**	**6.40**	**0.00**	-	21.47	85.86	0.00	85.86
MEDIAN	**267.71**	**25.70**	**353.50**	**14.26**	**636.84**	**45.20**	**102.36**	-	340.11	636.84	102.36	1,360.42
SUM	**39,706.00**	**5,060.44**	**13,080.31**	**873.74**	**95,616.72**	**4,048.48**	**12,725.36**	-	40,282.10	95,616.72	12,725.36	161,128.38
ENDOSULPHAN II												
	Dry season 1	±sd	Wet seaon	±sd	Dry season 2	±sd	Short rain	±sd				
MUHURUBAY	4,540.94	52.58	0.00	0.00	71.00	9.42	0.00	0.00	1,152.98	4,540.94	0.00	4,611.93
SORI	0.00	0.00	90.03	10.32	101.66	11.05	151.20	7.52	85.72	151.20	0.00	342.90
MBITA LHSD	0.00	0.00	956.70	57.52	522.27	101.20	0.00	0.00	369.74	956.70	0.00	1,478.97
MBITA WG	0.00	0.00	788.11	42.58	8,742.97	234.13	0.00	0.00	2,382.77	8,742.97	0.00	9,531.09

HOMABAY	133.91	9.07	1,048.04	20.90	203.06	12.72	302.70	5.04	421.93	1,048.04	133.91	1,687.71
KENDUBAY	1,122.81	61.09	338.65	37.37	33,881.56	3,068.74	302.36	16.15	8,911.34	33,881.56	302.36	35,645.38
KUSA	1,996.19	95.73	295.32	6.18	107.11	35.90	0.00	0.00	599.65	1,996.19	0.00	2,398.62
DUNGA BEACH	142.21	9.67	76.58	22.74	108.77	40.33	70.31	4.12	99.47	142.21	70.31	397.88
HIPPOPOINT	0.00	0.00	337.90	31.63	495.52	89.65	431.14	473.14	316.14	495.52	0.00	1,264.56
RAILWAYS	137.91	10.65	405.57	45.82	536.87	78.78	0.00	0.00	270.09	536.87	0.00	1,080.35
LUANDA	11,188.48	799.57	79.92	16.40	76.09	23.43	0.00	0.00	2,836.12	11,188.48	0.00	11,344.49
MISORI	1,569.51	2,081.46	411.03	18.38	72.02	10.00	0.00	0.00	513.14	1,569.51	0.00	2,052.56
USENGE	0.00	0.00	5,037.40	56.43	660.11	44.39	183.74	3.75	1,470.31	5,037.40	0.00	5,881.25
PORT VICTORIA	74.32	3.19	347.34	80.42	191.46	15.71	207.48	13.32	205.15	347.34	74.32	820.59
SIO PORT	2,036.30	147.85	698.95	13.49	158.18	33.20	75.62	5.52	742.26	2,036.30	75.62	2,969.06
R. KUJA	103.83	10.82	451.64	45.80	84.37	10.23	73.37	2.19	178.30	451.64	73.37	713.21
R. AWACH	0.00	0.00	58.76	1.84	174.95	29.93	0.00	0.00	58.43	174.95	0.00	233.71
R. SONDU	83.19	10.02	611.44	129.37	225.79	17.82	83.48	12.29	250.98	611.44	83.19	1,003.90
R. NYANDO	333.15	497.35	313.97	13.89	347.28	54.60	2,111.95	158.10	776.59	2,111.95	313.97	3,106.35
R. NYAMASARIA	126.80	3.55	1,048.85	227.83	769.35	957.92	85.93	21.38	507.73	1,048.85	85.93	2,030.93
R. KISIAN	97.72	28.27	954.44	79.55	72.45	7.62	73.85	14.54	299.62	954.44	72.45	1,198.46
R. MUGRUK	4,352.51	294.76	0.00	0.00	86.97	12.28	72.19	10.95	1,127.92	4,352.51	0.00	4,511.67
R. AWACH SEME	172.10	46.37	94.27	23.87	132.85	11.42	215.26	12.03	153.62	215.26	94.27	614.48
R. YALA	1,486.94	79.11	1,926.47	83.13	489.79	85.62	79.45	9.96	995.66	1,926.47	79.45	3,982.66
R. NZOIA	110.23	43.74	15,988.01	689.90	143.84	9.00	336.93	94.35	4,144.75	15,988.01	110.23	16,579.01
R. SIO	323.62	39.77	100.53	13.19	82.49	17.41	579.48	89.44	271.53	579.48	82.49	1,086.11
NYALENDA	122.56	2.89	290.32	11.02	72.73	6.02	0.00	0.00	121.40	290.32	0.00	485.61
KWASCO	0.00	0.00	0.00	0.00	625.44	119.90	0.00	0.00	156.36	625.44	0.00	625.44
KISATI	4,962.22	336.29	80.62	13.38	1,000.18	24.94	83.51	17.67	1,531.63	4,962.22	80.62	6,126.52
SAKA	1,393.33	122.30	259.71	12.25	473.10	63.78	0.00	0.00	531.53	1,393.33	0.00	2,126.14
									#DIV/0!	0.00	0.00	0.00
MEAN	**1,220.36**	**159.54**	**1,103.02**	**60.17**	**1,690.34**	**174.57**	**184.00**	**32.38**	1,049.43	1,690.34	184.00	4,197.72
MAX	**11,188.48**	**2,081.46**	**15,988.01**	**689.90**	**33,881.56**	**3,068.74**	**2,111.95**	**473.14**	15,792.50	33,881.56	2,111.95	63,170.00
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**71.00**	**6.02**	**0.00**	**0.00**	17.75	71.00	0.00	71.00
MEDIAN	**135.91**	**19.55**	**338.28**	**21.82**	**183.20**	**27.44**	**74.74**	**5.28**	183.03	338.28	74.74	732.13
SUM	**36,610.77**	**4,786.09**	**33,090.59**	**1,805.19**	**50,710.21**	**5,237.17**	**5,519.95**	**971.45**	31,482.88	50,710.21	5,519.95	125,931.52
ENDOSULPHAN SULPHATE												
	Dry season 1	±sd	Wet seaon	±sd	Dry season 2	±sd	Short rain	±sd				

MUHURUBAY	132,134.11	1,620.37	0.00	0.00	565.37	66.42	0.00	0.00	33,174.87	132,134.11	0.00	132,699.48
SORI	0.00	0.00	804.36	56.32	0.00	0.00	178.53	26.03	245.72	804.36	0.00	982.90
MBITA LHSD	0.00	0.00	3,682.52	5,913.64	699.58	103.12	0.00	0.00	1,095.52	3,682.52	0.00	4,382.10
MBITA WG	0.00	0.00	8,137.51	1,537.54	27,370.14	574.03	0.00	0.00	8,876.91	27,370.14	0.00	35,507.65
HOMABAY	670.41	36.06	9,144.48	456.70	979.85	124.79	149.10	12.49	2,735.96	9,144.48	149.10	10,943.84
KENDUBAY	1,980.32	144.30	494.70	183.19	40,248.44	1,031.14	937.09	160.10	10,915.14	40,248.44	494.70	43,660.54
KUSA	4,901.54	216.76	0.00	0.00	3,336.66	246.27	0.00	0.00	2,059.55	4,901.54	0.00	8,238.20
DUNGA BEACH	1,115.09	81.27	612.34	70.29	1,058.96	250.21	640.37	42.80	856.69	1,115.09	612.34	3,426.76
HIPPOPOINT	0.00	0.00	3,398.41	284.83	5,185.65	321.98	45,517.16	1,511.30	13,525.31	45,517.16	0.00	54,101.23
RAILWAYS	1,098.98	96.31	3,246.73	2,474.52	762.77	148.76	0.00	0.00	1,277.12	3,246.73	0.00	5,108.48
LUANDA	10,816.31	255.94	759.98	215.68	825.82	129.94	0.00	0.00	3,100.53	10,816.31	0.00	12,402.10
MISORI	1,976.68	49.39	0.00	0.00	0.00	0.00	0.00	0.00	494.17	1,976.68	0.00	1,976.68
USENGE	0.00	0.00	29,382.15	1,505.08	5,694.78	323.60	2,012.15	46.83	9,272.27	29,382.15	0.00	37,089.08
PORT VICTORIA	1,578.65	517.44	8,729.14	781.33	8,840.21	977.10	836.40	75.38	4,996.10	8,840.21	836.40	19,984.40
SIO PORT	12,150.71	1,377.87	5,759.84	1,003.12	587.06	109.30	4,036.36	236.54	5,633.49	12,150.71	587.06	22,533.96
R. KUJA	2,052.52	185.52	4,027.79	52.29	0.00	0.00	200.00	22.19	1,570.08	4,027.79	0.00	6,280.31
R. AWACH	0.00	0.00	530.97	11.57	641.48	53.55	32.77	65.54	301.30	641.48	0.00	1,205.21
R. SONDU	869.89	91.14	2,321.67	2,639.36	1,860.24	158.74	0.00	0.00	1,262.95	2,321.67	0.00	5,051.81
R. NYANDO	7,322.43	231.09	5,673.71	389.35	1,997.79	139.26	0.00	0.00	3,748.48	7,322.43	0.00	14,993.93
R. NYAMASARIA	1,045.50	73.14	3,996.45	479.10	2,292.01	248.06	0.00	0.00	1,833.49	3,996.45	0.00	7,333.96
R. KISIAN	6,143.14	497.75	1,966.89	169.93	0.00	0.00	6,250.65	567.09	3,590.17	6,250.65	0.00	14,360.68
R. MUGRUK	3,381.17	208.77	0.00	0.00	1,977.22	77.96	0.00	0.00	1,339.60	3,381.17	0.00	5,358.38
R. AWACH SEME	1,297.12	5.10	620.83	56.44	605.88	31.55	462.61	122.93	746.61	1,297.12	462.61	2,986.44
R. YALA	685.34	33.89	932.86	50.64	3,630.15	368.92	837.98	196.28	1,521.59	3,630.15	685.34	6,086.34
R. NZOIA	2,959.85	123.10	0.00	0.00	1,390.17	221.04	5,226.68	545.76	2,394.17	5,226.68	0.00	9,576.70
R. SIO	2,916.81	257.77	814.93	42.93	942.13	151.86	1,015.09	85.31	1,422.24	2,916.81	814.93	5,688.96
NYALENDA	659.78	42.88	2,568.16	48.62	25,085.16	926.00	0.00	0.00	7,078.28	25,085.16	0.00	28,313.10
KWASCO	0.00	0.00	0.00	0.00	4,863.91	179.68	0.00	0.00	1,215.98	4,863.91	0.00	4,863.91
KISATI	7,447.29	666.48	593.30	10.83	4,472.01	375.34	610.86	25.05	3,280.86	7,447.29	593.30	13,123.46
SAKA	8,834.40	273.52	8,763.65	825.65	4,977.59	53.63	0.00	0.00	5,643.91	8,834.40	0.00	22,575.65
									#DIV/0!	0.00	0.00	0.00
MEAN	**7,134.60**	**236.19**	**3,565.45**	**641.96**	**5,029.70**	**246.41**	**2,298.13**	**124.72**	4,506.97	7,134.60	2,298.13	18,027.87
MAX	**132,134.11**	**1,620.37**	**29,382.15**	**5,913.64**	**40,248.44**	**1,031.14**	**45,517.16**	**1,511.30**	61,820.47	132,134.11	29,382.15	247,281.86
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.00	0.00	0.00	0.00

MEDIAN	**1,437.88**	**93.72**	**1,449.88**	**120.11**	**1,625.21**	**150.31**	90.94	17.34	1,150.98	1,625.21	90.94	4,603.90
SUM	**214,038.04**	**7,085.85**	**106,963.36**	**19,258.94**	**150,891.02**	**7,392.25**	**68,943.80**	**3,741.61**	135,209.06	214,038.04	68,943.80	540,836.23
ENDRIN	Dry season 1	±sd	Wet seaon	±sd	Dry season 2	±sd	Short rain	±sd				
MUHURUBAY	9,680.84	1,112.81	0.00	0.00	517.10	69.82	0.00	0.00	2,549.48	9,680.84	0.00	10,197.94
SORI	0.00	0.00	75.40	15.64	351.02	27.97	69.92	23.87	124.08	351.02	0.00	496.33
MBITA LHSD	0.00	0.00	698.26	18.23	372.62	66.37	0.00	0.00	267.72	698.26	0.00	1,070.88
MBITA WG	0.00	0.00	773.49	32.89	6,881.23	176.62	0.00	0.00	1,913.68	6,881.23	0.00	7,654.72
HOMABAY	0.00	0.00	401.72	20.91	149.83	7.77	390.07	11.19	235.40	401.72	0.00	941.62
KENDUBAY	1,060.52	110.11	327.74	22.43	326.33	17.76	94.75	20.41	452.34	1,060.52	94.75	1,809.35
KUSA	1,654.78	57.92	1,947.92	109.38	286.39	38.25	0.00	0.00	972.27	1,947.92	0.00	3,889.09
DUNGA BEACH	105.94	8.60	455.76	44.79	6,081.31	4,361.45	53.54	3.58	1,674.14	6,081.31	53.54	6,696.55
HIPPOPOINT	0.00	0.00	313.10	63.98	389.18	31.80	947.50	83.49	412.45	947.50	0.00	1,649.78
RAILWAYS	121.29	20.54	532.03	104.47	1,523.46	8.94	0.00	0.00	544.19	1,523.46	0.00	2,176.77
LUANDA	28,338.20	1,396.18	58.62	9.54	82.41	29.05	0.00	0.00	7,119.81	28,338.20	0.00	28,479.23
MISORI	380.12	24.34	1,918.62	101.32	1,239.56	259.63	0.00	0.00	884.58	1,918.62	0.00	3,538.30
USENGE	0.00	0.00	6,301.62	228.95	1,794.27	307.69	257.06	13.95	2,088.24	6,301.62	0.00	8,352.96
PORT VICTORIA	473.13	115.13	341.71	33.75	400.06	18.11	1,575.85	47.62	697.69	1,575.85	341.71	2,790.75
SIO PORT	83.86	29.52	501.20	129.00	126.68	45.66	4,944.45	517.95	1,414.05	4,944.45	83.86	5,656.19
R. KUJA	112.83	4.90	719.15	93.41	12,744.90	653.47	603.95	41.48	3,545.21	12,744.90	112.83	14,180.82
R. AWACH	0.00	0.00	58.56	13.32	415.00	97.09	0.00	0.00	118.39	415.00	0.00	473.57
R. SONDU	83.34	25.73	424.18	106.34	738.61	103.61	942.70	77.26	547.21	942.70	83.34	2,188.83
R. NYANDO	143.65	14.12	404.58	13.63	736.44	195.83	1,919.86	97.92	801.13	1,919.86	143.65	3,204.53
R. NYAMASARIA	499.70	15.64	445.09	54.40	391.20	14.08	1,902.81	116.93	809.70	1,902.81	391.20	3,238.80
R. KISIAN	312.89	9.62	1,030.70	842.66	2,319.94	266.04	431.18	99.87	1,023.68	2,319.94	312.89	4,094.71
R. MUGRUK	83.93	25.92	419.55	29.01	72.74	24.64	66.49	23.49	160.68	419.55	66.49	642.71
R. AWACH SEME	6,699.82	186.52	69.11	16.10	269.45	32.26	331.80	25.80	1,842.55	6,699.82	69.11	7,370.18
R. YALA	793.66	9.68	699.40	8.74	334.39	94.18	233.53	50.49	515.24	793.66	233.53	2,060.97
R. NZOIA	837.20	86.10	14,596.82	387.25	1,254.76	268.96	476.63	88.93	4,291.35	14,596.82	476.63	17,165.42
R. SIO	1,217.71	134.53	78.36	12.25	42,826.96	2,583.33	813.68	73.59	11,234.18	42,826.96	78.36	44,936.70
NYALENDA	5,745.40	273.77	383.32	24.84	2,344.09	254.64	0.00	0.00	2,118.20	5,745.40	0.00	8,472.82
KWASCO	0.00	0.00	0.00	0.00	532.81	45.48	868.09	32.44	350.23	868.09	0.00	1,400.90
KISATI	10,799.74	1,876.47	67.27	15.51	669.33	96.75	802.12	59.60	3,084.61	10,799.74	67.27	12,338.46
SAKA	2,071.99	112.61	348.47	25.27	3,341.74	415.60	0.00	0.00	1,440.55	3,341.74	0.00	5,762.20

									#DIV/0!	0.00	0.00	0.00
MEAN	**2,376.68**	**188.36**	**1,146.39**	**85.93**	**2,983.79**	**353.76**	**590.87**	**50.33**	1,774.43	2,983.79	590.87	7,097.74
MAX	**28,338.20**	**1,876.47**	**14,596.82**	**842.66**	**42,826.96**	**4,361.45**	**4,944.45**	**517.95**	22,676.61	42,826.96	4,944.45	90,706.43
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**72.74**	**7.77**	**0.00**	**0.00**	18.19	72.74	0.00	72.74
MEDIAN	**228.27**	**22.44**	**412.06**	**27.14**	**524.96**	**82.00**	**245.30**	**23.68**	352.65	524.96	228.27	1,410.58
SUM	**71,300.54**	**5,650.76**	**34,391.73**	**2,578.03**	**89,513.84**	**10,612.84**	**17,725.99**	**1,509.84**	53,233.02	89,513.84	17,725.99	212,932.10
ENDRIN ALDEHYDE												
	Dry season 1	±sd	Wet seaon	±sd	Dry season 2	±sd	Short rain	±sd				
MUHURUBAY	113,130.76	9,061.56	0.00	0.00	40,645.41	1,259.63	0.00	0.00	38,444.04	113,130.76	0.00	153,776.17
SORI	0.00	0.00	0.00	0.00	58,853.99	1,479.31	195.27	8.04	14,762.32	58,853.99	0.00	59,049.26
MBITA LHSD	0.00	0.00	830.67	65.24	24,318.25	1,186.03	0.00	0.00	6,287.23	24,318.25	0.00	25,148.92
MBITA WG	0.00	0.00	3,984.03	337.82	0.00	0.00	0.00	0.00	996.01	3,984.03	0.00	3,984.03
HOMABAY	9,245.51	412.21	27,531.56	1,233.91	62,653.82	2,519.58	106.07	13.39	24,884.24	62,653.82	106.07	99,536.96
KENDUBAY	0.00	0.00	4,024.27	5,047.30	541.68	57.90	6,726.14	607.12	2,823.02	6,726.14	0.00	11,292.09
KUSA	368,363.17	4,496.92	1,232.48	112.31	5,577.47	398.05	0.00	0.00	93,793.28	368,363.17	0.00	375,173.13
DUNGA BEACH	0.00	0.00	0.00	0.00	284,548.19	8,354.16	98.98	19.57	71,161.79	284,548.19	0.00	284,647.16
HIPPOPOINT	0.00	0.00	1,600.82	123.91	393.32	131.75	6,178.29	629.20	2,043.11	6,178.29	0.00	8,172.42
RAILWAYS	0.00	0.00	288.62	19.54	374.39	145.34	0.00	0.00	165.75	374.39	0.00	663.02
LUANDA	590,118.42	100,239.77	0.00	0.00	0.00	0.00	0.00	0.00	147,529.60	590,118.42	0.00	590,118.42
MISORI	69,414.02	3,763.14	173.59	27.91	28,963.08	1,543.16	0.00	0.00	24,637.67	69,414.02	0.00	98,550.68
USENGE	0.00	0.00	4,889.56	350.82	2,947.71	88.61	386.25	24.36	2,055.88	4,889.56	0.00	8,223.51
PORT VICTORIA	2,034.05	70.98	161.23	23.18	17,728.22	1,207.28	5,828.29	858.61	6,437.95	17,728.22	161.23	25,751.78
SIO PORT	53,889.60	3,126.25	924.05	136.22	7,993.49	71.99	57,709.20	771.46	30,129.09	57,709.20	924.05	120,516.34
R. KUJA	4,116.60	268.66	430.82	97.70	0.00	0.00	11,530.76	1,275.36	4,019.54	11,530.76	0.00	16,078.17
R. AWACH	0.00	0.00	0.00	0.00	2,702.31	154.17	644.66	158.95	836.74	2,702.31	0.00	3,346.97
R. SONDU	4,278.42	338.78	15,379.70	1,070.33	15,101.92	1,047.85	102.84	15.86	8,715.72	15,379.70	102.84	34,862.88
R. NYANDO	133,045.54	170,633.45	1,128.94	95.16	0.00	0.00	30,917.75	1,608.88	41,273.06	133,045.54	0.00	165,092.23
R. NYAMASARIA	2,516.85	96.66	450.32	82.26	3,956.27	475.40	38,906.69	1,928.50	11,457.54	38,906.69	450.32	45,830.14
R. KISIAN	0.00	0.00	4,383.87	7,615.21	23,459.38	2,373.68	73,527.04	5,165.94	25,342.57	73,527.04	0.00	101,370.29
R. MUGRUK	3,855.48	204.29	149.53	15.16	0.00	0.00	0.00	0.00	1,001.25	3,855.48	0.00	4,005.02
R. AWACH SEME	3,794.50	208.49	0.00	0.00	187.86	15.62	985.15	78.56	1,241.88	3,794.50	0.00	4,967.51
R. YALA	42,843.39	2,507.54	4,103.57	304.54	2,717.28	403.67	514.78	59.76	12,544.75	42,843.39	514.78	50,179.01
R. NZOIA	5,673.71	574.24	9,525.04	559.65	3,511.44	447.31	2,038.70	57.07	5,187.22	9,525.04	2,038.70	20,748.89

R. SIO	59,698.10	2,254.65	0.00	0.00	866.76	92.05	1,192.92	143.10	15,439.45	59,698.10	0.00	61,757.78
NYALENDA	9,382.31	408.20	261.30	3.55	281.91	27.67	0.00	0.00	2,481.38	9,382.31	0.00	9,925.51
KWASCO	0.00	0.00	0.00	0.00	2,927.60	106.88	960.14	67.85	971.93	2,927.60	0.00	3,887.74
KISATI	0.00	0.00	0.00	0.00	12,937.32	826.80	12,128.95	1,140.25	6,266.57	12,937.32	0.00	25,066.27
SAKA	0.00	0.00	4,250.61	240.74	58,002.39	2,668.03	0.00	0.00	15,563.25	58,002.39	0.00	62,253.00
									#DIV/0!	0.00	0.00	0.00
MEAN	**49,180.01**	**9,955.53**	**2,856.82**	**585.41**	**22,073.05**	**902.73**	**8,355.96**	**487.73**	20,616.46	49,180.01	2,856.82	82,465.84
MAX	**590,118.42**	**170,633.45**	**27,531.56**	**7,615.21**	**284,548.19**	**8,354.16**	**73,527.04**	**5,165.94**	243,931.30	590,118.42	27,531.56	975,725.21
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.00	0.00	0.00	0.00
MEDIAN	**3,155.68**	**150.47**	**440.57**	**73.75**	**3,229.57**	**276.11**	**450.51**	**40.71**	1,819.08	3,229.57	440.57	7,276.33
SUM	**1,475,400.43**	**298,665.79**	**85,704.56**	**17,562.45**	**662,191.45**	**27,081.90**	**250,678.88**	**14,631.85**	618,493.83	1,475,400.43	85,704.56	2,473,975.32

α-HCH	**Dry season 1**	**±sd**	**Wet seaon**	**±sd**	**Dry season 2**	**±sd**	**Short rain**	**±sd**				
MUHURUBAY	1,125.44	4.67	0.00	0.00	832.05	23.09	0.00	0.00	489.37	1,125.44	0.00	1,957.48
SORI	0.00	0.00	325.62	6.06	1,128.34	61.81	283.32	16.18	434.32	1,128.34	0.00	1,737.28
MBITA LHSD	1,430.47	10.39	766.33	1,101.94	2,243.07	65.34	0.00	0.00	1,109.97	2,243.07	0.00	4,439.87
MBITA WG	0.00	0.00	216.24	20.92	2,226.62	38.65	231.98	7.36	668.71	2,226.62	0.00	2,674.84
HOMABAY	846.25	12.01	206.59	5.64	9,291.99	59.85	51.91	7.90	2,599.19	9,291.99	51.91	10,396.75
KENDUBAY	0.00	0.00	360.90	58.96	4,881.68	9.73	0.00	0.00	1,310.65	4,881.68	0.00	5,242.58
KUSA	1,989.53	10.99	0.00	0.00	854.63	25.94	0.00	0.00	711.04	1,989.53	0.00	2,844.17
DUNGA BEACH	6,134.80	12.72	0.00	0.00	812.52	18.23	781.40	35.31	1,932.18	6,134.80	0.00	7,728.71
HIPPOPOINT	0.00	0.00	268.07	16.09	4,265.48	57.26	0.00	0.00	1,133.39	4,265.48	0.00	4,533.56
RAILWAYS	2,895.67	108.95	620.66	10.40	2,260.13	25.26	0.00	0.00	1,444.12	2,895.67	0.00	5,776.46
LUANDA	0.00	0.00	325.89	7.04	1,594.59	82.93	2,143.25	56.10	1,015.94	2,143.25	0.00	4,063.74
MISORI	970.69	55.27	929.87	17.52	0.00	0.00	0.00	0.00	475.14	970.69	0.00	1,900.55
USENGE	827.00	32.92	146.39	46.51	876.05	65.07	816.78	36.86	666.56	876.05	146.39	2,666.23
PORT VICTORIA	2,312.86	64.81	0.00	0.00	897.35	3.32	1,343.19	5.98	1,138.35	2,312.86	0.00	4,553.41
SIO PORT	1,208.06	70.89	332.02	10.70	1,672.15	54.87	4,463.95	44.98	1,919.05	4,463.95	332.02	7,676.18
R. KUJA	0.00	0.00	232.97	6.20	0.00	0.00	851.99	10.52	271.24	851.99	0.00	1,084.96
R. AWACH	0.00	0.00	239.63	73.30	175.42	6.38	0.00	0.00	103.76	239.63	0.00	415.05
R. SONDU	1,256.47	47.69	234.29	17.57	0.00	0.00	0.00	0.00	372.69	1,256.47	0.00	1,490.76
R. NYANDO	1,741.01	43.62	323.77	9.49	5,901.56	631.45	0.00	0.00	1,991.58	5,901.56	0.00	7,966.34
R. NYAMASARIA	2,500.94	40.57	0.00	0.00	1,580.71	45.70	0.00	0.00	1,020.41	2,500.94	0.00	4,081.65
R. KISIAN	847.23	45.86	228.38	2.45	0.00	0.00	304.60	27.27	345.05	847.23	0.00	1,380.21

R. MUGRUK	1,497.38	110.01	284.50	12.19	76.52	3.84	1,838.63	53.80	924.26	1,838.63	76.52	3,697.03
R. AWACH SEME	3,077.68	115.69	0.00	0.00	1,866.70	14.30	0.00	0.00	1,236.09	3,077.68	0.00	4,944.38
R. YALA	0.00	0.00	201.54	3.10	1,051.67	140.56	1,044.24	14.51	574.36	1,051.67	0.00	2,297.44
R. NZOIA	3,949.83	86.49	429.80	10.28	1,145.47	6.45	1,958.35	49.13	1,870.86	3,949.83	429.80	7,483.45
R. SIO	2,791.67	29.08	0.00	0.00	766.76	11.71	1,826.69	24.70	1,346.28	2,791.67	0.00	5,385.12
NYALENDA	2,530.08	40.99	415.74	5.40	1,994.37	13.76	0.00	0.00	1,235.05	2,530.08	0.00	4,940.19
KWASCO	882.25	27.33	0.00	0.00	884.29	71.85	0.00	0.00	441.64	884.29	0.00	1,766.54
KISATI	0.00	0.00	949.08	8.22	1,291.82	194.00	178.81	23.67	604.93	1,291.82	0.00	2,419.71
SAKA	0.00	0.00	0.00	0.00	0.00	0.00	1,342.71	378.50	335.68	1,342.71	0.00	1,342.71
MEAN	**1,360.51**	**32.36**	**267.94**	**48.33**	**1,685.73**	**57.71**	**648.73**	**26.43**	990.73	1,685.73	267.94	3,962.91
MAX	**6,134.80**	**115.69**	**949.08**	**1,101.94**	**9,291.99**	**631.45**	**4,463.95**	**378.50**	5,209.95	9,291.99	949.08	20,839.82
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.00	0.00	0.00	0.00
MEDIAN	**1,048.06**	**20.03**	**233.63**	**6.62**	**1,090.00**	**24.18**	**115.36**	**6.67**	621.76	1,090.00	115.36	2,487.05
SUM	**40,815.29**	**970.95**	**8,038.30**	**1,449.99**	**50,571.95**	**1,731.37**	**19,461.81**	**792.77**	29,721.84	50,571.95	8,038.30	118,887.35
β-HCH	**Dry season 1**	**±sd**	**Wet seaon**	**±sd**	**Dry season 2**	**±sd**	**Short rain**	**±sd**				
MUHURUBAY	426.11	25.56	0.00	0.00	1,479.50	58.25	0.00	0.00	476.40	1,479.50	0.00	1,905.61
SORI	0.00	0.00	345.87	4.33	1,206.86	19.06	0.00	0.00	388.18	1,206.86	0.00	1,552.73
MBITA LHSD	0.00	0.00	0.00	0.00	329.43	18.38	0.00	0.00	82.36	329.43	0.00	329.43
MBITA WG	0.00	0.00	0.00	0.00	15,252.43	277.96	0.00	0.00	3,813.11	15,252.43	0.00	15,252.43
HOMABAY	4,153.12	114.08	174.39	24.73	0.00	0.00	0.00	0.00	1,081.88	4,153.12	0.00	4,327.51
KENDUBAY	3,235.87	48.81	0.00	0.00	4,051.02	59.11	9,167.54	65.22	4,113.61	9,167.54	0.00	16,454.43
KUSA	488.21	15.32	0.00	0.00	413.71	17.44	0.00	0.00	225.48	488.21	0.00	901.92
DUNGA BEACH	0.00	0.00	0.00	0.00	1,082.98	76.63	0.00	0.00	270.75	1,082.98	0.00	1,082.98
HIPPOPOINT	0.00	0.00	3,525.43	88.07	2,836.06	333.30	150.96	4.38	1,628.11	3,525.43	0.00	6,512.45
RAILWAYS	0.00	0.00	323.74	26.33	353.08	45.40	0.00	0.00	169.20	353.08	0.00	676.82
LUANDA	333.95	3.82	317.42	28.96	643.90	48.58	0.00	0.00	323.82	643.90	0.00	1,295.27
MISORI	0.00	0.00	0.00	0.00	444.70	54.72	0.00	0.00	111.17	444.70	0.00	444.70
USENGE	0.00	0.00	0.00	0.00	151.55	39.18	741.90	46.14	223.36	741.90	0.00	893.45
PORT VICTORIA	5,904.54	104.60	0.00	0.00	919.97	37.64	5,455.39	58.46	3,069.97	5,904.54	0.00	12,279.90
SIO PORT	1,931.57	81.30	4,946.80	109.79	184.74	12.07	0.00	0.00	1,765.78	4,946.80	0.00	7,063.12
R. KUJA	56.58	38.73	0.00	0.00	1,125.61	66.83	261.79	28.16	360.99	1,125.61	0.00	1,443.98
R. AWACH	0.00	0.00	0.00	0.00	1,107.71	18.06	1,295.48	25.07	600.80	1,295.48	0.00	2,403.19

R. SONDU	7,113.53	83.34	2,873.06	157.61	843.09	68.74	2,075.78	101.43	3,226.37	7,113.53	843.09	12,905.47
R. NYANDO	3,022.72	12.53	0.00	0.00	3,929.08	697.25	6,975.42	50.36	3,481.80	6,975.42	0.00	13,927.21
R. NYAMASARIA	6,204.73	103.66	863.26	47.29	329.95	16.09	20,115.84	266.12	6,878.44	20,115.84	329.95	27,513.78
R. KISIAN	785.34	40.43	25,353.62	921.75	0.00	0.00	1,046.97	37.21	6,796.48	25,353.62	0.00	27,185.93
R. MUGRUK	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R. AWACH SEME	1,913.58	18.16	0.00	0.00	528.13	51.25	2,661.83	416.34	1,275.88	2,661.83	0.00	5,103.53
R. YALA	259.51	15.22	8,427.54	394.68	656.41	75.78	186.24	19.64	2,382.42	8,427.54	186.24	9,529.70
R. NZOIA	10,344.97	230.69	0.00	0.00	180.76	6.39	115.82	7.70	2,660.39	10,344.97	0.00	10,641.56
R. SIO	982.94	26.37	127.87	24.96	369.49	28.90	0.00	0.00	370.07	982.94	0.00	1,480.29
NYALENDA	0.00	0.00	302.23	15.78	778.36	16.18	0.00	0.00	270.15	778.36	0.00	1,080.59
KWASCO	0.00	0.00	0.00	0.00	470.48	24.99	0.00	0.00	117.62	470.48	0.00	470.48
KISATI	6,639.20	230.43	0.00	0.00	2,890.53	127.76	1,085.17	49.66	2,653.72	6,639.20	0.00	10,614.90
SAKA	1,512.47	16.88	160.27	6.65	864.65	38.97	2,154.27	123.15	1,172.91	2,154.27	160.27	4,691.66
MEAN	**1,843.63**	**40.33**	**1,591.38**	**61.70**	**1,447.47**	**77.83**	**1,783.01**	**43.30**	1,666.37	1,843.63	1,447.47	6,665.50
MAX	**10,344.97**	**230.69**	**25,353.62**	**921.75**	**15,252.43**	**697.25**	**20,115.84**	**416.34**	17,766.72	25,353.62	10,344.97	71,066.87
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.00	0.00	0.00	0.00
MEDIAN	**380.03**	**15.27**	**0.00**	**0.00**	**650.16**	**39.08**	**57.91**	**2.19**	272.03	650.16	0.00	1,088.10
SUM	**55,308.94**	**1,209.91**	**47,741.49**	**1,850.93**	**43,424.16**	**2,334.93**	**53,490.38**	**1,299.01**	49,991.25	55,308.94	43,424.16	199,964.98
γ-HCH	**Dry season 1**	**±sd**	**Wet seaon**	**±sd**	**Dry season 2**	**±sd**	**Short rain**	**±sd**				
MUHURUBAY	2,433.22	78.98	0.00	0.00	1,510.17	85.10	0.00	0.00	985.85	2,433.22	0.00	3,943.39
SORI	0.00	0.00	172.25	20.89	553.34	49.26	0.00	0.00	181.40	553.34	0.00	725.59
MBITA LHSD	0.00	0.00	8,587.41	256.33	2,090.76	73.72	0.00	0.00	2,669.54	8,587.41	0.00	10,678.17
MBITA WG	0.00	0.00	4,157.46	108.10	3,715.12	185.34	0.00	0.00	1,968.15	4,157.46	0.00	7,872.58
HOMABAY	570.75	32.07	711.54	17.00	221.30	11.00	0.00	0.00	375.90	711.54	0.00	1,503.59
KENDUBAY	12,845.34	234.77	633.61	35.85	617.56	30.51	575.78	39.87	3,668.07	12,845.34	575.78	14,672.29
KUSA	5,975.22	50.76	0.00	0.00	736.18	168.45	0.00	0.00	1,677.85	5,975.22	0.00	6,711.41
DUNGA BEACH	537.50	31.11	890.48	45.46	551.30	97.50	129.05	8.63	527.08	890.48	129.05	2,108.33
HIPPOPOINT	0.00	0.00	572.72	50.79	220.40	36.86	172.71	10.16	241.46	572.72	0.00	965.83
RAILWAYS	477.80	66.20	242.74	35.69	735.54	59.40	0.00	0.00	364.02	735.54	0.00	1,456.08
LUANDA	1,660.22	34.47	170.07	72.72	2,190.38	153.42	0.00	0.00	1,005.17	2,190.38	0.00	4,020.67
MISORI	130.33	11.44	0.00	0.00	186.19	5.70	0.00	0.00	79.13	186.19	0.00	316.52
USENGE	0.00	0.00	0.00	0.00	2,081.74	87.98	143.77	17.69	556.38	2,081.74	0.00	2,225.51

PORT VICTORIA	6,206.59	255.38	207.90	51.76	8,565.46	263.13	739.08	46.73	3,929.76	8,565.46	207.90	15,719.03
SIO PORT	1,670.92	26.80	930.65	9.93	1,633.78	98.89	128.81	1.75	1,091.04	1,670.92	128.81	4,364.15
R. KUJA	440.38	54.42	0.00	0.00	759.33	70.21	199.19	5.55	349.73	759.33	0.00	1,398.90
R. AWACH	0.00	0.00	112.13	14.83	1,493.62	59.08	2,619.48	-	1,056.31	2,619.48	0.00	4,225.23
R. SONDU	746.35	37.79	120.55	10.00	1,580.67	55.29	1,428.14	78.16	968.93	1,580.67	120.55	3,875.71
R. NYANDO	1,246.43	37.11	0.00	0.00	4,387.15	1,170.17	334.34	29.60	1,491.98	4,387.15	0.00	5,967.92
R. NYAMASARIA	3,672.37	65.58	283.51	5.86	384.08	22.42	1,386.34	20.49	1,431.57	3,672.37	283.51	5,726.29
R. KISIAN	831.45	29.80	3,826.09	98.64	190.85	9.23	1,099.17	63.04	1,486.89	3,826.09	190.85	5,947.56
R. MUGRUK	135.02	6.79	0.00	0.00	2,908.56	58.04	419.04	527.34	865.65	2,908.56	0.00	3,462.62
R. AWACH SEME	7,047.22	134.03	133.93	14.80	131.78	3.13	703.49	25.78	2,004.10	7,047.22	131.78	8,016.42
R. YALA	261.49	11.06	785.52	134.44	357.88	95.76	137.19	13.66	385.52	785.52	137.19	1,542.08
R. NZOIA	12,575.36	445.81	293.44	3.15	1,740.58	66.74	385.49	69.82	3,748.72	12,575.36	293.44	14,994.87
R. SIO	1,042.70	26.71	160.96	10.55	975.14	6.56	695.47	6.44	718.57	1,042.70	160.96	2,874.28
NYALENDA	2,135.54	93.47	0.00	0.00	1,264.81	206.33	0.00	0.00	850.09	2,135.54	0.00	3,400.35
KWASCO	0.00	0.00	0.00	0.00	754.10	29.16	0.00	0.00	188.53	754.10	0.00	754.10
KISATI	1,006.11	90.98	133.97	16.91	1,070.11	40.49	800.96	9.61	752.79	1,070.11	133.97	3,011.15
SAKA	141.64	27.03	2,182.17	137.94	2,097.93	75.76	0.00	0.00	1,105.44	2,182.17	0.00	4,421.75
												0.00
MEAN	**2,126.33**	**62.75**	**843.64**	**38.39**	**1,523.53**	**112.49**	**403.25**	-	1,224.19	2,126.33	403.25	4,896.75
MAX	**12,845.34**	**445.81**	**8,587.41**	**256.33**	**8,565.46**	**1,170.17**	**2,619.48**	-	8,154.42	12,845.34	2,619.48	32,617.70
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**131.78**	**3.13**	**0.00**	-	32.94	131.78	0.00	131.78
MEDIAN	**658.55**	**31.59**	**171.16**	**14.81**	**1,022.62**	**63.07**	**140.48**	-	498.20	1,022.62	140.48	1,992.82
SUM	**63,789.96**	**1,882.56**	**25,309.10**	**1,151.63**	**45,705.82**	**3,374.61**	**12,097.50**	-	36,725.59	63,789.96	12,097.50	146,902.37
γ-HCH	**Dry season 1**	**±sd**	**Wet seaon**	**±sd**	**Dry season 2**	**±sd**	**Short rain**	**±sd**				
MUHURUBAY	3,976.50	53.52	0.00	0.00	1,062.92	147.89	0.00	0.00	1,259.85	3,976.50	0.00	5,039.42
SORI	0.00	0.00	849.59	45.54	1,304.64	14.03	0.00	0.00	538.56	1,304.64	0.00	2,154.23
MBITA LHSD	0.00	0.00	1,005.22	22.45	779.29	87.63	0.00	0.00	446.13	1,005.22	0.00	1,784.51
MBITA WG	0.00	0.00	3,289.32	167.38	8,677.33	259.57	0.00	0.00	2,991.66	8,677.33	0.00	11,966.65
HOMABAY	2,670.94	36.94	1,862.66	59.56	961.33	63.68	0.00	0.00	1,373.73	2,670.94	0.00	5,494.92
KENDUBAY	6,057.78	55.51	817.69	100.52	1,771.38	37.63	561.48	377.21	2,302.08	6,057.78	561.48	9,208.32
KUSA	1,252.94	46.25	724.86	24.37	1,307.51	282.63	0.00	0.00	821.33	1,307.51	0.00	3,285.31
DUNGA BEACH	4,652.10	152.95	689.52	19.19	883.32	40.94	764.33	51.09	1,747.32	4,652.10	689.52	6,989.27
HIPPOPOINT	0.00	0.00	814.92	44.86	990.21	123.34	125.91	6.76	482.76	990.21	0.00	1,931.04

RAILWAYS	1,753.86	72.06	1,622.59	113.97	1,246.90	301.12	0.00	0.00	1,155.84	1,753.86	0.00	4,623.36
LUANDA	2,487.12	64.42	839.09	140.03	1,415.38	95.31	0.00	0.00	1,185.40	2,487.12	0.00	4,741.58
MISORI	5,142.26	121.22	2,183.81	73.91	834.82	24.12	0.00	0.00	2,040.22	5,142.26	0.00	8,160.88
USENGE	0.00	0.00	3,064.37	36.62	956.12	105.77	792.61	35.68	1,203.27	3,064.37	0.00	4,813.10
PORT VICTORIA	1,546.82	67.15	2,441.14	44.04	1,612.51	50.82	1,092.14	68.32	1,673.15	2,441.14	1,092.14	6,692.61
SIO PORT	2,060.94	65.29	10,704.27	432.93	866.98	144.14	700.09	20.68	3,583.07	10,704.27	700.09	14,332.28
R. KUJA	972.84	10.08	1,088.33	22.92	1,532.11	36.96	798.29	12.66	1,097.89	1,532.11	798.29	4,391.57
R. AWACH	0.00	0.00	618.88	15.73	4,394.63	325.54	0.00	0.00	1,253.38	4,394.63	0.00	5,013.51
R. SONDU	2,247.84	302.32	778.64	146.00	1,019.81	77.70	811.37	25.17	1,214.41	2,247.84	778.64	4,857.66
R. NYANDO	739.72	85.84	1,006.88	14.49	1,649.87	103.59	7,595.94	278.45	2,748.10	7,595.94	739.72	10,992.40
R. NYAMASARIA	762.65	17.38	1,555.36	168.21	1,426.10	111.84	1,259.35	49.42	1,250.87	1,555.36	762.65	5,003.46
R. KISIAN	923.80	64.61	895.62	15.98	1,628.45	48.81	843.25	19.44	1,072.78	1,628.45	843.25	4,291.12
R. MUGRUK	883.97	103.49	2,161.82	102.42	3,074.95	132.52	622.54	19.95	1,685.82	3,074.95	622.54	6,743.28
R. AWACH SEME	745.08	65.58	752.99	28.71	862.85	89.80	518.21	7.25	719.78	862.85	518.21	2,879.12
R. YALA	856.46	29.00	773.86	39.94	1,164.79	149.07	286.16	572.32	770.32	1,164.79	286.16	3,081.27
R. NZOIA	819.51	56.15	1,433.67	27.79	1,783.14	608.89	913.10	52.88	1,237.36	1,783.14	819.51	4,949.43
R. SIO	2,090.38	106.59	864.24	64.91	949.22	49.22	1,121.42	40.39	1,256.31	2,090.38	864.24	5,025.26
NYALENDA	793.18	100.89	910.95	25.26	4,990.10	32.62	0.00	0.00	1,673.56	4,990.10	0.00	6,694.23
KWASCO	0.00	0.00	0.00	0.00	1,542.12	60.71	817.42	34.55	589.89	1,542.12	0.00	2,359.54
KISATI	8,726.72	353.00	761.78	48.97	1,031.06	52.02	797.97	31.25	2,829.38	8,726.72	761.78	11,317.52
SAKA	2,440.03	77.81	774.78	78.52	1,350.12	47.45	0.00	0.00	1,141.23	2,440.03	0.00	4,564.94
									#DIV/0!	0.00	0.00	0.00
MEAN	**1,820.12**	**70.27**	**1,509.56**	**70.84**	**1,769.00**	**123.51**	**680.72**	**56.78**	1,444.85	1,820.12	680.72	5,779.39
MAX	**8,726.72**	**353.00**	**10,704.27**	**432.93**	**8,677.33**	**608.89**	**7,595.94**	**572.32**	8,926.07	10,704.27	7,595.94	35,704.26
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**779.29**	**14.03**	**0.00**	**0.00**	194.82	779.29	0.00	779.29
MEDIAN	**948.32**	**60.28**	**879.93**	**44.45**	**1,306.07**	**88.72**	**539.85**	**16.05**	918.54	1,306.07	539.85	3,674.17
SUM	**54,603.45**	**2,108.04**	**45,286.83**	**2,125.21**	**53,069.94**	**3,705.36**	**20,421.59**	**1,703.48**	43,345.45	54,603.45	20,421.59	173,381.80
METHOXYCHLOR												
	Dry season 1	±sd	Wet seaon	±sd	Dry season 2	±sd	Short rain	±sd				
MUHURUBAY	148.56	7.55	0.00	0.00	3,528.02	449.18	0.00	0.00	919.14	3,528.02	0.00	3,676.58
SORI	0.00	0.00	185.92	15.75	42,834.88	1,964.10	754.37	46.86	10,943.79	42,834.88	0.00	43,775.18
MBITA LHSD	0.00	0.00	295.57	8.47	14,578.56	620.20	0.00	0.00	3,718.53	14,578.56	0.00	14,874.13
MBITA WG	0.00	0.00	1,424.27	247.89	141,326.74	1,152.00	0.00	0.00	35,687.75	141,326.74	0.00	142,751.02

HOMABAY	2,460.46	83.97	863.85	38.44	578.81	755.97	592.43	79.41	1,123.89	2,460.46	578.81	4,495.55
KENDUBAY	40,693.80	1,469.90	653.08	53.82	932.47	61.99	1,016.14	192.77	10,823.87	40,693.80	653.08	43,295.48
KUSA	11,247.99	990.56	0.00	0.00	12,717.14	403.16	0.00	0.00	5,991.28	12,717.14	0.00	23,965.12
DUNGA BEACH	286.27	16.10	136.82	12.33	159.90	15.33	145.32	9.71	182.08	286.27	136.82	728.31
HIPPOPOINT	0.00	0.00	1,128.37	55.24	1,172.26	156.02	405.71	13.11	676.59	1,172.26	0.00	2,706.34
RAILWAYS	45,107.95	957.51	5,243.00	718.63	1,245.54	261.31	0.00	0.00	12,899.12	45,107.95	0.00	51,596.50
LUANDA	161,082.35	1,224.07	146.06	4.28	616.36	98.82	0.00	0.00	40,461.19	161,082.35	0.00	161,844.76
MISORI	8,497.31	536.37	587.74	440.61	117.10	13.08	0.00	0.00	2,300.54	8,497.31	0.00	9,202.16
USENGE	0.00	0.00	14,908.09	95.98	3,495.57	749.82	269.12	125.75	4,668.19	14,908.09	0.00	18,672.78
PORT VICTORIA	6,964.03	254.41	171.28	7.82	11,422.64	783.77	3,831.21	208.75	5,597.29	11,422.64	171.28	22,389.17
SIO PORT	85,892.31	5,217.21	1,624.95	36.95	3,177.07	4,194.15	3,643.41	58.67	23,584.43	85,892.31	1,624.95	94,337.73
R. KUJA	159.90	19.24	2,993.13	10.13	153.16	6.53	6,181.50	330.41	2,371.93	6,181.50	153.16	9,487.70
R. AWACH	0.00	0.00	129.53	9.37	239.34	66.37	146.72	5.72	128.90	239.34	0.00	515.60
R. SONDU	10,985.54	150.66	133.27	12.01	19,516.54	744.10	179.21	15.86	7,703.64	19,516.54	133.27	30,814.55
R. NYANDO	36,275.64	2,510.39	1,869.16	86.50	10,919.07	835.72	2,937.02	112.35	13,000.22	36,275.64	1,869.16	52,000.90
R. NYAMASARIA	1,499.65	69.13	3,575.33	424.42	4,926.38	245.75	1,302.23	92.07	2,825.90	4,926.38	1,302.23	11,303.58
R. KISIAN	694.85	6.48	1,434.48	31.68	55,455.91	4,791.40	6,744.75	561.69	16,082.50	55,455.91	694.85	64,329.99
R. MUGRUK	21,097.10	844.18	4,117.08	93.32	8,008.20	725.74	141.50	18.62	8,340.97	21,097.10	141.50	33,363.87
R. AWACH SEME	5,832.95	247.13	152.33	12.81	168.94	34.68	1,035.53	25.07	1,797.44	5,832.95	152.33	7,189.74
R. YALA	12,100.53	1,587.09	1,015.46	196.87	18,064.01	990.42	8,223.59	294.32	9,850.90	18,064.01	1,015.46	39,403.60
R. NZOIA	3,493.46	138.40	10,253.91	551.49	3,835.64	214.85	368.14	267.54	4,487.79	10,253.91	368.14	17,951.15
R. SIO	21,816.94	1,532.93	186.86	12.82	179.51	43.13	7,523.94	764.72	7,426.81	21,816.94	179.51	29,707.24
NYALENDA	151.08	10.49	0.00	0.00	146.84	10.53	0.00	0.00	74.48	151.08	0.00	297.93
KWASCO	0.00	0.00	0.00	0.00	142.29	7.17	0.00	0.00	35.57	142.29	0.00	142.29
KISATI	72,690.45	2,195.42	143.27	8.13	148.04	4.40	2,991.07	102.38	18,993.21	72,690.45	143.27	75,972.83
SAKA	44,832.63	1,594.66	728.93	6.57	2,586.39	585.80	0.00	0.00	12,036.99	44,832.63	0.00	48,147.95
									#DIV/0!	0.00	0.00	0.00
MEAN	**19,800.39**	**722.13**	**1,803.39**	**106.41**	**12,079.78**	**699.52**	**1,614.43**	**110.86**	8,824.50	19,800.39	1,614.43	35,297.99
MAX	**161,082.35**	**5,217.21**	**14,908.09**	**718.63**	**141,326.74**	**4,791.40**	**8,223.59**	**764.72**	81,385.19	161,082.35	8,223.59	325,540.77
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**117.10**	**4.40**	**0.00**	**0.00**	29.28	117.10	0.00	117.10
MEDIAN	**4,663.21**	**144.53**	**620.41**	**14.28**	**2,881.73**	**332.24**	**318.63**	**21.85**	2,120.99	4,663.21	318.63	8,483.98
SUM	**594,011.73**	**21,663.87**	**54,101.74**	**3,192.33**	**362,393.34**	**20,985.49**	**48,432.91**	**3,325.78**	264,734.93	594,011.73	48,432.91	1,058,939.72
	Dry season 1	±sd	Wet seaon	±sd	Dry season 2	±sd	Short rain	±sd		0.00	0.00	0.00

MUHURUBAY	8,666.57	555.55	0.00	0.00	474.95	50.05	0.00	0.00	2,285.38	8,666.57	0.00	9,141.52
SORI	0.00	0.00	463.02	32.21	932.78	94.97	0.00	0.00	348.95	932.78	0.00	1,395.80
MBITA LHSD	0.00	0.00	420.85	67.33	501.24	96.43	0.00	0.00	230.52	501.24	0.00	922.09
MBITA WG	0.00	0.00	0.00	0.00	19,924.10	587.80	0.00	0.00	4,981.02	19,924.10	0.00	19,924.10
HOMABAY	2,495.77	74.09	683.17	26.61	2,489.78	15.47	0.00	0.00	1,417.18	2,495.77	0.00	5,668.72
KENDUBAY	1,457.68	27.76	0.00	0.00	25,795.21	813.01	505.75	88.92	6,939.66	25,795.21	0.00	27,758.64
KUSA	670.18	50.17	0.00	0.00	470.85	66.27	0.00	0.00	285.26	670.18	0.00	1,141.03
DUNGA BEACH	768.55	20.76	483.33	126.08	746.02	121.56	410.29	27.42	602.04	768.55	410.29	2,408.18
HIPPOPOINT	0.00	0.00	830.93	30.10	724.62	50.35	1,716.13	49.54	817.92	1,716.13	0.00	3,271.69
RAILWAYS	1,464.35	49.40	385.97	21.23	715.50	204.08	0.00	0.00	641.46	1,464.35	0.00	2,565.82
LUANDA	7,306.43	156.22	405.18	9.03	368.62	45.30	0.00	0.00	2,020.06	7,306.43	0.00	8,080.23
MISORI	5,879.66	224.81	0.00	0.00	777.43	99.23	0.00	0.00	1,664.27	5,879.66	0.00	6,657.09
USENGE	0.00	0.00	3,822.11	2,554.47	224.25	36.15	423.75	42.95	1,117.53	3,822.11	0.00	4,470.11
PORT VICTORIA	4,320.12	263.63	462.38	41.59	1,529.45	162.67	4,360.37	309.14	2,668.08	4,360.37	462.38	10,672.33
SIO PORT	396.52	13.88	5,993.72	151.68	359.37	44.50	56,248.31	2,096.21	15,749.48	56,248.31	359.37	62,997.92
R. KUJA	1,568.84	163.56	0.00	0.00	1,020.60	20.17	4,045.64	2,247.17	1,658.77	4,045.64	0.00	6,635.08
R. AWACH	0.00	0.00	311.54	25.14	5,067.08	119.75	0.00	0.00	1,344.65	5,067.08	0.00	5,378.61
R. SONDU	3,566.54	96.37	409.98	42.29	670.67	242.01	1,563.19	65.75	1,552.60	3,566.54	409.98	6,210.39
R. NYANDO	337.99	25.33	0.00	0.00	454.26	18.61	18,477.89	429.32	4,817.54	18,477.89	0.00	19,270.14
R. NYAMASARIA	5,158.59	123.39	519.74	101.78	621.24	41.05	510.58	10.01	1,702.54	5,158.59	510.58	6,810.15
R. KISIAN	3,413.11	35.18	24,599.31	489.54	2,137.48	60.70	611.44	15.84	7,690.34	24,599.31	611.44	30,761.34
R. MUGRUK	3,631.91	107.39	0.00	0.00	4,599.14	167.96	335.78	31.46	2,141.71	4,599.14	0.00	8,566.83
R. AWACH SEME	17,923.20	95.77	386.53	12.57	414.00	15.00	1,110.93	39.93	4,958.67	17,923.20	386.53	19,834.66
R. YALA	616.87	27.55	299.86	12.28	1,877.25	185.42	404.15	3.60	799.53	1,877.25	299.86	3,198.13
R. NZOIA	695.85	55.83	1,610.68	128.71	834.02	108.74	658.20	53.06	949.69	1,610.68	658.20	3,798.75
R. SIO	955.53	153.34	450.98	48.33	3,967.10	58.68	1,058.56	31.33	1,608.04	3,967.10	450.98	6,432.18
NYALENDA	391.99	11.49	0.00	0.00	1,656.69	130.00	0.00	0.00	512.17	1,656.69	0.00	2,048.68
KWASCO	0.00	0.00	0.00	0.00	929.34	240.46	215.07	14.21	286.10	929.34	0.00	1,144.42
KISATI	33,422.60	1,216.88	384.75	15.27	599.71	162.23	587.38	11.63	8,748.61	33,422.60	384.75	34,994.45
SAKA	3,846.54	188.91	16,374.14	1,188.13	2,329.69	277.87	0.00	0.00	5,637.59	16,374.14	0.00	22,550.38
									#DIV/0!	0.00	0.00	0.00
MEAN	**3,631.85**	**124.57**	**1,976.61**	**170.81**	**2,773.75**	**144.55**	**3,108.11**	**185.58**	2,872.58	3,631.85	1,976.61	11,490.31
MAX	**33,422.60**	**1,216.88**	**24,599.31**	**2,554.47**	**25,795.21**	**813.01**	**56,248.31**	**2,247.17**	35,016.36	56,248.31	24,599.31	140,065.43
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**224.25**	**15.00**	**0.00**	**0.00**	56.06	224.25	0.00	224.25

MEDIAN	1,206.61	49.79	395.85	23.19	805.72	97.83	407.22	12.92	703.85	1,206.61	395.85	2,815.40
SUM	108,955.40	3,737.25	59,298.16	5,124.37	83,212.47	4,336.49	93,243.42	5,567.50	86,177.36	108,955.40	59,298.16	344,709.45
	Dry season 1	±sd	Wet seaon	±sd	Dry season 2	±sd	Short rain	±sd	#DIV/0!	0.00	0.00	0.00
MUHURUBAY	3,198.29	176.99	0.00	0.00	520.61	16.33	0.00	0.00	929.73	3,198.29	0.00	3,718.91
SORI	0.00	0.00	0.00	0.00	266.06	5.57	0.00	0.00	66.51	266.06	0.00	266.06
MBITA LHSD	0.00	0.00	6,338.28	244.67	558.58	94.71	0.00	0.00	1,724.22	6,338.28	0.00	6,896.86
MBITA WG	0.00	0.00	900.17	87.06	7,111.30	141.08	0.00	0.00	2,002.87	7,111.30	0.00	8,011.47
HOMABAY	521.49	86.51	614.38	28.09	132.19	20.55	166.23	6.08	358.57	614.38	132.19	1,434.29
KENDUBAY	2,152.40	115.90	195.51	6.69	3,208.00	161.38	1,548.45	69.72	1,776.09	3,208.00	195.51	7,104.37
KUSA	1,869.44	30.54	189.90	6.29	133.51	17.58	0.00	0.00	548.21	1,869.44	0.00	2,192.84
DUNGA BEACH	1,291.72	85.44	39.26	78.51	77.25	32.32	0.00	0.00	352.06	1,291.72	0.00	1,408.22
HIPPOPOINT	0.00	0.00	264.39	72.30	265.01	48.19	137.08	3.24	166.62	265.01	0.00	666.48
RAILWAYS	514.27	10.11	322.14	59.08	2,368.79	240.12	0.00	0.00	801.30	2,368.79	0.00	3,205.20
LUANDA	11,023.04	240.54	204.60	9.83	226.68	30.50	0.00	0.00	2,863.58	11,023.04	0.00	11,454.33
MISORI	163.54	8.42	210.31	4.29	512.84	9.52	0.00	0.00	221.67	512.84	0.00	886.69
USENGE	0.00	0.00	1,487.57	43.46	300.86	79.72	0.00	0.00	447.11	1,487.57	0.00	1,788.43
PORT VICTORIA	95.25	4.75	197.70	41.27	296.90	57.36	2,118.80	88.95	677.16	2,118.80	95.25	2,708.65
SIO PORT	1,712.32	178.53	488.98	33.50	326.39	19.90	165.14	8.07	673.21	1,712.32	165.14	2,692.83
R. KUJA	538.70	31.33	197.10	45.49	334.79	13.90	664.61	115.36	433.80	664.61	197.10	1,735.20
R. AWACH	0.00	0.00	0.00	0.00	91.31	10.90	70.19	25.10	40.37	91.31	0.00	161.50
R. SONDU	365.12	23.60	193.73	37.86	321.29	79.41	1,729.42	26.37	652.39	1,729.42	193.73	2,609.55
R. NYANDO	1,030.37	193.81	185.98	9.55	433.27	17.94	0.00	0.00	412.41	1,030.37	0.00	1,649.62
R. NYAMASARIA	117.07	11.21	281.00	35.95	176.34	67.23	2,507.30	80.74	770.43	2,507.30	117.07	3,081.71
R. KISIAN	1,669.23	38.96	344.09	34.08	607.88	15.22	1,801.24	63.43	1,105.61	1,801.24	344.09	4,422.43
R. MUGRUK	159.32	15.22	213.40	23.71	0.00	0.00	0.00	0.00	93.18	213.40	0.00	372.72
R. AWACH SEME	2,106.13	143.64	0.00	0.00	224.70	24.66	1,699.06	7.55	1,007.47	2,106.13	0.00	4,029.89
R. YALA	123.27	2.57	334.46	31.46	174.05	24.42	126.22	4.41	189.50	334.46	123.27	758.00
R. NZOIA	908.20	149.63	1,963.43	69.57	153.18	48.45	194.72	46.37	804.88	1,963.43	153.18	3,219.52
R. SIO	6,569.00	134.59	0.00	0.00	101.58	17.51	407.41	84.95	1,769.50	6,569.00	0.00	7,077.98
NYALENDA	1,270.79	38.61	229.97	31.36	1,671.25	98.28	0.00	0.00	793.00	1,671.25	0.00	3,172.01
KWASCO	0.00	0.00	0.00	0.00	2,215.79	27.78	493.53	4.58	677.33	2,215.79	0.00	2,709.32
KISATI	6,313.19	219.80	0.00	0.00	1,472.99	43.31	920.73	54.26	2,176.73	6,313.19	0.00	8,706.90
SAKA	3,401.08	87.77	388.03	13.55	2,133.61	65.84	0.00	0.00	1,480.68	3,401.08	0.00	5,922.73

MEAN	**1,570.44**	**67.62**	**526.15**	**34.92**	**880.57**	**50.99**	**491.67**	**22.97**	867.21	1,570.44	491.67	3,468.82
MAX	**11,023.04**	**240.54**	**6,338.28**	**244.67**	**7,111.30**	**240.12**	**2,507.30**	**115.36**	6,744.98	11,023.04	2,507.30	26,979.92
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.00	0.00	0.00	0.00
MEDIAN	**530.10**	**30.93**	**207.46**	**29.72**	**311.08**	**29.14**	**98.21**	**3.82**	286.71	530.10	98.21	1,146.84
SUM	**47,113.23**	**2,028.46**	**15,784.37**	**1,047.61**	**26,416.99**	**1,529.68**	**14,750.12**	**689.17**	26,016.18	47,113.23	14,750.12	104,064.71

Table 4.4.3A: Mean pesticide concentrations in soil from Lake Victoria Basin (ng/kg)

ALDRIN	Dry season 1	±sd	Wet seaon	±sd	Dry season 2	±sd	Short rain	±sd	Mean	max	Min	Sum
MUHURUBAY	227.65	31.46	5,400.19	783.65	0.00	0.00	0.00	0.00	1,406.96	5,400.19	0.00	5,627.83
SORI	23.29	19.37	2,466.07	121.08	0.00	0.00	147.69	101.56	659.26	2,466.07	0.00	2,637.05
MBITA LHSD	129.44	21.50	495.33	110.72	0.00	0.00	0.00	0.00	156.19	495.33	0.00	624.77
MBITA WG	29.76	15.64	119.90	35.39	0.00	0.00	2,618.05	29.62	691.93	2,618.05	0.00	2,767.71
HOMABAY	116.93	5.99	6,567.77	4,805.24	0.00	0.00	0.00	0.00	1,671.17	6,567.77	0.00	6,684.69
KENDUBAY	0.00	0.00	0.00	0.00	4,190.14	272.20	0.00	0.00	1,047.54	4,190.14	0.00	4,190.14
KUSA	5,359.69	256.08	4,890.43	347.12	0.00	0.00	144.13	96.39	2,598.56	5,359.69	0.00	10,394.26
DUNGA BEACH	0.00	0.00	3,961.90	50.68	373.88	123.48	333.26	62.52	1,167.26	3,961.90	0.00	4,669.03
HIPPOPOINT	5,338.43	177.74	1,363.63	65.06	80.86	28.19	0.00	0.00	1,695.73	5,338.43	0.00	6,782.92
RAILWAYS	0.00	0.00	4,833.43	274.04	24,893.58	683.93	1,706.66	69.45	7,858.42	24,893.58	0.00	31,433.68
LUANDA	4,498.67	97.29	0.00	0.00	-26.16	45.32	6,014.94	76.89	2,621.86	6,014.94	-26.16	10,487.45
MISORI	925.66	52.72	0.00	0.00	0.00	0.00	25,383.41	567.80	6,577.27	25,383.41	0.00	26,309.07
USENGE	271.58	14.83	214.15	33.12	0.00	0.00	988.13	36.74	368.47	988.13	0.00	1,473.87
PORT VICTORIA	0.00	0.00	0.00	0.00	0.00	0.00	409.53	120.71	102.38	409.53	0.00	409.53
SIO PORT	0.00	0.00	482.26	135.34	875.58	151.56	905.75	65.99	565.90	905.75	0.00	2,263.58
R. KUJA	0.00	0.00	0.00	0.00	139.74	37.49	1,999.83	173.05	534.89	1,999.83	0.00	2,139.57
R. AWACH	101.28	27.29	1,015.99	166.49	0.00	0.00	0.00	0.00	279.32	1,015.99	0.00	1,117.28
R. SONDU	0.00	0.00	14,656.33	545.94	1,934.99	75.58	0.00	0.00	4,147.83	14,656.33	0.00	16,591.32
R. NYANDO	139.14	17.04	3,118.63	361.40	1,133.09	148.59	672.98	179.51	1,265.96	3,118.63	139.14	5,063.84
R. NYAMASARIA	0.00	0.00	1,159.09	110.00	25,139.57	1,023.92	0.00	0.00	6,574.67	25,139.57	0.00	26,298.67
R. KISIAN	0.00	0.00	2,027.18	155.53	0.00	0.00	0.00	0.00	506.80	2,027.18	0.00	2,027.18
R. MUGRUK	0.00	0.00	0.00	0.00	690.68	145.61	276.38	22.73	241.76	690.68	0.00	967.06
R. AWACH SEME	0.00	0.00	0.00	0.00	0.00	0.00	1,164.98	235.16	291.25	1,164.98	0.00	1,164.98
R. YALA	696.49	85.23	1,064.66	76.74	0.00	0.00	1,202.26	166.04	740.85	1,202.26	0.00	2,963.40
R. NZOIA	1,097.09	67.71	921.27	93.21	0.00	0.00	0.00	0.00	504.59	1,097.09	0.00	2,018.36
R. SIO	0.00	0.00	0.00	0.00	0.00	0.00	3,596.13	812.49	899.03	3,596.13	0.00	3,596.13
NYALENDA	0.00	0.00	0.00	0.00	0.00	0.00	191.26	57.57	47.81	191.26	0.00	191.26
KWASCO	602.30	65.54	0.00	0.00	532.87	82.61	21,455.22	528.49	5,647.60	21,455.22	0.00	22,590.39
KISATI	0.00	0.00	866.84	110.87	2,125.46	141.15	844.73	100.44	959.26	2,125.46	0.00	3,837.03
SAKA	0.00	0.00	954.91	129.78	1,196.94	151.84	47.58	-	549.86	1,196.94	0.00	2,199.43
MEAN	**651.91**	**31.85**	**1,886.00**	**283.71**	**2,109.37**	**103.72**	**2,336.76**	**-**	**1,746.01**	**2,336.76**	**651.91**	**6,984.05**
MAX	**5,359.69**	**256.08**	**14,656.33**	**4,805.24**	**25,139.57**	**1,023.92**	**25,383.41**	**-**	**17,634.75**	**25,383.41**	**5,359.69**	**70,539.00**

MIN	0.00	0.00	0.00	0.00	-26.16	0.00	0.00	-	-6.54	0.00	-26.16	-26.16
MEDIAN	11.65	2.99	894.06	84.97	0.00	0.00	304.82	-	302.63	894.06	0.00	1,210.52
SUM	19,557.40	955.44	56,579.97	8,511.39	63,281.22	3,111.47	70,102.88	-				209,521.47
Dieldrin	**Dry season 1**	**STD**	**Wet season**	**STD**	**Dry season 2**	**STD**	**Short rain**	**STD**	**MEAN**	**MAX**	**MIN**	
MUHURUBAY	380.36	20.82	4,840.77	254.86	230.37	46.39	0.00	0.00	1,362.87	4,840.77	0.00	5,451.50
SORI	59.83	21.98	0.00	0.00	0.00	0.00	0.00	0.00	14.96	59.83	0.00	59.83
MBITA LHSD	0.00	0.00	2,402.53	346.33	0.00	0.00	319.23	38.07	680.44	2,402.53	0.00	2,721.76
MBITA WG	510.74	58.35	171.78	49.83	1,051.43	168.48	208.10	74.92	485.51	1,051.43	171.78	1,942.05
HOMABAY	0.00	0.00	570.89	28.76	50,049.61	6,537.45	0.00	0.00	12,655.13	50,049.61	0.00	50,620.51
KENDUBAY	0.00	0.00	0.00	0.00	5,761.44	1,068.04	0.00	0.00	1,440.36	5,761.44	0.00	5,761.44
KUSA	775.62	21.63	206.11	9.38	0.00	0.00	1,882.36	36.80	716.02	1,882.36	0.00	2,864.08
DUNGA BEACH	0.00	0.00	0.00	0.00	92.87	33.96	290.87	31.31	95.94	290.87	0.00	383.74
HIPPOPOINT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RAILWAYS	0.00	0.00	26,095.57	3,093.87	36,729.28	903.15	0.00	0.00	15,706.21	36,729.28	0.00	62,824.86
LUANDA	953.64	69.21	206,076.00	150,004.46	1,626.06	101.13	0.00	0.00	52,163.92	206,076.00	0.00	208,655.69
MISORI	88.02	22.90	180.01	11.72	0.00	0.00	106.00	12.02	93.51	180.01	0.00	374.03
USENGE	1,107.56	119.46	953.26	90.38	0.00	0.00	0.00	0.00	515.20	1,107.56	0.00	2,060.82
PORT VICTORIA	0.00	0.00	0.00	0.00	0.00	0.00	2,927.74	139.38	731.94	2,927.74	0.00	2,927.74
SIO PORT	0.00	0.00	3,231.78	613.90	0.00	0.00	467.22	46.14	924.75	3,231.78	0.00	3,699.00
R. KUJA	0.00	0.00	0.00	0.00	530.67	76.83	9,858.22	749.62	2,597.22	9,858.22	0.00	10,388.89
R. AWACH	84.97	18.10	4,140.27	514.29	0.00	0.00	0.00	0.00	1,056.31	4,140.27	0.00	4,225.24
R. SONDU	0.00	0.00	5,775.02	991.60	0.00	0.00	0.00	0.00	1,443.76	5,775.02	0.00	5,775.02
R. NYANDO	1,103.86	51.47	9,485.29	943.68	0.00	0.00	278.14	27.09	2,716.82	9,485.29	0.00	10,867.29
R. NYAMASARIA	0.00	0.00	0.00	0.00	43,239.17	2,055.95	0.00	0.00	10,809.79	43,239.17	0.00	43,239.17
R. KISIAN	471.11	79.91	1,506.31	37.05	0.00	0.00	0.00	0.00	494.35	1,506.31	0.00	1,977.42
R. MUGRUK	0.00	0.00	0.00	0.00	0.00	0.00	587.23	118.99	146.81	587.23	0.00	587.23
R. AWACH SEME	0.00	0.00	498.38	115.74	127.50	20.76	1,520.38	423.78	536.56	1,520.38	0.00	2,146.25
R. YALA	355.90	142.00	3,155.67	153.52	0.00	0.00	933.55	58.74	1,111.28	3,155.67	0.00	4,445.12
R. NZOIA	62.92	9.43	0.00	0.00	0.00	0.00	5,293.01	5,165.52	1,338.98	5,293.01	0.00	5,355.93
R. SIO	0.00	0.00	0.00	0.00	0.00	0.00	692.89	46.09	173.22	692.89	0.00	692.89
NYALENDA	249,841.40	1,460.97	0.00	0.00	652,527.23	938.71	962.13	64.54	225,832.69	652,527.23	0.00	903,330.76
KWASCO	149.68	17.01	9,908.61	356.64	0.00	0.00	0.00	0.00	2,514.57	9,908.61	0.00	10,058.29
KISATI	0.00	0.00	0.00	0.00	6,618.03	494.80	301.44	3.23	1,729.87	6,618.03	0.00	6,919.48
SAKA	0.00	0.00	0.00	0.00	0.00	0.00	98,893.80	818.29	24,723.45	98,893.80	0.00	98,893.80
MEAN	8,531.52	70.44	9,306.61	5,253.87	26,619.46	414.85	4,184.08	261.82	12,160.42	26,619.46	4,184.08	48,641.66

MAX	**249,841.40**	**1,460.97**	**206,076.00**	**150,004.46**	**652,527.23**	**6,537.45**	**98,893.80**	**5,165.52**	**301,834.61**	**652,527.23**	**98,893.80**	**1,207,338.43**
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
MEDIAN	**0.00**	**0.00**	**193.06**	**20.24**	**0.00**	**0.00**	**243.12**	**19.55**	**109.05**	**243.12**	**0.00**	**436.18**
SUM	**255,945.60**	**2,113.24**	**279,198.25**	**157,616.03**	**798,583.67**	**12,445.64**	**125,522.29**	**7,854.53**				**1,459,249.81**
***p,p'*–DDT**	**Dry season 1**	**Wet season**	**Wet season**	**Short rain**	**Dry season 2**		**Short rain**		**MEAN**	**MAX**	**MIN**	**0.00**
MUHURUBAY	0	0	2902.39	115.56	0	0	0	0		**2,902.39**	**0.00**	**2,902.39**
SORI	0	0	11529.06	1104.31	0	0	18247.6176	584.028647	0.00	**18,247.62**	**0.00**	**29,776.68**
MBITA LHSD	0	0	6791.02	373.18	10998.90	681.004117	39189.0542	1456.35983	584.03	**39,189.05**	0.00	**56,978.97**
MBITA WG	674.32	156.67	9446.98	466.08	5600.66	15.6027144	26223.6395	1396.82303	1,456.36	**26,223.64**	**674.32**	**41,945.60**
HOMABAY	0	0	13565.07	508.59	11482.86	1331.48676	17839.8299	708.874975	1,396.82	**17,839.83**	**0.00**	**42,887.75**
KENDUBAY	0	0	44401.84	1447.89	25026.75	838.89958	0	0	708.87	**44,401.84**	**0.00**	**69,428.59**
KUSA	452.82	43.67	108030.69	2393.30	190.15	27.4242865	8835.25958	1068.57804	0.00	**108,030.69**	**190.15**	**117,508.92**
DUNGA BEACH	0	0	11457.98	1113.84	0	0	22552.8273	2223.90343	1,068.58	**22,552.83**	**0.00**	**34,010.80**
HIPPOPOINT	24961.14	107.84	0	0	3815.42	127.302078	0	0	2,223.90	**24,961.14**	**0.00**	**28,776.56**
RAILWAYS	0	0	3799.25	234.368709	176717.25	3713.62862	11422.5815	719.278246	0.00	**176,717.25**	**0.00**	**191,939.08**
LUANDA	11817.79	923.71	0	0	110804.67	3135.29124	18111.4762	591.78971	719.28	**110,804.67**	**0.00**	**140,733.94**
MISORI	7277.13	883.84	22996.87	15357.63	0	0	3524.75262	130.314365	591.79	**22,996.87**	**0.00**	**33,798.75**
USENGE	19971.93	1343.57	182441.39	135317.074	0	0	279.882162	22.4682146	130.31	**182,441.39**	**0.00**	**202,693.21**
PORT VICTORIA	8311.44	397.81	2944.40	116.13	0	0	0	0	22.47	**8,311.44**	**0.00**	**11,255.84**
SIO PORT	0	0	14914.54	372.71	13139.33	17080.1926	0	0	0.00	**14,914.54**	**0.00**	**28,053.87**
R. KUJA	0	0	0	0	14696.92	884.062596	47503.9841	2529.45933	0.00	**47,503.98**	**0.00**	**62,200.90**
R. AWACH	32912.82	2317.35	0	0	25583.96	998.808478	26104.664	2183.28181	2,529.46	**32,912.82**	**0.00**	**84,601.44**
R. SONDU	0	0	50393.13	614.21	479.50	25.0246588	0	0	2,183.28	**50,393.13**	**0.00**	**50,872.63**
R. NYANDO	7714.12	553.39	14628.24	658.68	90804.73	1510.5784	24912.6701	985.316954	0.00	**90,804.73**	**7,714.12**	**138,059.76**
R. NYAMASARIA	0	0	0	0	0	0	0	0	985.32	**0.00**	**0.00**	**0.00**
R. KISIAN	49685.96	5985.77	0	0	0	0	5173.92874	520.261932	0.00	**49,685.96**	**0.00**	**54,859.89**
R. MUGRUK	0	0	0	0	0	0	13364.376	580.372961	520.26	**13,364.38**	**0.00**	**13,364.38**
R. AWACH SEME	0	0	1841.06	97.40	0	0	0	0	580.37	**1,841.06**	**0.00**	**1,841.06**
R. YALA	56457.13	1236.32	5781.62	210.58	0	0	5430.71076	513.124782	0.00	**56,457.13**	**0.00**	**67,669.47**
R. NZOIA	6502.38	166.80	7593.15	632.54	48897.60	1480.82762	31347.8388	1381.63835	513.12	**48,897.60**	**6,502.38**	**94,340.97**
R. SIO	11.70	29.10	0	0	291.72	23.7216762	4800.49508	807.674491	1,381.64	**4,800.50**	**0.00**	**5,103.91**
NYALENDA	0	0	0	0	60382.53	1438.13808	7852.65538	207.996256	0.00	**60,382.53**	**0.00**	**68,235.18**
KWASCO	368.35	131.68	0	0	0	0	35473.4303	812.954977	208.00	**35,473.43**	**0.00**	**35,841.78**
KISATI	29821.68	1323.09	52379.99	1436.69	265.39	38.7066713	203698.977	6103.77689	812.95	**203,698.98**	**265.39**	**286,166.04**
SAKA	0	0	0	0	32056.43	1617.56413	96119.0277	3949.56777	6,103.78	**96,119.03**	**0.00**	**128,175.45**

MEAN	8,564.69	520.02	18,927.96	5,419.03	21,041.16	1,165.61	22,266.99	982.59	17,700.20	22,266.99	8,564.69	70,800.79
MAX	56,457.13	5,985.77	182,441.39	135,317.07	176,717.25	17,080.19	203,698.98	6,103.78	154,828.69	203,698.98	56,457.13	619,314.75
MIN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MEDIAN	5.85	14.55	4,790.44	222.47	385.61	26.22	10,128.92	587.91	3,827.70	10,128.92	5.85	15,310.82
SUM	256,940.72	15,600.61	567,838.67	162,570.78	631,234.75	34,968.26	668,009.68	29,477.85				2,124,023.82
p,p'–DDE	Dry season 1	STD	Wet season	STD	Dry season 2	STD	Short rain	STD	MEAN	MAX	MIN	0.00
MUHURUBAY	175.88	18.18	9,047.20	116.05	0.00	0.00	0.00	0.00	2,305.77	9,047.20	0.00	9,223.08
SORI	2,586.86	68.46	147.95	16.52	159.66	14.66	181.50	23.35	768.99	2,586.86	147.95	3,075.97
MBITA LHSD	234.88	18.53	17,901.31	528.49	139.62	30.51	291.17	7.56	4,641.74	17,901.31	139.62	18,566.98
MBITA WG	156.83	31.80	251.59	17.94	563.33	48.09	4,291.38	165.88	1,315.78	4,291.38	156.83	5,263.14
HOMABAY	227.86	38.37	400.48	26.91	214.17	11.11	525.98	52.47	342.12	525.98	214.17	1,368.49
KENDUBAY	0.00	0.00	180.83	21.84	1,221.13	86.87	0.00	0.00	350.49	1,221.13	0.00	1,401.96
KUSA	1,799.23	357.93	3,598.85	233.91	222.53	35.56	215.94	51.57	1,459.14	3,598.85	215.94	5,836.56
DUNGA BEACH	0.00	0.00	174.31	37.26	188.40	73.97	679.52	99.91	260.56	679.52	0.00	1,042.23
HIPPOPOINT	4,497.94	390.66	167.76	15.00	184.26	12.52	0.00	0.00	1,212.49	4,497.94	0.00	4,849.96
RAILWAYS	0.00	0.00	353.73	20.86	7,493.38	199.87	262.02	8.76	2,027.28	7,493.38	0.00	8,109.13
LUANDA	201.72	50.90	3,698.69	209.23	270.67	10.53	964.21	48.86	1,283.82	3,698.69	201.72	5,135.30
MISORI	416.89	101.90	251.83	34.49	0.00	0.00	246.79	75.83	228.88	416.89	0.00	915.51
USENGE	195.57	36.60	2,961.07	215.38	0.00	0.00	506.00	14.64	915.66	2,961.07	0.00	3,662.64
PORT VICTORIA	1,930.83	545.96	83.52	16.24	0.00	0.00	445.91	100.46	615.06	1,930.83	0.00	2,460.26
SIO PORT	0.00	0.00	266.81	23.33	352.43	50.39	611.48	78.15	307.68	611.48	0.00	1,230.72
R. KUJA	469.48	78.85	156.89	14.42	314.66	19.89	2,567.20	1,636.87	877.06	2,567.20	156.89	3,508.24
R. AWACH	279.44	124.32	339.52	20.24	246.22	89.72	217.82	57.51	270.75	339.52	217.82	1,082.99
R. SONDU	0.00	0.00	137.67	14.90	273.82	13.52	0.00	0.00	102.87	273.82	0.00	411.49
R. NYANDO	489.04	157.54	838.36	49.32	191.17	19.23	267.08	71.61	446.41	838.36	191.17	1,785.65
R. NYAMASARIA	0.00	0.00	241.42	53.02	1,925.74	168.17	212.76	26.33	594.98	1,925.74	0.00	2,379.92
R. KISIAN	260.59	80.41	176.38	29.29	0.00	0.00	145.96	15.02	145.73	260.59	0.00	582.93
R. MUGRUK	0.00	0.00	0.00	0.00	0.00	0.00	332.82	51.95	83.21	332.82	0.00	332.82
R. AWACH SEME	0.00	0.00	137.58	13.36	0.00	0.00	954.32	87.83	272.98	954.32	0.00	1,091.91
R. YALA	227.76	32.80	169.12	6.43	0.00	0.00	2,924.32	202.25	830.30	2,924.32	0.00	3,321.20
R. NZOIA	164.03	19.68	166.84	34.20	136.66	10.82	7,194.38	765.06	1,915.48	7,194.38	136.66	7,661.92
R. SIO	0.00	0.00	0.00	0.00	124.88	42.74	292.19	9.52	104.27	292.19	0.00	417.07
NYALENDA	186.48	56.70	0.00	0.00	74,198.90	1,681.06	376.07	31.92	18,690.36	74,198.90	0.00	74,761.46
KWASCO	1,111.87	270.63	177.55	6.86	151.32	12.47	468.39	41.68	477.28	1,111.87	151.32	1,909.13
KISATI	2,110.31	105.43	145.15	25.81	224.32	41.26	1,177.52	101.36	914.32	2,110.31	145.15	3,657.29

SAKA	0.00	0.00	168.03	13.16	122.36	6.95	27,427.97	401.39	6,929.59	27,427.97	0.00	27,718.36
MEAN	**590.78**	**86.19**	**1,411.35**	**60.48**	**2,963.99**	**89.33**	**1,792.69**	**140.92**	**1,689.70**	**2,963.99**	**590.78**	**6,758.81**
MAX	**4,497.94**	**545.96**	**17,901.31**	**528.49**	**74,198.90**	**1,681.06**	**27,427.97**	**1,636.87**	**31,006.53**	**74,198.90**	**4,497.94**	**124,026.12**
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
MEDIAN	**198.65**	**34.70**	**176.96**	**21.35**	**186.33**	**14.09**	**354.44**	**51.76**	**229.10**	**354.44**	**176.96**	**0.00**
SUM	**17,723.49**	**2,585.64**	**42,340.44**	**1,814.44**	**88,919.64**	**2,679.88**	**53,780.71**	**4,227.74**				**916.39**
												202,764.28
p,p'–DDD	**Dry season 1**	**STD**	**Wet season**	**STD**	**Dry season 2**	**STD**	**Short rain**	**STD**	**MEAN**	**MAX**	**MIN**	**0.00**
MUHURUBAY	203.79	5.64	612.77	67.02	68.52	9.75	0.00	0.00	221.27	612.77	0.00	885.08
SORI	249.98	19.80	187.23	12.38	214.96	31.67	249.06	34.00	225.31	249.98	187.23	901.23
MBITA LHSD	360.53	29.78	213.94	39.09	167.53	15.95	273.29	33.14	253.82	360.53	167.53	1,015.30
MBITA WG	218.15	28.28	250.47	28.03	218.69	29.99	478.18	27.26	291.37	478.18	218.15	1,165.49
HOMABAY	324.92	21.77	935.72	113.98	275.09	28.47	441.49	77.79	494.30	935.72	275.09	1,977.22
KENDUBAY	0.00	0.00	632.54	60.97	305.42	21.92	0.00	0.00	234.49	632.54	0.00	937.96
KUSA	1,578.04	159.64	215.95	71.62	0.00	0.00	761.87	121.96	638.96	1,578.04	0.00	2,555.86
DUNGA BEACH	0.00	0.00	229.21	56.68	374.25	41.13	1,037.48	66.47	410.23	1,037.48	0.00	1,640.93
HIPPOPOINT	211.65	33.82	624.92	88.47	248.98	45.14	0.00	0.00	271.38	624.92	0.00	1,085.54
RAILWAYS	0.00	0.00	1,648.56	197.54	230.33	53.33	400.42	49.45	569.83	1,648.56	0.00	2,279.32
LUANDA	386.31	54.35	3,366.36	310.50	436.69	75.62	219.99	8.46	1,102.34	3,366.36	219.99	4,409.35
MISORI	265.72	7.14	225.02	43.24	0.00	0.00	268.50	61.06	189.81	268.50	0.00	759.24
USENGE	392.11	2.91	617.33	113.25	0.00	0.00	225.96	51.16	308.85	617.33	0.00	1,235.40
PORT VICTORIA	212.10	33.79	0.00	0.00	0.00	0.00	238.94	42.37	112.76	238.94	0.00	451.04
SIO PORT	0.00	0.00	286.89	14.30	254.64	24.30	289.48	17.78	207.75	289.48	0.00	831.01
R. KUJA	230.67	35.28	216.67	32.47	396.32	6.48	208.34	16.01	263.00	396.32	208.34	1,052.00
R. AWACH	330.10	57.19	314.68	53.84	219.47	27.87	240.55	12.15	276.20	330.10	219.47	1,104.79
R. SONDU	0.00	0.00	175.66	31.42	271.73	22.65	0.00	0.00	111.85	271.73	0.00	447.39
R. NYANDO	248.40	16.34	244.49	55.17	240.48	40.87	288.09	38.97	255.37	288.09	240.48	1,021.46
R. NYAMASARIA	0.00	0.00	250.34	9.78	202.65	5.37	277.87	15.83	182.72	277.87	0.00	730.86
R. KISIAN	699.70	28.84	215.47	31.77	0.00	0.00	185.65	15.05	275.21	699.70	0.00	1,100.83
R. MUGRUK	0.00	0.00	0.00	0.00	0.00	0.00	514.60	24.75	128.65	514.60	0.00	514.60
R. AWACH SEME	0.00	0.00	211.93	45.64	0.00	0.00	227.04	42.11	109.74	227.04	0.00	438.96
R. YALA	953.45	46.82	281.48	57.99	0.00	0.00	349.95	45.14	396.22	953.45	0.00	1,584.87
R. NZOIA	949.98	173.24	2,594.45	126.86	192.37	13.88	315.19	30.69	1,013.00	2,594.45	192.37	4,051.99
R. SIO	0.00	0.00	0.00	0.00	284.52	28.49	358.46	52.58	160.74	358.46	0.00	642.97
NYALENDA	272.61	7.82	274.43	10.20	361.24	20.60	374.03	11.15	320.58	374.03	272.61	1,282.31
KWASCO	411.43	43.08	531.40	66.75	240.47	54.83	2,478.36	183.44	915.41	2,478.36	240.47	3,661.65

KISATI	237.41	71.40	1,237.77	55.78	589.84	68.26	243.98	22.60	577.25	1,237.77	237.41	2,309.00
SAKA	0.00	0.00	221.63	26.63	296.42	89.70	2,376.13	179.24	723.55	2,376.13	0.00	2,894.18
MEAN	**291.23**	**29.23**	**560.58**	**60.71**	**203.02**	**25.21**	**444.10**	**42.69**	**374.73**	**560.58**	**203.02**	**1,498.93**
MAX	**1,578.04**	**173.24**	**3,366.36**	**310.50**	**589.84**	**89.70**	**2,478.36**	**183.44**	**2,003.15**	**3,366.36**	**589.84**	**8,012.60**
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
MEDIAN	**234.04**	**18.07**	**250.40**	**49.74**	**224.90**	**22.29**	**275.58**	**31.92**	**246.23**	**275.58**	**224.90**	**984.92**
SUM	**8,737.03**	**876.92**	**16,817.29**	**1,821.38**	6,090.61	756.26	**13,322.89**	**1,280.60**				**44,967.82**
HEPTACHLOR	**Dry season 1**	**STD**	**Wet season**	**STD**	**Dry season 2**	**STD**	**Short rain**	**STD**	**MEAN**	**MAX**	**MIN**	**0.00**
MUHURUBAY	600.37	79.19	16,449.66	912.67	163.24	41.11	0.00	0.00	**4,303.32**	**16,449.66**	**0.00**	**17,213.27**
SORI	39,212.75	1,662.76	544.10	132.33	446.10	65.09	3,953.90	240.72	**11,039.21**	**39,212.75**	**446.10**	**44,156.84**
MBITA LHSD	561.12	49.12	5,969.75	935.56	347.13	52.63	2,320.20	269.61	**2,299.55**	**5,969.75**	**347.13**	**9,198.20**
MBITA WG	559.33	160.46	702.64	99.60	11,826.05	1,447.59	796.12	160.78	**3,471.04**	**11,826.05**	**559.33**	**13,884.14**
HOMABAY	1,425.21	68.29	5,473.79	603.01	605.33	64.10	750.02	144.60	**2,063.59**	**5,473.79**	**605.33**	**8,254.34**
KENDUBAY	0.00	0.00	0.00	0.00	6,932.52	963.25	0.00	0.00	**1,733.13**	**6,932.52**	**0.00**	**6,932.52**
KUSA	2,025.95	419.66	1,949.57	63.88	0.00	0.00	3,783.83	213.68	**1,939.84**	**3,783.83**	**0.00**	**7,759.36**
DUNGA BEACH	0.00	0.00	636.53	240.82	2,957.25	84.80	843.11	188.91	**1,109.22**	**2,957.25**	**0.00**	**4,436.90**
HIPPOPOINT	1,191.59	214.46	4,185.85	99.71	576.81	145.15	0.00	0.00	**1,488.56**	**4,185.85**	**0.00**	**5,954.24**
RAILWAYS	0.00	0.00	4,058.22	121.07	1,578.50	88.70	1,795.46	192.64	**1,858.05**	**4,058.22**	**0.00**	**7,432.18**
LUANDA	1,450.53	250.34	6,878.41	260.43	9,365.92	335.20	3,856.94	310.74	**5,387.95**	**9,365.92**	**1,450.53**	**21,551.80**
MISORI	449.35	53.69	499.70	150.20	0.00	0.00	2,600.29	70.53	**887.33**	**2,600.29**	**0.00**	**3,549.33**
USENGE	1,015.87	24.60	4,921.85	390.46	0.00	0.00	2,502.99	363.96	**2,110.18**	**4,921.85**	**0.00**	**8,440.71**
PORT VICTORIA	544.24	80.38	0.00	0.00	0.00	0.00	3,631.61	420.44	**1,043.96**	**3,631.61**	**0.00**	**4,175.85**
SIO PORT	0.00	0.00	885.99	71.23	13,449.05	514.77	532.88	461.63	**3,716.98**	**13,449.05**	**0.00**	**14,867.91**
R. KUJA	816.61	162.83	429.73	64.97	2,930.64	130.37	2,421.27	376.61	**1,649.56**	**2,930.64**	**429.73**	**6,598.25**
R. AWACH	765.26	60.99	3,976.32	607.62	431.39	62.02	6,612.98	187.78	**2,946.49**	**6,612.98**	**431.39**	**11,785.95**
R. SONDU	0.00	0.00	2,954.92	120.93	635.07	75.02	0.00	0.00	**897.50**	**2,954.92**	**0.00**	**3,589.99**
R. NYANDO	1,173.09	42.24	10,495.48	898.70	661.30	273.47	1,349.72	220.56	**3,419.90**	**10,495.48**	**661.30**	**13,679.60**
R. NYAMASARIA	0.00	0.00	3,939.85	76.81	30,928.46	1,245.43	702.27	164.58	**8,892.65**	**30,928.46**	**0.00**	**35,570.58**
R. KISIAN	595.67	57.94	4,043.63	323.23	0.00	0.00	430.77	82.79	**1,267.52**	**4,043.63**	**0.00**	**5,070.07**
R. MUGRUK	0.00	0.00	0.00	0.00	4,066.12	129.91	662.42	191.68	**1,182.14**	**4,066.12**	**0.00**	**4,728.54**
R. AWACH SEME	0.00	0.00	504.53	94.43	268.27	34.58	7,846.00	1,604.82	**2,154.70**	**7,846.00**	**0.00**	**8,618.81**
R. YALA	942.88	134.27	10,921.58	854.68	0.00	0.00	3,108.20	176.38	**3,743.16**	**10,921.58**	**0.00**	**14,972.66**
R. NZOIA	610.30	48.38	37,545.07	1,124.32	418.01	78.42	2,824.89	270.43	**10,349.57**	**37,545.07**	**418.01**	**41,398.27**
R. SIO	0.00	0.00	0.00	0.00	0.00	0.00	535.95	74.89	**133.99**	**535.95**	**0.00**	**535.95**
NYALENDA	583.01	126.93	392.60	9.92	386,805.53	3,639.53	893.30	19.91	**97,168.61**	**386,805.53**	**392.60**	**388,674.44**

KWASCO	128.76	21.20	8,913.82	672.56	2,748.81	62.20	81,906.06	8,419.62	23,424.36	81,906.06	128.76	93,697.44
KISATI	560.65	131.93	9,445.36	688.86	524.05	160.35	2,284.51	593.35	3,203.64	9,445.36	524.05	12,814.57
SAKA	0.00	0.00	10,414.28	619.55	6,616.37	433.28	108,918.38	5,976.49	31,487.26	108,918.38	0.00	125,949.03
MEAN	**1,840.42**	**128.32**	**5,237.77**	**341.25**	**16,176.06**	**337.57**	**8,262.14**	**713.27**	**7,879.10**	**16,176.06**	**1,840.42**	**31,516.39**
MAX	**39,212.75**	**1,662.76**	**37,545.07**	**1,124.32**	**386,805.53**	**3,639.53**	**108,918.38**	**8,419.62**	**97,168.61**	**386,805.53**	**37,545.07**	**572,481.73**
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**133.99**	**0.00**	**0.00**	**0.00**
MEDIAN	**560.89**	**51.41**	**3,958.09**	**141.27**	**591.07**	**76.72**	**2,039.99**	**192.16**	**2,227.13**	**3,958.09**	**560.89**	**7,150.03**
SUM	**55,212.54**	**3,849.65**	**157,133.21**	**10,237.56**	**485,281.93**	**10,126.98**	**247,864.08**	**21,398.13**	**236,372.94**			**945,491.77**
HEPTACHLOR EPOXIDE												
	Dry season 1	**STD**	**Wet season**	**STD**	**Dry season 2**	**STD**	**Short rain**	**STD**	**MEAN**	**MAX**	**MIN**	**0.00**
MUHURUBAY	89.47	19.74	2,937.26	93.72	81.72	24.69	0.00	0.00	777.11	2,937.26	0.00	3,108.45
SORI	389.32	57.86	1,929.37	133.20	2,366.09	184.10	1,155.50	278.75	1,460.07	2,366.09	389.32	5,840.27
MBITA LHSD	126.32	880.60	1,166.15	137.16	573.09	86.41	489.95	140.59	588.88	1,166.15	126.32	2,355.51
MBITA WG	43.21	30.58	182.26	17.80	803.33	71.74	171.72	27.97	300.13	803.33	43.21	1,200.53
HOMABAY	1,497.30	52.95	979.57	24.24	1,408.51	220.51	14,354.12	375.92	4,559.87	14,354.12	979.57	18,239.50
KENDUBAY	0.00	0.00	362.47	47.36	8,564.93	530.30	0.00	0.00	2,231.85	8,564.93	0.00	8,927.39
KUSA	3,627.36	198.93	17,177.24	22,490.86	75.79	23.50	130.51	10.14	5,252.73	17,177.24	75.79	21,010.90
DUNGA BEACH	0.00	0.00	5,051.39	85.47	370.34	48.04	440.78	73.53	1,465.63	5,051.39	0.00	5,862.52
HIPPOPOINT	0.00	0.00	684.08	31.91	0.00	0.00	0.00	0.00	171.02	684.08	0.00	684.08
RAILWAYS	0.00	0.00	802.59	21.93	26,864.99	2,005.51	3,678.16	366.26	7,836.44	26,864.99	0.00	31,345.74
LUANDA	596.87	111.30	7,771.91	1,133.65	64.38	22.33	2,482.68	128.23	2,728.96	7,771.91	64.38	10,915.84
MISORI	38.32	35.89	294.45	10.20	0.00	0.00	627.18	61.72	239.99	627.18	0.00	959.95
USENGE	141.65	10.83	581.20	34.34	0.00	0.00	1,672.17	96.74	598.75	1,672.17	0.00	2,395.02
PORT VICTORIA	121.06	24.82	0.00	0.00	0.00	0.00	711.07	54.87	208.03	711.07	0.00	832.13
SIO PORT	0.00	0.00	493.85	11.27	769.51	85.07	0.00	0.00	315.84	769.51	0.00	1,263.36
R. KUJA	114.26	18.43	2,425.05	98.32	104.77	22.13	967.19	123.54	902.82	2,425.05	104.77	3,611.27
R. AWACH	261.80	36.72	5,126.18	1,038.87	2,066.07	87.88	167.46	87.02	1,905.38	5,126.18	167.46	7,621.51
R. SONDU	0.00	0.00	3,294.59	117.12	265.56	54.41	0.00	0.00	890.04	3,294.59	0.00	3,560.15
R. NYANDO	193.15	14.53	5,388.12	3,403.17	873.16	119.14	1,230.90	180.65	1,921.33	5,388.12	193.15	7,685.33
R. NYAMASARIA	0.00	0.00	866.13	46.44	25,184.79	501.04	0.00	0.00	6,512.73	25,184.79	0.00	26,050.92
R. KISIAN	105.20	25.10	625.33	73.27	0.00	0.00	2,436.47	133.85	791.75	2,436.47	0.00	3,167.00
R. MUGRUK	0.00	0.00	0.00	0.00	0.00	0.00	221.59	95.21	55.40	221.59	0.00	221.59
R. AWACH SEME	0.00	0.00	620.94	46.55	0.00	0.00	1,724.85	64.89	586.45	1,724.85	0.00	2,345.79
R. YALA	210.78	30.65	890.60	80.90	0.00	0.00	0.00	0.00	275.34	890.60	0.00	1,101.38
R. NZOIA	308.69	42.41	395.43	8.63	551.55	81.50	2,531.46	112.76	946.78	2,531.46	308.69	3,787.13

R. SIO	0.00	0.00	0.00	0.00	107.34	16.18	1,365.57	106.93	368.23	1,365.57	0.00	1,472.91
NYALENDA	0.00	0.00	1,532.31	125.43	0.00	0.00	420.66	112.30	488.24	1,532.31	0.00	1,952.98
KWASCO	0.00	0.00	968.81	41.87	1,001.13	23.96	3,243.04	71.36	1,303.24	3,243.04	0.00	5,212.98
KISATI	0.00	0.00	5,276.78	229.46	0.00	0.00	1,068.49	56.12	1,586.32	5,276.78	0.00	6,345.28
SAKA	0.00	0.00	384.59	666.14	225.45	32.08	0.00	0.00	152.51	384.59	0.00	610.05
MEAN	**262.16**	**53.04**	**2,273.62**	**1,008.31**	**2,410.75**	**141.35**	**1,376.38**	**91.98**	**1,580.73**	**2,410.75**	**262.16**	**6,322.91**
MAX	**3,627.36**	**880.60**	**17,177.24**	**22,490.86**	**26,864.99**	**2,005.51**	**14,354.12**	**375.92**	**15,505.93**	**26,864.99**	**3,627.36**	**62,023.71**
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
MEDIAN	**40.77**	**12.68**	**878.36**	**60.32**	**166.39**	**24.33**	**558.56**	**72.44**	**411.02**	**878.36**	**40.77**	**1,644.09**
SUM	7,864.77	1,591.34	68,208.63	30,249.29	72,322.52	4,240.52	41,291.51	2,759.34	**47,421.86**	**72,322.52**	**7,864.77**	**189,687.43**

α-HCH	**Dry season 1**	**STD**	**Wet season**	**STD**	**Dry season 2**	**STD**	**Short rain**	**STD**	**MEAN**	**MAX**	**MIN**	**0.00**
MUHURUBAY	1,746.77	8.34	12,583.03	520.02	0.00	0.00	0.00	0.00	**3,582.45**	**12,583.03**	**0.00**	**14,329.80**
SORI	970.15	43.44	877.80	145.69	716.50	29.11	10,396.25	199.24	**3,240.17**	**10,396.25**	**716.50**	**12,960.69**
MBITA LHSD	724.25	23.65	771.70	154.53	580.20	27.14	859.64	9.08	**733.95**	**859.64**	**580.20**	**2,935.79**
MBITA WG	439.61	106.90	679.09	22.51	687.90	32.90	730.69	20.45	**634.32**	**730.69**	**439.61**	**2,537.29**
HOMABAY	1,108.89	2.66	8,160.75	6,101.74	1,053.98	68.82	4,637.96	49.71	**3,740.39**	**8,160.75**	**1,053.98**	**14,961.57**
KENDUBAY	0.00	0.00	1,157.44	33.10	1,260.65	77.38	0.00	-	**604.52**	**1,260.65**	**0.00**	**2,418.09**
KUSA	17,307.24	692.67	3,519.85	60.66	40.87	15.11	3,463.38	4,473.60	**6,082.84**	**17,307.24**	**40.87**	**24,331.34**
DUNGA BEACH	0.00	0.00	2,510.89	21.83	879.58	61.33	967.04	33.02	**1,089.37**	**2,510.89**	**0.00**	**4,357.50**
HIPPOPOINT	900.72	92.93	2,117.25	62.61	763.66	14.69	0.00	-	**945.41**	**2,117.25**	**0.00**	**3,781.63**
RAILWAYS	0.00	0.00	841.51	90.60	2,590.19	72.23	1,329.32	18.03	**1,190.26**	**2,590.19**	**0.00**	**4,761.02**
LUANDA	672.01	118.56	12,371.10	312.21	13,397.83	166.19	23,828.59	632.75	**12,567.39**	**23,828.59**	**672.01**	**50,269.54**
MISORI	35,196.06	548.57	754.00	45.14	0.00	0.00	2,833.80	33.66	**9,695.97**	**35,196.06**	**0.00**	**38,783.87**
USENGE	799.18	45.88	6,373.81	195.73	0.00	0.00	1,762.88	1,188.00	**2,233.97**	**6,373.81**	**0.00**	**8,935.87**
PORT VICTORIA	606.63	49.13	0.00	0.00	0.00	0.00	1,521.81	-	**532.11**	**1,521.81**	**0.00**	**2,128.43**
SIO PORT	0.00	0.00	781.02	27.12	983.42	21.70	2,212.27	97.99	**994.18**	**2,212.27**	**0.00**	**3,976.72**
R. KUJA	811.99	12.07	757.73	59.14	729.41	90.45	4,265.82	227.24	**1,641.24**	**4,265.82**	**729.41**	**6,564.95**
R. AWACH	862.79	55.44	2,649.13	135.57	722.44	25.41	852.69	27.33	**1,271.76**	**2,649.13**	**722.44**	**5,087.06**
R. SONDU	0.00	0.00	592.65	76.06	756.92	14.74	0.00	0.00	**337.39**	**756.92**	**0.00**	**1,349.57**
R. NYANDO	953.38	10.91	4,237.23	562.79	1,308.65	50.64	858.29	37.66	**1,839.39**	**4,237.23**	**858.29**	**7,357.54**
R. NYAMASARIA	0.00	0.00	1,305.60	50.67	1,994.17	9.31	982.01	37.04	**1,070.44**	**1,994.17**	**0.00**	**4,281.78**
R. KISIAN	705.14	15.45	868.75	73.80	0.00	-	618.94	35.63	**548.21**	**868.75**	**0.00**	**2,192.83**
R. MUGRUK	0.00	0.00	0.00	-	811.93	29.11	655.92	57.44	**366.96**	**811.93**	**0.00**	**1,467.85**
R. AWACH SEME	0.00	0.00	1,667.30	97.39	0.00	0.00	5,681.37	6,830.49	**1,837.17**	**5,681.37**	**0.00**	**7,348.66**
R. YALA	976.20	25.37	1,056.28	69.02	0.00	0.00	5,421.56	83.35	**1,863.51**	**5,421.56**	**0.00**	**7,454.03**

R. NZOIA	729.74	25.98	1,956.56	85.68	7,315.54	1,130.01	7,909.08	82.86	4,477.73	7,909.08	729.74	17,910.92
R. SIO	0.00	0.00	0.00	0.00	0.00	0.00	762.73	33.65	190.68	762.73	0.00	762.73
NYALENDA	61,885.73	1,921.92	895.14	55.36	176,662.61	5,820.06	1,091.68	85.65	60,133.79	176,662.61	895.14	240,535.17
KWASCO	818.10	16.19	1,267.71	17.32	968.00	40.87	1,101.62	50.60	1,038.86	1,267.71	818.10	4,155.43
KISATI	741.94	19.03	5,107.25	347.88	757.40	39.52	990.13	89.61	1,899.18	5,107.25	741.94	7,596.72
SAKA	0.00	0.00	1,203.10	50.87	666.53	29.48	21,735.98	316.57	5,901.40	21,735.98	0.00	23,605.61
MEAN	4,298.55	127.84	2,568.79	-	7,188.28	-	3,582.38	-	4,409.50	7,188.28	2,568.79	17,638.00
MAX	61,885.73	1,921.92	12,583.03	-	176,662.61	-	23,828.59	-	68,739.99	176,662.61	12,583.03	274,959.97
MIN	0.00	0.00	0.00	-	0.00	-	0.00	-	0.00	0.00	0.00	0.00
MEDIAN	726.99	15.82	1,180.27	-	743.17	-	1,096.65	-	936.77	1,180.27	726.99	3,747.08
SUM	128,956.50	3,835.09	77,063.69	-	215,648.38	-	107,471.43	-				
												529,140.00
β-HCH	**Dry season 1**	**STD**	**Wet season**	**STD**	**Dry season 2**	**STD**	**Short rain**	**STD**	**MEAN**	**MAX**	**MIN**	**0.00**
MUHURUBAY	707.47	38.78	207,399.68	336.47	0.00	0.00	373.13	472.83	52,120.07	207,399.68	0.00	208,480.27
SORI	4,620.75	53.16	35,908.06	779.30	25,278.54	274.03	2,336.96	3,229.77	17,036.08	35,908.06	2,336.96	68,144.30
MBITA LHSD	698.26	51.53	32,001.38	1,488.20	12,716.80	185.25	374.90	457.31	11,447.83	32,001.38	374.90	45,791.34
MBITA WG	1,298.87	49.78	952.61	18.47	15,176.85	355.26	674.32	883.24	4,525.66	15,176.85	674.32	18,102.65
HOMABAY	17,834.16	818.83	20,966.61	866.59	109,565.36	3,421.83	9,326.49	12,031.65	39,423.16	109,565.36	9,326.49	157,692.62
KENDUBAY	0.00	0.00	60,851.71	202.23	6,830.45	8,764.62	0.00	0.00	16,920.54	60,851.71	0.00	67,682.17
KUSA	10,422.93	14,514.64	89,076.78	1,378.91	891.79	98.76	12,468.79	2,893.28	28,215.07	89,076.78	891.79	112,860.29
DUNGA BEACH	0.00	0.00	22,842.72	151.77	2,632.43	55.44	0.00	0.00	6,368.79	22,842.72	0.00	25,475.15
HIPPOPOINT	854.10	129.80	6,052.81	453.14	8,819.19	729.52	491.95	512.15	4,054.51	8,819.19	491.95	16,218.05
RAILWAYS	0.00	0.00	68,531.68	1,109.70	3,410.31	175.94	0.00	0.00	17,985.50	68,531.68	0.00	71,941.99
LUANDA	5,223.21	8.06	49,970.96	156.70	163,256.26	4,105.69	2,615.63	3,687.67	55,266.51	163,256.26	2,615.63	221,066.06
MISORI	250.08	30.45	16,610.01	1,044.73	0.00	0.00	140.27	155.30	4,250.09	16,610.01	0.00	17,000.36
USENGE	0.00	0.00	27,999.97	1,661.88	0.00	0.00	0.00	0.00	6,999.99	27,999.97	0.00	27,999.97
PORT VICTORIA	2,561.42	112.06	9,088.05	679.12	0.00	0.00	1,336.74	1,731.96	3,246.55	9,088.05	0.00	12,986.22
SIO PORT	0.00	0.00	6,867.94	102.18	8,249.67	545.53	0.00	0.00	3,779.40	8,249.67	0.00	15,117.61
R. KUJA	4,447.22	119.46	24,887.29	822.80	237.69	11.77	2,283.34	3,060.18	7,963.89	24,887.29	237.69	31,855.55
R. AWACH	3,638.28	506.01	7,290.18	1,148.89	49,660.32	637.85	2,072.14	2,214.85	15,665.23	49,660.32	2,072.14	62,660.93
R. SONDU	0.00	0.00	6,013.52	1,055.61	3,889.93	5,008.53	0.00	0.00	2,475.86	6,013.52	0.00	9,903.46
R. NYANDO	1,631.36	35.28	39,585.17	1,157.43	32,414.77	630.09	833.32	1,128.60	18,616.15	39,585.17	833.32	74,464.62
R. NYAMASARIA	0.00	0.00	15,707.60	-	12,418.48	342.72	0.00	0.00	7,031.52	15,707.60	0.00	28,126.09
R. KISIAN	745.06	49.38	51,045.61	1,668.58	0.00	0.00	397.22	491.93	13,046.97	51,045.61	0.00	52,187.89
R. MUGRUK	0.00	0.00	0.00	-	3,905.92	97.64	0.00	0.00	976.48	3,905.92	0.00	3,905.92
R. AWACH SEME	0.00	0.00	25,153.85	1,199.02	0.00	0.00	0.00	0.00	6,288.46	25,153.85	0.00	25,153.85

R. YALA	2,632.94	125.22	3,604.36	415.38	0.00	0.00	1,379.08	1,773.22	1,904.09	3,604.36	0.00	7,616.38
R. NZOIA	66.17	29.99	0.00	0.00	0.00	0.00	48.08	25.58	28.56	66.17	0.00	114.25
R. SIO	100.33	21.77	0.00	0.00	161.70	23.39	61.05	55.55	80.77	161.70	0.00	323.08
NYALENDA	0.00	0.00	24,702.52	972.35	455,600.95	334,319.93	0.00	0.00	120,075.87	455,600.95	0.00	480,303.48
KWASCO	57.09	21.32	20,422.99	730.06	7,752.23	236.18	39.20	25.29	7,067.88	20,422.99	39.20	28,271.52
KISATI	0.00	0.00	27,788.48	257.21	0.00	0.00	0.00	0.00	6,947.12	27,788.48	0.00	27,788.48
SAKA	0.00	0.00	0.00	0.00	14,676.42	585.89	0.00	0.00	3,669.11	14,676.42	0.00	14,676.42
MEAN	**1,926.32**	**557.18**	**30,044.09**	-	**31,251.54**	**12,020.20**	**1,241.75**	**1,161.01**	**16,115.92**	**31,251.54**	**1,241.75**	**64,463.70**
MAX	**17,834.16**	**14,514.64**	**207,399.68**	-	**455,600.95**	**334,319.93**	**12,468.79**	**12,031.65**	**173,325.89**	**455,600.95**	**12,468.79**	**693,303.57**
MIN	**0.00**	**0.00**	**0.00**	-	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
MEDIAN	**175.21**	**25.88**	**21,904.67**	-	**3,897.93**	**180.59**	**100.66**	**105.43**	**6,519.62**	**21,904.67**	**100.66**	**26,078.46**
SUM	**57,789.70**	**16,715.54**	**901,322.56**	-	**937,546.09**	**360,605.87**	**37,252.62**	**34,830.37**				
												1,933,910.96
γ-HCH	**Dry season 1**	**STD**	**Wet season**	**STD**	**Dry season 2**	**STD**	**Short rain**	**STD**	**MEAN**	**MAX**	**MIN**	**0.00**
MUHURUBAY	304.99	45.88	2,663.86	59.64	0.00	0.00	0.00	0.00	742.21	2,663.86	0.00	2,968.85
SORI	1,224.12	19.00	3,013.51	55.21	2,827.49	27.82	11,518.30	228.27	4,645.85	11,518.30	1,224.12	18,583.42
MBITA LHSD	212.23	31.57	3,583.17	183.44	1,635.80	23.81	155.74	11.51	1,396.73	3,583.17	155.74	5,586.93
MBITA WG	229.95	58.05	241.14	32.57	941.64	64.13	350.05	27.23	440.69	941.64	229.95	1,762.78
HOMABAY	7,054.93	574.54	2,958.58	108.97	2,697.28	30.31	121,997.36	538.14	33,677.04	121,997.36	2,697.28	134,708.15
KENDUBAY	0.00	0.00	3,081.77	85.67	4,558.77	91.72	0.00	0.00	1,910.14	4,558.77	0.00	7,640.54
KUSA	3,082.58	167.59	2,439.92	116.70	121.93	2.79	1,509.72	68.53	1,788.53	3,082.58	121.93	7,154.14
DUNGA BEACH	0.00	0.00	5,031.76	500.24	994.81	55.92	1,645.26	98.00	1,917.96	5,031.76	0.00	7,671.83
HIPPOPOINT	222.76	19.32	923.61	93.24	133.78	1.54	0.00	0.00	320.04	923.61	0.00	1,280.14
RAILWAYS	0.00	0.00	2,501.31	91.18	3,207.34	51.08	469.57	43.73	1,544.56	3,207.34	0.00	6,178.22
LUANDA	443.89	9.73	9,260.43	524.08	38,555.33	1,203.42	86,899.93	1,437.87	33,789.90	86,899.93	443.89	135,159.58
MISORI	171.46	29.56	3,447.32	58.14	0.00	0.00	12,435.65	321.84	4,013.61	12,435.65	0.00	16,054.43
USENGE	132.19	26.96	20,376.35	264.48	0.00	0.00	8,673.57	484.42	7,295.53	20,376.35	0.00	29,182.11
PORT VICTORIA	182.88	26.96	2,909.67	128.46	0.00	0.00	822.05	52.82	978.65	2,909.67	0.00	3,914.60
SIO PORT	0.00	0.00	392.93	11.40	454.80	48.08	2,130.34	65.94	744.52	2,130.34	0.00	2,978.07
R. KUJA	307.78	29.91	5,757.22	89.52	624.79	31.27	20,312.82	535.32	6,750.65	20,312.82	307.78	27,002.61
R. AWACH	427.98	73.90	26,176.62	371.15	4,488.70	19.21	282.68	222.33	7,844.00	26,176.62	282.68	31,375.98
R. SONDU	0.00	0.00	25,341.72	473.09	246.01	7.67	0.00	0.00	6,396.93	25,341.72	0.00	25,587.72
R. NYANDO	383.04	36.51	4,863.33	312.35	875.23	84.14	271.87	62.95	1,598.37	4,863.33	271.87	6,393.48
R. NYAMASARIA	0.00	0.00	2,786.04	22.07	2,788.13	121.69	176.66	12.89	1,437.71	2,788.13	0.00	5,750.84
R. KISIAN	263.35	30.33	6,822.81	8,868.03	0.00	0.00	10,209.83	474.93	4,324.00	10,209.83	0.00	17,295.99
R. MUGRUK	52.01	25.93	0.00	0.00	305.47	9.24	317.10	92.34	168.64	317.10	0.00	674.58

R. AWACH SEME	0.00	0.00	3,983.07	81.45	0.00	0.00	26,338.94	306.09	7,580.50	26,338.94	0.00	30,322.01
R. YALA	208.00	23.04	491.23	11.09	0.00	0.00	14,823.45	766.16	3,880.67	14,823.45	0.00	15,522.69
R. NZOIA	287.86	16.00	1,750.52	58.44	125.42	22.17	35,470.53	522.80	9,408.58	35,470.53	125.42	37,634.32
R. SIO	0.00	0.00	0.00	0.00	0.00	0.00	245.88	5.61	61.47	245.88	0.00	245.88
NYALENDA	157.20	25.04	2,750.50	41.67	259,589.11	6,813.88	367.54	36.72	65,716.09	259,589.11	157.20	262,864.35
KWASCO	894.50	117.19	3,958.96	55.26	1,617.82	4.31	512.38	33.95	1,745.91	3,958.96	512.38	6,983.65
KISATI	130.97	13.11	61,572.62	702.01	190.49	65.96	7,834.41	236.23	17,432.12	61,572.62	130.97	69,728.49
SAKA	0.00	0.00	9,903.85	47.20	6,856.91	118.40	1,338.98	56.56	4,524.93	9,903.85	0.00	18,099.74
MEAN	**545.82**	**46.67**	**7,299.46**	**448.22**	**11,127.90**	**296.62**	**12,237.02**	**224.77**	**7,802.55**	**12,237.02**	**545.82**	**31,210.20**
MAX	**7,054.93**	**574.54**	**61,572.62**	**8,868.03**	**259,589.11**	**6,813.88**	**121,997.36**	**1,437.87**	**112,553.50**	**259,589.11**	**7,054.93**	**450,214.02**
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
MEDIAN	**195.44**	**24.04**	**3,047.64**	**87.59**	**539.80**	**22.99**	**1,080.52**	**67.23**	**1,215.85**	**3,047.64**	**195.44**	**4,863.40**
SUM	**16,374.67**	**1,400.10**	**218,983.79**	**13,446.75**	**333,837.05**	**8,898.55**	**367,110.62**	**6,743.17**				**936,306.13**
δ-HCH	**Dry season 1**	**STD**	**Wet season**	**STD**	**Dry season 2**	**STD**	**Short rain**	**STD**	**MEAN**	**MAX**	**MIN**	**0.00**
MUHURUBAY	1,071.24	95.00	4,762.56	758.15	0.00	0.00	0.00	0.00	**1,458.45**	**4,762.56**	**0.00**	**5,833.81**
SORI	1,039.95	4,967.00	5,728.74	3,916.30	16,523.71	617.74	757.90	41.79	**6,012.57**	**16,523.71**	**757.90**	**24,050.29**
MBITA LHSD	732.66	81.49	6,928.87	460.28	2,542.14	72.49	19,882.03	13,282.33	**7,521.42**	**19,882.03**	**732.66**	**30,085.69**
MBITA WG	523.66	160.42	3,997.77	620.03	2,387.78	177.23	4,648.97	6,342.69	**2,889.55**	**4,648.97**	**523.66**	**11,558.18**
HOMABAY	6,435.68	463.12	30,539.49	620.80	6,665.47	352.57	36,467.29	526.30	**20,026.98**	**36,467.29**	**6,435.68**	**80,107.94**
KENDUBAY	0.00	0.00	794.50	58.55	1,818.34	393.73	0.00	0.00	**653.21**	**1,818.34**	**0.00**	**2,612.84**
KUSA	5,186.87	1,021.27	1,018.02	49.33	78.76	24.40	795.25	118.79	**1,769.72**	**5,186.87**	**78.76**	**7,078.90**
DUNGA BEACH	0.00	0.00	19,387.15	706.18	700.48	51.47	1,335.14	165.23	**5,355.69**	**19,387.15**	**0.00**	**21,422.77**
HIPPOPOINT	1,063.91	306.40	11,954.36	909.70	3,958.31	266.94	0.00	0.00	**4,244.15**	**11,954.36**	**0.00**	**16,976.58**
RAILWAYS	0.00	0.00	855.55	122.04	2,424.48	118.81	22,549.82	774.77	**6,457.46**	**22,549.82**	**0.00**	**25,829.86**
LUANDA	1,137.02	112.96	21,786.35	391.99	353,617.20	1,281.89	809.85	57.71	**94,337.61**	**353,617.20**	**809.85**	**377,350.42**
MISORI	769.85	75.58	9,213.06	560.63	0.00	0.00	650.08	44.69	**2,658.25**	**9,213.06**	**0.00**	**10,632.98**
USENGE	809.10	46.26	9,185.03	553.37	0.00	0.00	743.79	167.07	**2,684.48**	**9,185.03**	**0.00**	**10,737.92**
PORT VICTORIA	595.75	78.40	6,623.26	265.47	0.00	0.00	12,472.31	1,074.49	**4,922.83**	**12,472.31**	**0.00**	**19,691.32**
SIO PORT	0.00	0.00	898.36	65.46	0.00	0.00	4,601.39	6,132.74	**1,374.94**	**4,601.39**	**0.00**	**5,499.75**
R. KUJA	1,184.67	422.09	17,938.13	292.39	1,981.07	360.39	774.15	98.42	**5,469.50**	**17,938.13**	**774.15**	**21,878.02**
R. AWACH	946.92	23.09	752.71	112.61	7,037.24	766.27	14,068.10	930.14	**5,701.24**	**14,068.10**	**752.71**	**22,804.97**
R. SONDU	0.00	0.00	1,127.86	140.62	771.05	94.62	0.00	0.00	**474.73**	**1,127.86**	**0.00**	**1,898.92**
R. NYANDO	1,322.26	3.44	4,894.50	149.34	879.13	161.19	1,402.95	254.61	**2,124.71**	**4,894.50**	**879.13**	**8,498.84**
R. NYAMASARIA	0.00	0.00	1,062.87	147.35	4,872.72	101.90	9,576.50	118.33	**3,878.02**	**9,576.50**	**0.00**	**15,512.09**
R. KISIAN	867.65	54.06	5,649.82	439.75	0.00	0.00	8,268.74	567.19	**3,696.55**	**8,268.74**	**0.00**	**14,786.21**

R. MUGRUK	0.00	0.00	0.00	0.00	477.81	51.20	662.76	74.37	285.14	662.76	0.00	1,140.57
R. AWACH SEME	0.00	0.00	1,106.10	76.52	0.00	0.00	916.42	112.56	505.63	1,106.10	0.00	2,022.52
R. YALA	1,010.76	381.34	4,381.50	132.21	0.00	0.00	713.24	102.43	1,526.37	4,381.50	0.00	6,105.49
R. NZOIA	864.63	56.07	6,931.88	181.10	142,569.80	921.06	1,045.74	24.29	37,853.01	142,569.80	864.63	151,412.05
R. SIO	0.00	0.00	0.00	0.00	738.08	46.51	779.19	20.60	379.32	779.19	0.00	1,517.27
NYALENDA	895.52	63.81	7,859.95	763.74	1,301.65	76.88	1,325.01	49.35	2,845.53	7,859.95	895.52	11,382.13
KWASCO	14,165.68	1,117.26	20,028.68	230.15	802.31	120.36	2,518.80	154.37	9,378.87	20,028.68	802.31	37,515.47
KISATI	746.11	58.19	15,811.65	958.28	2,013.20	88.25	920.61	135.31	4,872.89	15,811.65	746.11	19,491.57
SAKA	0.00	0.00	785.15	22.32	11,057.31	935.75	648.60	118.21	3,122.76	11,057.31	0.00	12,491.06
MEAN	**1,379.00**	**319.58**	**7,400.13**	**456.82**	**18,840.60**	**236.06**	**4,977.82**	**1,049.63**	**8,149.39**	**18,840.60**	**1,379.00**	**32,597.55**
MAX	**14,165.68**	**4,967.00**	**30,539.49**	**3,916.30**	**353,617.20**	**1,281.89**	**36,467.29**	**13,282.33**	**108,697.41**	**353,617.20**	**14,165.68**	**434,789.66**
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
MEDIAN	**789.47**	**57.13**	**5,272.16**	**247.81**	**1,090.39**	**91.43**	**918.51**	**118.27**	**2,017.63**	**5,272.16**	**789.47**	**8,070.53**
SUM	**41,369.88**	**9,587.25**	**222,003.87**	**13,704.65**	**565,218.05**	**7,081.67**	**149,334.61**	**31,488.78**				**977,926.41**
												0.00
ENDOSULPHAN I	**Dry season 1**	**STD**	**Wet season**	**STD**	**Dry season 2**	**STD**	**Short rain**	**STD**	**MEAN**	**MAX**	**MIN**	**0.00**
MUHURUBAY	2,151.36	92.18	2,930.14	101.93	0.00	0.00	0.00	0.00	1,270.38	2,930.14	0.00	5,081.51
SORI	519.66	77.17	4,851.06	937.18	633.42	114.66	1,685.63	57.07	1,922.44	4,851.06	519.66	7,689.77
MBITA LHSD	454.01	107.30	361.52	31.84	92.45	29.05	98.07	5.69	251.51	454.01	92.45	1,006.05
MBITA WG	611.29	45.64	305.02	12.71	82.06	7.82	1,123.08	101.77	530.36	1,123.08	82.06	2,121.45
HOMABAY	118.67	21.57	1,956.11	74.67	115.55	6.84	6,068.23	815.44	2,064.64	6,068.23	115.55	8,258.57
KENDUBAY	0.00	0.00	117.53	30.95	118.59	8.79	0.00	0.00	59.03	118.59	0.00	236.12
KUSA	2,376.93	327.73	3,580.70	123.40	0.00	0.00	617.37	81.29	1,643.75	3,580.70	0.00	6,575.00
DUNGA BEACH	0.00	0.00	2,453.99	151.68	537.98	131.25	1,871.43	95.75	1,215.85	2,453.99	0.00	4,863.40
HIPPOPOINT	2,352.03	83.44	183.72	8.57	96.91	18.25	0.00	0.00	658.16	2,352.03	0.00	2,632.66
RAILWAYS	0.00	0.00	97.85	13.03	9,365.83	430.44	877.62	21.73	2,585.32	9,365.83	0.00	10,341.30
LUANDA	507.43	94.69	1,258.38	21.34	17,141.59	893.10	1,637.43	136.22	5,136.21	17,141.59	507.43	20,544.82
MISORI	16,917.77	541.19	2,893.83	200.47	0.00	0.00	251.15	11.54	5,015.69	16,917.77	0.00	20,062.75
USENGE	667.22	57.83	680.63	69.49	0.00	0.00	169.55	15.33	379.35	680.63	0.00	1,517.40
PORT VICTORIA	398.68	59.49	0.00	0.00	0.00	0.00	705.70	116.62	276.09	705.70	0.00	1,104.38
SIO PORT	0.00	0.00	600.07	18.76	265.57	46.48	162.59	17.55	257.06	600.07	0.00	1,028.23
R. KUJA	186.88	15.02	93.41	15.54	482.32	40.03	373.68	12.87	284.07	482.32	93.41	1,136.28
R. AWACH	375.99	103.87	953.24	176.55	85.54	21.45	258.57	44.49	418.33	953.24	85.54	1,673.34
R. SONDU	0.00	0.00	69.43	13.46	314.50	69.59	0.00	0.00	95.98	314.50	0.00	383.94
R. NYANDO	2,957.08	134.77	1,248.22	116.70	2,895.30	260.03	665.42	28.25	1,941.51	2,957.08	665.42	7,766.02
R. NYAMASARIA	0.00	0.00	633.77	64.29	364.80	47.61	420.70	45.14	354.82	633.77	0.00	1,419.28

R. KISIAN	439.74	121.31	1,284.96	38.26	0.00	0.00	386.59	14.69	527.82	1,284.96	0.00	2,111.30
R. MUGRUK	0.00	0.00	0.00	0.00	0.00	0.00	516.84	102.46	129.21	516.84	0.00	516.84
R. AWACH SEME	0.00	0.00	74.70	16.78	0.00	0.00	84.42	22.43	39.78	84.42	0.00	159.12
R. YALA	591.83	15.02	1,534.79	108.41	0.00	0.00	545.68	72.30	668.08	1,534.79	0.00	2,672.31
R. NZOIA	433.07	140.58	99.99	29.43	482.81	42.75	121.50	7.97	284.34	482.81	99.99	1,137.38
R. SIO	0.00	0.00	0.00	0.00	283.12	95.93	275.07	9.42	139.55	283.12	0.00	558.19
NYALENDA	17,444.29	316.00	0.00	0.00	912.12	17.78	546.54	58.92	4,725.74	17,444.29	0.00	18,902.94
KWASCO	42.83	30.44	1,418.70	15.96	629.75	125.26	2,599.71	397.44	1,172.75	2,599.71	42.83	4,690.99
KISATI	80.92	10.41	1,380.69	145.41	192.09	19.23	654.32	97.68	577.01	1,380.69	80.92	2,308.02
SAKA	0.00	0.00	128.69	50.77	95.75	26.14	12,571.43	776.40	3,198.97	12,571.43	0.00	12,795.87
MEAN	**1,654.26**	**79.85**	**1,039.71**	**86.25**	**1,172.93**	**81.75**	**1,176.28**	**105.55**	**1,260.79**	**1,654.26**	**1,039.71**	**5,043.17**
MAX	**17,444.29**	**541.19**	**4,851.06**	**937.18**	**17,141.59**	**893.10**	**12,571.43**	**815.44**	**13,002.09**	**17,444.29**	**4,851.06**	**52,008.36**
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
MEDIAN	**387.33**	**38.04**	**616.92**	**31.39**	**117.07**	**20.34**	**468.77**	**36.37**	**397.52**	**616.92**	**117.07**	**1,590.09**
SUM	**49,627.68**	**2,395.64**	**31,191.17**	**2,587.60**	**35,188.04**	**2,452.46**	**35,288.33**	**3,166.44**				**151,295.22**
Endosulphan Ii	**Dry season 1**	**STD**	**Wet season**	**STD**	**Dry season 2**	**STD**	**Short rain**	**STD**	**MEAN**	**MAX**	**MIN**	**0.00**
MUHURUBAY	68.57	16.97	85.03	27.62	0.00	0.00	0.00	0.00	38.40	85.03	0.00	153.59
SORI	118.54	22.08	180.43	28.12	96.55	27.95	90.96	20.74	121.62	180.43	90.96	486.47
MBITA LHSD	88.80	34.17	1,387.87	91.96	17.29	29.95	314.92	23.07	452.22	1,387.87	17.29	1,808.89
MBITA WG	194.64	17.71	135.70	41.86	151.49	46.68	286.78	7.71	192.15	286.78	135.70	768.61
HOMABAY	104.51	37.91	12,624.56	405.55	181.75	78.66	136.19	24.44	3,261.75	12,624.56	104.51	13,047.01
KENDUBAY	0.00	0.00	724.27	149.80	140.18	38.82	0.00	0.00	216.11	724.27	0.00	864.44
KUSA	1,984.93	128.01	74.20	24.61	381.34	30.45	245.92	39.51	671.60	1,984.93	74.20	2,686.39
DUNGA BEACH	0.00	0.00	71.52	7.89	87.38	17.80	931.12	108.39	272.50	931.12	0.00	1,090.02
HIPPOPOINT	3,054.41	398.77	262.78	18.06	116.16	10.98	0.00	0.00	858.34	3,054.41	0.00	3,433.35
RAILWAYS	0.00	0.00	1,933.61	76.52	4,874.88	578.66	1,808.14	105.24	2,154.16	4,874.88	0.00	8,616.64
LUANDA	217.48	51.71	1,382.49	64.43	138.80	24.28	83.62	13.50	455.60	1,382.49	83.62	1,822.40
MISORI	169.33	59.68	101.77	16.63	0.00	0.00	111.72	15.61	95.70	169.33	0.00	382.82
USENGE	588.98	204.73	398.52	41.31	0.00	0.00	102.16	17.05	272.41	588.98	0.00	1,089.66
PORT VICTORIA	91.10	38.50	65.08	27.31	0.00	0.00	103.72	22.67	64.98	103.72	0.00	259.90
SIO PORT	0.00	0.00	362.44	34.66	117.12	45.18	192.03	11.05	167.90	362.44	0.00	671.58
R. KUJA	75.70	23.02	90.71	21.00	136.58	9.03	380.53	45.00	170.88	380.53	75.70	683.51
R. AWACH	792.89	116.72	81.71	20.56	118.79	52.98	115.07	10.67	277.12	792.89	81.71	1,108.47
R. SONDU	0.00	0.00	66.73	12.88	160.80	16.94	0.00	0.00	56.88	160.80	0.00	227.53
R. NYANDO	75.77	27.56	79.47	18.14	317.69	12.27	126.02	26.93	149.74	317.69	75.77	598.95

R. NYAMASARIA	0.00	0.00	96.93	11.28	516.28	68.37	106.93	24.51	180.03	516.28	0.00	720.14
R. KISIAN	290.42	33.02	197.17	16.60	0.00	0.00	131.88	61.97	154.87	290.42	0.00	619.47
R. MUGRUK	0.00	0.00	0.00	0.00	0.00	0.00	680.76	103.14	170.19	680.76	0.00	680.76
R. AWACH SEME	0.00	0.00	652.09	48.96	0.00	0.00	74.34	19.75	181.61	652.09	0.00	726.43
R. YALA	89.34	6.92	128.65	70.96	0.00	0.00	306.37	48.08	131.09	306.37	0.00	524.36
R. NZOIA	64.48	19.11	88.48	29.80	90.73	26.43	524.69	76.05	192.09	524.69	64.48	768.38
R. SIO	0.00	0.00	0.00	0.00	74.43	3.70	319.75	25.89	98.54	319.75	0.00	394.18
NYALENDA	85.53	21.97	0.00	0.00	2,131.05	86.03	233.33	56.23	612.48	2,131.05	0.00	2,449.91
KWASCO	399.00	30.10	96.47	16.39	101.77	37.76	81.48	21.37	169.68	399.00	81.48	678.73
KISATI	71.26	25.06	2,841.49	342.37	183.77	26.27	83.45	7.48	794.99	2,841.49	71.26	3,179.98
SAKA	0.00	0.00	101.14	27.72	77.07	23.53	83.05	20.11	65.32	101.14	0.00	261.26
MEAN	**287.52**	**43.79**	**810.38**	**56.43**	**340.40**	**43.09**	**255.16**	**31.87**	**423.37**	**810.38**	**255.16**	**1,693.46**
MAX	**3,054.41**	**398.77**	**12,624.56**	**405.55**	**4,874.88**	**578.66**	**1,808.14**	**108.39**	**5,590.50**	**12,624.56**	**1,808.14**	**22,362.00**
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
MEDIAN	**80.65**	**22.03**	**101.45**	**27.46**	**108.97**	**23.91**	**120.55**	**22.02**	**102.90**	**120.55**	**80.65**	**411.62**
SUM	8,625.68	1,313.72	24,311.29	1,692.98	10,211.91	1,292.73	7,654.93	956.16	**12,700.95**	**24,311.29**	**7,654.93**	**50,803.81**
ENDOSULPHAN SULPHATE	**Dry season 1**	**STD**	**Wet season**	**STD**	**Dry season 2**	**STD**	**Short rain**	**STD**	**MEAN**	**MAX**	**MIN**	**0.00**
MUHURUBAY	0.00	0.00	1,015.33	67.49	165.05	6.97	0.00	0.00	**295.10**	**1,015.33**	**0.00**	**1,180.39**
SORI	0.00	0.00	411.35	34.89	0.00	-	0.00	0.00	**102.84**	**411.35**	**0.00**	**411.35**
MBITA LHSD	1,250.34	29.86	1,892.31	3,123.47	0.00	-	0.00	0.00	**785.66**	**1,892.31**	**0.00**	**3,142.66**
MBITA WG	313.41	22.88	195.00	28.31	0.00	-	224.38	25.99	**183.20**	**313.41**	**0.00**	**732.80**
HOMABAY	0.00	0.00	387.49	22.91	0.00	533.92	0.00	0.00	**96.87**	**387.49**	**0.00**	**387.49**
KENDUBAY	0.00	0.00	0.00	0.00	0.00	-	168.78	11.98	**42.20**	**168.78**	**0.00**	**168.78**
KUSA	1,864.33	577.52	2,570.46	157.38	1,194.30	114.18	0.00	0.00	**1,407.27**	**2,570.46**	**0.00**	**5,629.09**
DUNGA BEACH	0.00	0.00	0.00	0.00	0.00	0.00	744.42	141.56	**186.10**	**744.42**	**0.00**	**744.42**
HIPPOPOINT	670.85	46.00	1,023.14	31.40	118.36	11.79	0.00	0.00	**453.09**	**1,023.14**	**0.00**	**1,812.35**
RAILWAYS	0.00	0.00	50,775.28	2,335.86	10,848.83	1,006.29	0.00	0.00	**15,406.03**	**50,775.28**	**0.00**	**61,624.11**
LUANDA	41.56	27.26	1,058.13	110.52	96.98	20.25	68,713.06	3,060.66	**17,477.43**	**68,713.06**	**41.56**	**69,909.73**
MISORI	79.42	13.63	3,851.72	210.76	0.00	0.00	0.00	0.00	**982.79**	**3,851.72**	**0.00**	**3,931.15**
USENGE	2,130.07	98.24	0.00	0.00	0.00	0.00	0.00	0.00	**532.52**	**2,130.07**	**0.00**	**2,130.07**
PORT VICTORIA	0.00	0.00	1,326.52	35.90	0.00	0.00	0.00	0.00	**331.63**	**1,326.52**	**0.00**	**1,326.52**
SIO PORT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**
R. KUJA	7,411.86	154.10	0.00	0.00	0.00	0.00	0.00	0.00	**1,852.96**	**7,411.86**	**0.00**	**7,411.86**
R. AWACH	1,371.38	139.54	861.29	108.63	0.00	0.00	0.00	0.00	**558.17**	**1,371.38**	**0.00**	**2,232.67**
R. SONDU	0.00	0.00	0.00	0.00	81.02	16.87	0.00	0.00	**20.25**	**81.02**	**0.00**	**81.02**

R. NYANDO	944.38	95.74	0.00	0.00	674.37	392.20	973.39	52.91	648.04	973.39	0.00	2,592.14
R. NYAMASARIA	0.00	0.00	8,885.91	437.45	1,033.59	53.36	0.00	0.00	2,479.87	8,885.91	0.00	9,919.50
R. KISIAN	4,925.09	88.01	0.00	0.00	0.00	0.00	0.00	0.00	1,231.27	4,925.09	0.00	4,925.09
R. MUGRUK	607.86	796.57	0.00	0.00	514.70	73.24	523.60	138.02	411.54	607.86	0.00	1,646.15
R. AWACH SEME	0.00	0.00	0.00	0.00	292.67	12.27	970.30	95.39	315.74	970.30	0.00	1,262.97
R. YALA	475.67	45.95	0.00	0.00	0.00	0.00	496.74	99.76	243.10	496.74	0.00	972.40
R. NZOIA	0.00	0.00	505.71	24.59	0.00	0.00	1,482.07	48.85	496.94	1,482.07	0.00	1,987.78
R. SIO	202.25	5.38	0.00	0.00	1,080.48	63.52	384.25	48.80	416.74	1,080.48	0.00	1,666.98
NYALENDA	0.00	0.00	193.76	10.86	40,662.81	2,461.78	2,059.99	59.06	10,729.14	40,662.81	0.00	42,916.57
KWASCO	539.09	40.44	490.35	21.44	0.00	0.00	2,007.18	99.64	759.16	2,007.18	0.00	3,036.62
KISATI	1,956.01	125.84	4,610.23	374.06	197.28	5.27	0.00	0.00	1,690.88	4,610.23	0.00	6,763.52
SAKA	0.00	0.00	979.93	81.61	0.00	0.00	0.00	0.00	244.98	979.93	0.00	979.93
MEAN	**826.12**	**76.90**	**2,701.13**	**240.58**	**1,898.68**	-	**2,624.94**	**129.42**	**2,012.72**	**2,701.13**	**826.12**	**8,050.87**
MAX	**7,411.86**	**796.57**	**50,775.28**	**3,123.47**	**40,662.81**	-	**68,713.06**	**3,060.66**	**41,890.75**	**68,713.06**	**7,411.86**	**167,563.01**
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	-	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
MEDIAN	**60.49**	**9.50**	**399.42**	**23.75**	**0.00**	-	**0.00**	**0.00**	**114.98**	**399.42**	**0.00**	**459.91**
SUM	**24,783.58**	**2,306.96**	**81,033.91**	**7,217.53**	**56,960.44**	-	**78,748.15**	**3,882.62**				**241,526.08**

ENDRIN	**Dry season 1**	**STD**	**Wet season**	**STD**	**Dry season 2**	**STD**	**Short rain**	**STD**	**MEAN**	**MAX**	**MIN**	**0.00**
MUHURUBAY	0.00	0.00	152.85	45.10	100.40	23.25	0.00	0.00	63.31	152.85	0.00	253.25
SORI	429.80	97.07	0.00	0.00	0.00	0.00	0.00	0.00	107.45	429.80	0.00	429.80
MBITA LHSD	48.50	26.77	627.60	54.37	0.00	0.00	0.00	0.00	169.02	627.60	0.00	676.09
MBITA WG	873.12	37.69	636.91	83.81	0.00	0.00	103.31	17.69	403.33	873.12	0.00	1,613.34
HOMABAY	0.00	0.00	619.66	77.17	0.00	0.00	0.00	0.00	154.91	619.66	0.00	619.66
KENDUBAY	0.00	0.00	0.00	0.00	375.35	30.11	0.00	0.00	93.84	375.35	0.00	375.35
KUSA	14,751.97	1,336.79	0.00	0.00	252.40	21.31	693.68	37.69	3,924.51	14,751.97	0.00	15,698.04
DUNGA BEACH	0.00	0.00	0.00	0.00	0.00	0.00	1,667.40	185.82	416.85	1,667.40	0.00	1,667.40
HIPPOPOINT	3,569.01	99.40	6,619.69	387.36	0.00	0.00	0.00	0.00	2,547.17	6,619.69	0.00	10,188.70
RAILWAYS	0.00	0.00	0.00	0.00	10,823.31	292.71	36,658.18	737.65	11,870.37	36,658.18	0.00	47,481.48
LUANDA	860.65	116.12	0.00	0.00	1,427.95	61.65	1,955.24	157.97	1,060.96	1,955.24	0.00	4,243.85
MISORI	111.94	38.12	116.90	26.04	0.00	0.00	132.94	31.13	90.45	132.94	0.00	361.78
USENGE	350.21	26.47	1,141.76	102.68	0.00	0.00	0.00	0.00	372.99	1,141.76	0.00	1,491.97
PORT VICTORIA	492.99	68.20	0.00	0.00	0.00	0.00	1,037.51	110.66	382.62	1,037.51	0.00	1,530.50
SIO PORT	0.00	0.00	654.32	99.38	0.00	0.00	1,215.59	134.65	467.48	1,215.59	0.00	1,869.90
R. KUJA	931.61	66.17	0.00	0.00	0.00	0.00	2,086.31	115.72	754.48	2,086.31	0.00	3,017.92
R. AWACH	2,462.78	129.41	1,192.86	269.30	0.00	0.00	0.00	0.00	913.91	2,462.78	0.00	3,655.64

R. SONDU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**
R. NYANDO	1,510.04	109.99	3,002.14	166.79	116.05	16.77	8,183.50	1,116.64	**3,202.93**	**8,183.50**	**116.05**	**12,811.72**
R. NYAMASARIA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**	**0.00**	**0.00**
R. KISIAN	425.03	49.24	1,614.48	85.21	0.00	0.00	0.00	0.00	**509.88**	**1,614.48**	**0.00**	**2,039.50**
R. MUGRUK	0.00	0.00	0.00	0.00	0.00	0.00	4,987.56	6,828.91	**1,246.89**	**4,987.56**	**0.00**	**4,987.56**
R. AWACH SEME	0.00	0.00	0.00	0.00	0.00	0.00	973.11	81.51	**243.28**	**973.11**	**0.00**	**973.11**
R. YALA	4,385.05	333.78	767.13	197.18	0.00	0.00	1,004.86	141.91	**1,539.26**	**4,385.05**	**0.00**	**6,157.04**
R. NZOIA	474.18	45.23	0.00	0.00	0.00	0.00	1,588.38	105.97	**515.64**	**1,588.38**	**0.00**	**2,062.56**
R. SIO	0.00	0.00	0.00	0.00	183.16	72.22	747.84	111.42	**232.75**	**747.84**	**0.00**	**931.01**
NYALENDA	213,290.11	2,000.88	0.00	0.00	487,167.75	11,954.09	869.59	101.02	**175,331.86**	**487,167.75**	**0.00**	**701,327.45**
KWASCO	4,384.96	403.49	2,793.44	261.37	0.00	0.00	487.74	80.65	**1,916.54**	**4,384.96**	**0.00**	**7,666.15**
KISATI	6,063.41	348.24	0.00	0.00	2,710.96	88.33	0.00	0.00	**2,193.59**	**6,063.41**	**0.00**	**8,774.37**
SAKA	0.00	0.00	0.00	0.00	0.00	0.00	88,820.58	2,761.28	**22,205.14**	**88,820.58**	**0.00**	**88,820.58**
MEAN	**8,513.84**	**177.77**	**664.66**	**61.86**	**16,771.91**	**418.68**	**5,107.11**	**428.61**	**7,764.38**	**16,771.91**	**664.66**	**31,057.52**
MAX	**213,290.11**	**2,000.88**	**6,619.69**	**387.36**	**487,167.75**	**11,954.09**	**88,820.58**	**6,828.91**	**198,974.53**	**487,167.75**	**6,619.69**	**795,898.13**
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
MEDIAN	**387.62**	**37.90**	**0.00**	**0.00**	**0.00**	**0.00**	**590.71**	**59.17**	**244.58**	**590.71**	**0.00**	**978.33**
SUM	**255,415.35**	**5,333.06**	**19,939.73**	**1,855.76**	**503,157.33**	**12,560.43**	**153,213.31**	**12,858.30**				**931,725.71**
ENDRIN ALDEHYDE	**Dry season 1**	**STD**	**Wet season**	**STD**	**Dry season 2**	**STD**	**Short rain**	**STD**	**MEAN**	**MAX**	**MIN**	**0.00**
MUHURUBAY	81,248.96	1,446.13	299.98	9.32	264.77	379.73	0.00	0.00	**20,453.43**	**81,248.96**	**0.00**	**81,813.70**
SORI	10,149.55	721.57	188.18	26.92	0.00	0.00	0.00	0.00	**2,584.43**	**10,149.55**	**0.00**	**10,337.73**
MBITA LHSD	7,619.76	486.08	110,339.32	1,289.34	15,328.25	376.01	0.00	0.00	**33,321.83**	**110,339.32**	**0.00**	**133,287.34**
MBITA WG	8,395.66	396.52	12,837.37	1,870.66	20,666.16	569.00	3,260.50	258.94	**11,289.92**	**20,666.16**	**3,260.50**	**45,159.69**
HOMABAY	0.00	0.00	23,692.24	2,489.30	304,068.17	22,667.03	0.00	0.00	**81,940.10**	**304,068.17**	**0.00**	**327,760.41**
KENDUBAY	0.00	0.00	0.00	0.00	457.85	192.50	136.51	18.24	**148.59**	**457.85**	**0.00**	**594.36**
KUSA	30,480.29	607.33	60,638.06	2,369.27	508.26	99.67	26,790.99	1,665.94	**29,604.40**	**60,638.06**	**508.26**	**118,417.60**
DUNGA BEACH	0.00	0.00	0.00	0.00	0.00	0.00	48,235.21	1,763.59	**12,058.80**	**48,235.21**	**0.00**	**48,235.21**
HIPPOPOINT	2,022.73	315.20	58,187.99	1,663.36	0.00	0.00	0.00	0.00	**15,052.68**	**58,187.99**	**0.00**	**60,210.72**
RAILWAYS	0.00	0.00	381,145.01	5,005.80	91,467.22	4,268.93	0.00	0.00	**118,153.06**	**381,145.01**	**0.00**	**472,612.22**
LUANDA	6,703.66	587.66	169.99	33.85	260.68	42.64	16,070.39	1,064.99	**5,801.18**	**16,070.39**	**169.99**	**23,204.74**
MISORI	1,491.92	33.04	6,579.36	1,041.12	0.00	0.00	26,771.62	1,820.35	**8,710.72**	**26,771.62**	**0.00**	**34,842.90**
USENGE	8,577.85	880.15	19,227.40	1,004.03	0.00	0.00	48,321.32	1,742.69	**19,031.64**	**48,321.32**	**0.00**	**76,126.57**
PORT VICTORIA	12,115.71	1,138.67	913.24	96.45	0.00	0.00	0.00	0.00	**3,257.24**	**12,115.71**	**0.00**	**13,028.96**
SIO PORT	0.00	0.00	30,176.56	524.79	15,014.12	678.91	6,912.16	119.87	**13,025.71**	**30,176.56**	**0.00**	**52,102.84**
R. KUJA	8,092.98	871.73	0.00	0.00	4,465.67	431.25	26,010.74	863.94	**9,642.35**	**26,010.74**	**0.00**	**38,569.38**

R. AWACH	6,393.31	1,211.19	10,173.96	540.98	0.00	0.00	0.00	0.00	4,141.82	10,173.96	0.00	16,567.27
R. SONDU	0.00	0.00	0.00	0.00	4,613.01	126.51	0.00	0.00	1,153.25	4,613.01	0.00	4,613.01
R. NYANDO	71,984.41	1,882.22	156,299.99	10,378.75	260.67	61.40	6,753.93	477.11	58,824.75	156,299.99	260.67	235,299.00
R. NYAMASARIA	0.00	0.00	276,598.31	23,231.33	0.00	0.00	0.00	0.00	69,149.58	276,598.31	0.00	276,598.31
R. KISIAN	5,442.12	402.06	13,809.39	1,730.29	0.00	0.00	0.00	0.00	4,812.88	13,809.39	0.00	19,251.51
R. MUGRUK	179.31	43.08	0.00	0.00	616.72	70.59	16,960.98	295.86	4,439.25	16,960.98	0.00	17,757.01
R. AWACH SEME	0.00	0.00	0.00	0.00	165.24	23.81	16,034.35	513.80	4,049.90	16,034.35	0.00	16,199.58
R. YALA	6,818.98	606.36	46,981.99	1,785.51	0.00	0.00	12,523.97	937.66	16,581.24	46,981.99	0.00	66,324.94
R. NZOIA	3,821.85	107.64	0.00	0.00	0.00	0.00	37,520.39	886.98	10,335.56	37,520.39	0.00	41,342.24
R. SIO	82.79	15.23	0.00	0.00	198.82	10.41	3,489.85	379.55	942.86	3,489.85	0.00	3,771.46
NYALENDA	0.00	0.00	1,603.98	161.61	299,598.63	4,526.10	8,771.44	764.46	77,493.51	299,598.63	0.00	309,974.04
KWASCO	31,025.39	978.08	0.00	0.00	0.00	0.00	214,661.90	1,645.39	61,421.82	214,661.90	0.00	245,687.29
KISATI	0.00	0.00	0.00	0.00	9,578.18	1,253.34	49,198.04	966.20	14,694.05	49,198.04	0.00	58,776.22
SAKA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MEAN	**10,088.24**	**424.33**	**40,328.74**	**1,841.76**	**25,584.41**	**1,192.59**	**18,947.48**	**539.52**	**23,737.22**	**40,328.74**	**10,088.24**	**94,948.88**
MAX	**81,248.96**	**1,882.22**	**381,145.01**	**23,231.33**	**304,068.17**	**22,667.03**	**214,661.90**	**1,820.35**	**245,281.01**	**381,145.01**	**81,248.96**	**981,124.04**
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
MEDIAN	**2,922.29**	**211.42**	**1,258.61**	**129.03**	**229.74**	**33.23**	**5,121.89**	**277.40**	**2,383.13**	**5,121.89**	**229.74**	**9,532.53**
SUM	**302,647.22**	**12,729.92**	**1,209,862.33**	**55,252.68**	**767,532.40**	**35,777.82**	**568,424.30**	**16,185.55**				**2,848,466.25**
METHOXYCHLOR	**Dry season 1**	**STD**	**Wet season**	**STD**	**Dry season 2**	**STD**	**Short rain**	**STD**	**MEAN**	**MAX**	**MIN**	**0.00**
MUHURUBAY	148.29	12.32	1,871.96	147.08	241.43	19.19	0.00	0.00	565.42	1,871.96	0.00	2,261.69
SORI	149.28	15.76	2,577.61	167.99	148.24	22.19	9,467.81	646.38	3,085.73	9,467.81	148.24	12,342.94
MBITA LHSD	1,538.48	81.39	2,999.86	578.59	117.39	14.38	205.85	50.11	1,215.40	2,999.86	117.39	4,861.58
MBITA WG	437.52	61.73	299.51	105.06	1,803.42	81.01	7,768.59	609.03	2,577.26	7,768.59	299.51	10,309.04
HOMABAY	240.15	30.62	5,836.21	523.98	174.41	36.77	48,857.44	2,665.80	13,777.05	48,857.44	174.41	55,108.21
KENDUBAY	0.00	0.00	155.55	12.89	29,645.54	556.06	291.91	64.58	7,523.25	29,645.54	0.00	30,093.01
KUSA	7,133.11	1,274.82	9,686.33	1,206.92	2,056.97	337.89	1,320.79	896.40	5,049.30	9,686.33	1,320.79	20,197.20
DUNGA BEACH	0.00	0.00	34,543.67	2,149.03	710.06	106.82	29,239.87	911.80	16,123.40	34,543.67	0.00	64,493.60
HIPPOPOINT	807.94	199.16	17,587.81	1,337.95	1,268.01	225.90	0.00	0.00	4,915.94	17,587.81	0.00	19,663.75
RAILWAYS	0.00	0.00	13,296.80	446.52	151.06	27.08	8,810.35	1,021.10	5,564.55	13,296.80	0.00	22,258.21
LUANDA	5,331.13	943.85	1,987.86	191.84	15,561.88	788.70	7,991.08	609.50	7,717.99	15,561.88	1,987.86	30,871.95
MISORI	6,007.12	8,131.30	470.72	93.69	0.00	0.00	3,252.41	253.73	2,432.56	6,007.12	0.00	9,730.25
USENGE	6,060.04	779.23	139.97	34.00	0.00	0.00	3,462.78	173.36	2,415.70	6,060.04	0.00	9,662.78
PORT VICTORIA	580.13	74.71	157.98	14.30	0.00	0.00	36,407.95	1,731.78	9,286.51	36,407.95	0.00	37,146.05
SIO PORT	0.00	0.00	6,129.43	549.16	2,312.15	186.46	1,050.44	150.69	2,373.00	6,129.43	0.00	9,492.02

R. KUJA	7,279.73	467.56	145.35	16.44	791.25	99.99	5,228.12	210.00	3,361.11	7,279.73	145.35	13,444.46
R. AWACH	3,263.15	17.83	15,412.03	1,218.47	113,853.89	9,578.24	210.16	57.98	33,184.81	113,853.89	210.16	132,739.23
R. SONDU	0.00	0.00	116.05	18.46	1,398.01	207.79	0.00	0.00	378.51	1,398.01	0.00	1,514.06
R. NYANDO	1,051.66	68.97	9,418.37	949.72	2,009.22	162.13	2,532.82	223.91	3,753.02	9,418.37	1,051.66	15,012.07
R. NYAMASARIA	0.00	0.00	6,371.83	1,087.94	151.53	14.72	201.56	27.98	1,681.23	6,371.83	0.00	6,724.91
R. KISIAN	528.25	30.71	2,222.43	204.51	0.00	0.00	168.83	46.13	729.88	2,222.43	0.00	2,919.50
R. MUGRUK	799.79	9.63	0.00	0.00	1,374.80	128.94	11,618.02	519.89	3,448.15	11,618.02	0.00	13,792.60
R. AWACH SEME	0.00	0.00	150.60	30.43	390.78	58.53	11,568.26	1,348.99	3,027.41	11,568.26	0.00	12,109.64
R. YALA	6,733.71	503.27	5,334.85	668.37	0.00	0.00	6,779.79	215.94	4,712.09	6,779.79	0.00	18,848.35
R. NZOIA	939.56	79.94	142.37	18.29	8,857.10	273.50	79,382.00	851.35	22,330.25	79,382.00	142.37	89,321.02
R. SIO	187.03	64.24	0.00	0.00	1,278.79	55.14	2,527.76	223.63	998.39	2,527.76	0.00	3,993.57
NYALENDA	119,660.31	3,885.34	2,982.90	215.03	154,058.03	7,651.33	2,659.23	109.71	69,840.12	154,058.03	2,659.23	279,360.48
KWASCO	151.10	12.42	204.75	49.81	1,934.76	141.83	80,731.53	1,304.33	20,755.54	80,731.53	151.10	83,022.15
KISATI	34,902.25	1,550.87	2,367.38	248.84	1,700.63	158.82	29,373.34	1,256.95	17,085.90	34,902.25	1,700.63	68,343.59
SAKA	0.00	0.00	7,774.86	754.49	150.18	33.59	59,721.08	510.83	16,911.53	59,721.08	0.00	67,646.12
MEAN	**6,797.66**	**609.86**	**5,012.83**	**434.66**	**11,404.65**	**698.90**	**15,027.66**	**556.40**	-	-	-	38,242.80
MAX	**119,660.31**	**8,131.30**	**34,543.67**	**2,149.03**	**154,058.03**	**9,578.24**	**80,731.53**	**2,665.80**	-	-	-	388,993.55
MIN	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	-	-	-	0.00
MEDIAN	**554.19**	**46.22**	**2,294.90**	**198.17**	**1,029.63**	**90.50**	**4,345.45**	**238.82**	-	-	-	8,224.17
SUM	203,929.71	18,295.66	150,385.03	13,039.78	342,139.51	20,967.01	450,829.78	16,691.88	-	-	-	1,147,284.03

ANNEX 4.5

Table 4.5.1A: Correlation of soil physico-chemical parameters and water phosphorus levels

Correlations

		Ph	N%	OC%	P%	K e%	Ca e%	Mg e %	Mn e%	Cu ppm	Fe ppm	Zn PPM	Na e %	Ec mS/cm	WET SEASON TRP	DRY SEASON II TRP	SHORT RAIN TRP	DRY SEASON I TRP	WET SEASON THP	DRY SEASON II THP	SHORT RAIN THP	DRY SEASON I THP
Ph	Pearson Correlation	1.000	-.328	-.327	-.428*	-.118	.450*	-.113	-.438*	.072	-.393*	-.014	.048	-.132	-.054	-.066	.087	.053	-.122	.056	.127	[illegible]
	Sig. (2-tailed)		.077	.078	.018	.534	.013	.553	.015	.704	.031	.943	.800	.666	.778	.857	.648	.780	.519	.771	.506	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	30	28	30	30	30	30	30	30
N%	Pearson Correlation	-.328	1.000	.805**	.279	-.008	-.029	.094	.433*	.268	.147	.460*	-.162	.213	.183	-.036	-.045	.111	-.081	.114	.144	[illegible]
	Sig. (2-tailed)	.077		.000	.135	.978	.879	.621	.017	.152	.437	.010	.392	.485	.333	.856	.800	.561	.669	.550	.331	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	30	28	30	30	30	30	30	30
OC%	Pearson Correlation	-.327	.805**	1.000	.278	.035	-.018	.117	.444*	.282	.136	.448*	-.132	.217	.189	-.057	-.084	.115	-.078	.133	.197	[illegible]
	Sig. (2-tailed)	.078	.000		.138	.855	.928	.537	.014	.183	.476	.013	.486	.477	.316	.773	.660	.546	.681	.484	.297	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	30	28	30	30	30	30	30	30
P%	Pearson Correlation	-.428*	.279	.278	1.000	.112	-.228	.182	.117	-.136	.177	.022	-.174	.042	.042	.015	-.116	-.105	-.180	-.084	.217	[illegible]
	Sig. (2-tailed)	.018	.135	.138		.555	.225	.336	.538	.483	.349	.908	.358	.892	.825	.939	.540	.582	.342	.659	.249	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	30	28	30	30	30	30	30	30
K e%	Pearson Correlation	-.118	-.008	.035	.112	1.000	.378*	.311	.144	-.008	.216	-.065	.392*	-.166	.150	-.114	-.142	-.035	-.231	.128	.137	[illegible]
	Sig. (2-tailed)	.534	.978	.855	.555		.040	.094	.448	.966	.247	.731	.032	.588	.428	.563	.456	.856	.219	.505	.471	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	30	28	30	30	30	30	30	30
Ca e%	Pearson Correlation	.450*	-.029	-.018	-.228	.378*	1.000	.474**	-.126	.004	.074	-.038	.197	.727**	.066	-.132	-.028	.012	-.298	.052	.206	[illegible]
	Sig. (2-tailed)	.013	.879	.928	.225	.040		.008	.509	.983	.698	.850	.296	.005	.730	.504	.880	.950	.113	.785	.275	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	30	28	30	30	30	30	30	30
Mg e %	Pearson Correlation	-.113	.094	.117	.182	.311	.474**	1.000	-.024	-.299	.140	-.201	.113	.613*	-.136	-.407*	-.146	-.140	-.402*	-.151	.243	[illegible]
	Sig. (2-tailed)	.553	.621	.537	.336	.094	.008		.899	.108	.460	.288	.551	.026	.469	.032	.436	.455	.028	.427	.196	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	30	28	30	30	30	30	30	30
Mn e%	Pearson Correlation	-.438*	.433*	.444*	.117	.144	-.126	-.024	1.000	.447*	.358	.452*	.057	-.033	.084	.074	-.136	.204	.218	.153	.120	[illegible]
	Sig. (2-tailed)	.015	.017	.014	.538	.448	.509	.899		.013	.051	.012	.847	.914	.620	.708	.474	.280	.248	.420	.528	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	30	28	30	30	30	30	30	30
Cu ppm	Pearson Correlation	.072	.268	.282	-.136	-.008	.004	-.299	.447*	1.000	.210	.619**	.072	-.019	-.113	-.053	-.152	.182	.169	-.123	.062	[illegible]
	Sig. (2-tailed)	.704	.152	.183	.483	.966	.983	.108	.013		.266	.000	.705	.950	.554	.789	.422	.335	.371	.516	.744	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	30	28	30	30	30	30	30	30
Fe ppm	Pearson Correlation	-.393*	.147	.136	.177	.216	.074	.140	.358	.210	1.000	.180	-.162	-.008	-.036	-.064	-.060	.086	.067	-.113	.197	[illegible]
	Sig. (2-tailed)	.031	.437	.476	.349	.247	.698	.460	.051	.266		.315	.392	.983	.851	.763	.753	.615	.725	.551	.296	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	30	28	30	30	30	30	30	30
Zn PPM	Pearson Correlation	-.014	.460*	.448*	.022	-.065	-.038	-.201	.452*	.619**	.180	1.000	.069	-.048	-.108	-.072	-.107	.116	.046	-.110	.100	[illegible]
	Sig. (2-tailed)	.943	.010	.013	.908	.731	.850	.288	.012	.000	.315		.718	.882	.585	.717	.573	.545	.812	.564	.599	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	30	28	30	30	30	30	30	30
Na e %	Pearson Correlation	.048	-.162	-.132	-.174	.392*	.197	.113	.057	.072	-.162	.069	1.000	.351	.065	-.140	-.215	-.108	-.094	.226	.084	[illegible]
	Sig. (2-tailed)	.800	.392	.486	.358	.032	.296	.551	.847	.705	.392	.718		.239	.732	.476	.254	.570	.621	.230	.660	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	30	28	30	30	30	30	30	30
Ec mS/cm	Pearson Correlation	-.132	.213	.217	.042	-.166	.727**	.613*	-.033	-.019	-.008	-.048	.351	1.000	.551	-.079	.178	.242	-.388	.211	.280	[illegible]
	Sig. (2-tailed)	.666	.485	.477	.892	.588	.005	.026	.914	.950	.983	.882	.239		.051	.807	.558	.426	.187	.489	.355	[illegible]
	N	13	13	13	13	13	13	13	13	13	13	13	13	13	13	12	13	13	13	13	13	13
WET SEASON TRP	Pearson Correlation	-.054	.183	.189	.042	.150	.066	-.136	.084	-.113	-.036	-.108	.065	.551	1.000	.736**	.485**	.320	-.223	.667**	-.146	[illegible]
	Sig. (2-tailed)	.778	.333	.316	.825	.428	.730	.469	.620	.554	.851	.585	.732	.051		.000	.010	.085	.236	.000	.439	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	30	28	30	30	30	30	30	30
DRY SEASON II TRP	Pearson Correlation	-.066	-.036	-.057	.015	-.114	-.132	-.407*	.074	-.053	-.064	-.072	-.140	-.079	.736**	1.000	.666**	.014	-.082	.523**	-.069	[illegible]
	Sig. (2-tailed)	.857	.856	.773	.939	.563	.504	.032	.708	.789	.763	.717	.476	.807	.000		.000	.942	.753	.004	.729	[illegible]
	N	28	28	28	28	28	28	28	28	28	28	28	28	12	28	28	28	28	28	28	28	28
SHORT RAIN TRP	Pearson Correlation	.087	-.045	-.084	-.116	-.142	-.028	-.146	-.136	-.152	-.060	-.107	-.215	.178	.485**	.666**	1.000	-.064	-.172	.116	.107	[illegible]
	Sig. (2-tailed)	.648	.800	.660	.540	.456	.880	.436	.474	.422	.753	.573	.254	.558	.010	.000		.777	.364	.543	.574	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	30	28	30	30	30	30	30	30
DRY SEASON I TRP	Pearson Correlation	.053	.111	.115	-.105	-.035	.012	-.140	.204	.182	.086	.116	-.108	.242	.320	.014	-.064	1.000	.176	.173	-.341	[illegible]
	Sig. (2-tailed)	.780	.561	.546	.582	.856	.950	.455	.280	.335	.615	.545	.570	.426	.085	.942	.777		.352	.360	.066	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	30	28	30	30	30	30	30	30
WET SEASON THP	Pearson Correlation	-.122	-.081	-.078	-.180	-.231	-.298	-.402*	.218	.169	.067	.046	-.094	-.388	-.223	-.082	-.172	.176	1.000	-.081	-.438*	[illegible]
	Sig. (2-tailed)	.519	.669	.681	.342	.219	.113	.028	.248	.371	.725	.812	.621	.187	.236	.753	.364	.352		.671	.015	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	30	28	30	30	30	30	30	30
DRY SEASON II THP	Pearson Correlation	.056	.114	.133	-.084	.128	.052	-.161	.153	-.123	-.113	-.110	.226	.211	.667**	.523**	.116	.173	-.081	1.000	-.048	[illegible]
	Sig. (2-tailed)	.771	.550	.484	.659	.505	.785	.427	.420	.516	.551	.564	.229	.489	.000	.004	.543	.360	.671		.807	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	30	28	30	30	30	30	30	30
SHORT RAIN THP	Pearson Correlation	-.127	.184	.197	.217	.137	.206	.243	.120	.062	.197	.100	.084	.280	-.146	-.069	.107	-.341	-.438*	-.048	1.000	[illegible]
	Sig. (2-tailed)	.506	.331	.297	.249	.471	.275	.196	.528	.744	.298	.599	.620	.355	.439	.729	.574	.066	.015	.807		[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	30	28	30	30	30	30	30	30
DRY SEASON I THP	Pearson Correlation	.241	.080	.052	-.044	-.099	.077	-.088	-.086	-.020	-.099	.102	.224	-.108	-.039	.116	.104	-.322	.300	.184	.048	1.000
	Sig. (2-tailed)	.199	.796	.786	.819	.613	.686	.626	.654	.915	.608	.591	.233	.730	.837	.560	.584	.083	.107	.305	.801	
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	30	28	30	30	30	30	30	30
WET SEASON TP	Pearson Correlation	.220	.019	.013	.118	-.110	-.078	-.223	.309	.086	.054	.043	-.132	.008	.136	.627**	-.036	.073	.275	.228	-.407*	[illegible]
	Sig. (2-tailed)	.244	.859	.948	.536	.562	.688	.236	.101	.614	.777	.820	.488	.979	.473	.000	.852	.700	.142	.226	.026	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	30	28	30	30	30	30	30	30
DRY SEASON II TP	Pearson Correlation	-.062	.028	.014	.012	.087	-.080	-.389*	.113	-.084	-.048	-.086	-.109	.125	.789**	.679**	.580**	.082	-.012	.676**	-.066	[illegible]
	Sig. (2-tailed)	.747	.883	.940	.949	.764	.717	.034	.553	.757	.799	.722	.566	.685	.000	.000	.001	.666	.949	.000	.648	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	30	28	30	30	30	30	30	30
SHORT RAIN TP	Pearson Correlation	.108	-.087	-.075	-.172	.051	.008	-.212	-.023	-.108	-.108	.027	-.056	-.022	.560**	.701**	.779**	.064	.170	.391*	.030	[illegible]
	Sig. (2-tailed)	.576	.789	.694	.362	.789	.977	.260	.903	.568	.570	.888	.769	.943	.001	.000	.000	.721	.369	.033	.878	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	30	28	30	30	30	30	30	30
DRY SEASON I TP	Pearson Correlation	.307	.113	.120	-.197	-.083	.229	-.056	.084	.176	.144	.132	-.036	.114	-.023	-.244	-.101	.601**	.180	-.046	-.282	[illegible]
	Sig. (2-tailed)	.099	.554	.528	.297	.740	.224	.773	.830	.308	.449	.486	.844	.712	.909	.210	.596	.000	.314	.800	.131	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	30	28	30	30	30	30	30	30

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Table 4.5.2A: Correlation of soil physico-chemical parameters and phosphorus levels in soil

Correlations

		Ph	N%	OC%	P%	K e%	Ca e%	Mg e %	Mn e%	Cu ppm	Fe ppm	Zn PPM	Na e %	Ec mS/cm	DRY SEASON II SAP	SHORT RAIN SAP	DRY SEASON I SAP
Ph	Pearson Correlation	1.000	-.328	-.327	-.428*	-.118	.450*	-.113	-.439*	.072	-.393*	-.014	.048	-.132	.533*	.440*	.350
	Sig. (2-tailed)	.	.077	.078	.018	.534	.013	.553	.015	.704	.031	.943	.800	.568	.013	.028	.094
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	21	25	24
N%	Pearson Correlation	-.328	1.000	.995**	.279	-.006	-.029	.094	.433*	.268	.147	.460*	-.162	.213	-.023	.029	.401
	Sig. (2-tailed)	.077	.	.000	.135	.976	.879	.621	.017	.152	.437	.010	.392	.485	.921	.889	.052
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	21	25	24
OC%	Pearson Correlation	-.327	.995**	1.000	.276	.035	-.018	.117	.444*	.262	.135	.448*	-.132	.217	-.023	.015	.378
	Sig. (2-tailed)	.078	.000	.	.139	.855	.926	.537	.014	.163	.478	.013	.488	.477	.922	.943	.069
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	21	25	24
P%	Pearson Correlation	-.428*	.279	.276	1.000	.112	-.228	.182	.117	-.139	.177	.022	-.174	.042	-.181	-.004	.121
	Sig. (2-tailed)	.018	.135	.139	.	.555	.225	.335	.538	.463	.349	.906	.359	.892	.433	.986	.574
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	21	25	24
K e%	Pearson Correlation	-.118	-.006	.035	.112	1.000	.378*	.311	.144	-.098	.218	-.065	.392*	-.166	.107	-.076	.009
	Sig. (2-tailed)	.534	.976	.855	.555	.	.040	.094	.448	.605	.247	.731	.032	.588	.646	.719	.966
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	21	25	24
Ca e%	Pearson Correlation	.450*	-.029	-.018	-.228	.378*	1.000	.474**	-.125	.004	.074	-.036	.197	.727**	.563**	.379	.489*
	Sig. (2-tailed)	.013	.879	.926	.225	.040	.	.008	.509	.983	.699	.850	.296	.005	.008	.062	.015
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	21	25	24
Mg e %	Pearson Correlation	-.113	.094	.117	.182	.311	.474**	1.000	-.024	-.299	.149	-.201	.113	.613*	.256	.230	.440*
	Sig. (2-tailed)	.553	.621	.537	.335	.094	.008	.	.899	.108	.430	.286	.551	.026	.262	.269	.032
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	21	25	24
Mn e%	Pearson Correlation	-.439*	.433*	.444*	.117	.144	-.125	-.024	1.000	.447*	.359	.452*	.037	-.033	-.374	-.488*	-.408*
	Sig. (2-tailed)	.015	.017	.014	.538	.448	.509	.899	.	.013	.051	.012	.847	.914	.095	.013	.048
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	21	25	24
Cu ppm	Pearson Correlation	.072	.268	.262	-.139	-.098	.004	-.299	.447*	1.000	.210	.919**	.072	-.019	.102	-.124	-.119
	Sig. (2-tailed)	.704	.152	.163	.463	.605	.983	.108	.013	.	.268	.000	.705	.950	.661	.558	.581
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	21	25	24
Fe ppm	Pearson Correlation	-.393*	.147	.135	.177	.218	.074	.149	.359	.210	1.000	.190	-.162	-.006	-.275	-.232	-.210
	Sig. (2-tailed)	.031	.437	.478	.349	.247	.699	.430	.051	.268	.	.315	.392	.983	.227	.264	.325
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	21	25	24
Zn PPM	Pearson Correlation	-.014	.460*	.448*	.022	-.065	-.036	-.201	.452*	.919**	.190	1.000	.069	-.046	.129	-.070	.015
	Sig. (2-tailed)	.943	.010	.013	.906	.731	.850	.286	.012	.000	.315	.	.719	.882	.578	.738	.943
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	21	25	24
Na e %	Pearson Correlation	.048	-.162	-.132	-.174	.392*	.197	.113	.037	.072	-.162	.069	1.000	.351	.295	.125	-.011
	Sig. (2-tailed)	.800	.392	.488	.359	.032	.296	.551	.847	.705	.392	.719	.	.239	.195	.552	.959
	N	30	30	30	30	30	30	30	30	30	30	30	30	13	21	25	24
Ec mS/cm	Pearson Correlation	-.132	.213	.217	.042	-.166	.727**	.613*	-.033	-.019	-.006	-.046	.351	1.000	.458	.445	.397
	Sig. (2-tailed)	.568	.485	.477	.892	.588	.005	.026	.914	.950	.983	.882	.239	.	.253	.197	.256
	N	13	13	13	13	13	13	13	13	13	13	13	13	13	8	10	10
DRY SEASON II SAP	Pearson Correlation	.533*	-.023	-.023	-.181	.107	.563**	.256	-.374	.102	-.275	.129	.295	.458	1.000	.748**	.773**
	Sig. (2-tailed)	.013	.921	.922	.433	.646	.008	.262	.095	.661	.227	.578	.195	.253	.	.000	.000
	N	21	21	21	21	21	21	21	21	21	21	21	21	8	21	18	18
SHORT RAIN SAP	Pearson Correlation	.440*	.029	.015	-.004	-.076	.379	.230	-.488*	-.124	-.232	-.070	.125	.445	.748**	1.000	.539*
	Sig. (2-tailed)	.028	.889	.943	.986	.719	.062	.269	.013	.558	.264	.738	.552	.197	.000	.	.014
	N	25	25	25	25	25	25	25	25	25	25	25	25	10	18	25	20
DRY SEASON I SAP	Pearson Correlation	.350	.401	.378	.121	.009	.489*	.440*	-.408*	-.119	-.210	.015	-.011	.397	.773**	.539*	1.000
	Sig. (2-tailed)	.094	.052	.069	.574	.966	.015	.032	.048	.581	.325	.943	.959	.256	.000	.014	.
	N	24	24	24	24	24	24	24	24	24	24	24	24	10	18	20	24

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4.5.3A: Correlation of soil physico-chemical parameters and phosphorus levels in sediments

Correlations

		Ph	N%	OC%	P%	K a%	Ca a%	Mg a %	Mn a%	Cu ppm	Fe ppm	Zn PPM	Na a %	Ec mS/cm
Ph	Pearson Correlation	1.000	-.328	-.327	-.428*	-.118	.450*	-.113	-.439*	.072	-.393*	-.014	.048	-.132
	Sig. (2-tailed)	.	.077	.078	.018	.534	.013	.553	.015	.704	.031	.943	.800	.668
	N	30	30	30	30	30	30	30	30	30	30	30	30	13
N%	Pearson Correlation	-.328	1.000	.995**	.279	-.008	-.029	.094	.433*	.268	.147	.460*	-.162	.213
	Sig. (2-tailed)	.077	.	.000	.135	.978	.879	.621	.017	.152	.437	.010	.392	.485
	N	30	30	30	30	30	30	30	30	30	30	30	30	13
OC%	Pearson Correlation	-.327	.995**	1.000	.278	.035	-.018	.117	.444*	.262	.135	.448*	-.132	.217
	Sig. (2-tailed)	.078	.000	.	.139	.855	.926	.537	.014	.163	.478	.013	.488	.477
	N	30	30	30	30	30	30	30	30	30	30	30	30	13
P%	Pearson Correlation	-.428*	.279	.278	1.000	.112	-.228	.182	.117	-.139	.177	.022	-.174	.042
	Sig. (2-tailed)	.018	.135	.139	.	.555	.225	.335	.538	.463	.349	.908	.359	.892
	N	30	30	30	30	30	30	30	30	30	30	30	30	13
K a%	Pearson Correlation	-.118	-.008	.035	.112	1.000	.378*	.311	.144	-.098	.218	-.065	.392*	-.166
	Sig. (2-tailed)	.534	.978	.855	.555	.	.040	.094	.448	.605	.247	.731	.032	.588
	N	30	30	30	30	30	30	30	30	30	30	30	30	13
Ca a%	Pearson Correlation	.450*	-.029	-.018	-.228	.378*	1.000	.474**	-.125	.004	.074	-.036	.197	.727**
	Sig. (2-tailed)	.013	.879	.926	.225	.040	.	.008	.509	.983	.698	.850	.298	.005
	N	30	30	30	30	30	30	30	30	30	30	30	30	13
Mg a %	Pearson Correlation	-.113	.094	.117	.182	.311	.474**	1.000	-.024	-.299	.149	-.201	.113	.613*
	Sig. (2-tailed)	.553	.621	.537	.335	.094	.008	.	.899	.108	.430	.286	.551	.026
	N	30	30	30	30	30	30	30	30	30	30	30	30	13
Mn a%	Pearson Correlation	-.439*	.433*	.444*	.117	.144	-.125	-.024	1.000	.447*	.358	.452*	.037	-.033
	Sig. (2-tailed)	.015	.017	.014	.538	.448	.509	.899	.	.013	.051	.012	.847	.914
	N	30	30	30	30	30	30	30	30	30	30	30	30	13
Cu ppm	Pearson Correlation	.072	.268	.262	-.139	-.098	.004	-.299	.447*	1.000	.210	.919**	.072	-.019
	Sig. (2-tailed)	.704	.152	.163	.463	.605	.983	.108	.013	.	.266	.000	.705	.950
	N	30	30	30	30	30	30	30	30	30	30	30	30	13
Fe ppm	Pearson Correlation	-.393*	.147	.135	.177	.218	.074	.149	.358	.210	1.000	.190	-.162	-.008
	Sig. (2-tailed)	.031	.437	.478	.349	.247	.698	.430	.051	.266	.	.315	.392	.983
	N	30	30	30	30	30	30	30	30	30	30	30	30	13
Zn PPM	Pearson Correlation	-.014	.460*	.448*	.022	-.065	-.036	-.201	.452*	.919**	.190	1.000	.089	-.048
	Sig. (2-tailed)	.943	.010	.013	.908	.731	.850	.286	.012	.000	.315	.	.719	.882
	N	30	30	30	30	30	30	30	30	30	30	30	30	13
Na a %	Pearson Correlation	.048	-.162	-.132	-.174	.392*	.197	.113	.037	.072	-.162	.089	1.000	.351
	Sig. (2-tailed)	.800	.392	.488	.359	.032	.298	.551	.847	.705	.392	.719	.	.239
	N	30	30	30	30	30	30	30	30	30	30	30	30	13
Ec mS/cm	Pearson Correlation	-.132	.213	.217	.042	-.166	.727**	.613*	-.033	-.019	-.008	-.048	.351	1.000
	Sig. (2-tailed)	.668	.485	.477	.892	.588	.005	.026	.914	.950	.983	.882	.239	.
	N	13	13	13	13	13	13	13	13	13	13	13	13	13
WET SEASON BAP	Pearson Correlation	-.519*	-.220	-.237	.125	-.156	-.383	-.380	.281	.212	.585**	-.058	-.189	-.250
	Sig. (2-tailed)	.013	.325	.288	.580	.488	.078	.073	.205	.343	.008	.798	.400	.488
	N	22	22	22	22	22	22	22	22	22	22	22	22	10
DRY SEASON II BAP	Pearson Correlation	-.263	-.018	-.024	.132	-.070	-.050	-.015	.220	.384	.089	.028	-.097	.128
	Sig. (2-tailed)	.262	.940	.919	.579	.770	.835	.949	.352	.095	.708	.906	.684	.728
	N	20	20	20	20	20	20	20	20	20	20	20	20	10
SHORT RAIN BAP	Pearson Correlation	-.464*	.185	.181	.117	.000	-.362	-.477**	.347	.334	.224	.334	-.198	-.377
	Sig. (2-tailed)	.011	.338	.405	.546	.999	.053	.009	.065	.076	.243	.078	.308	.227
	N	29	29	29	29	29	29	29	29	29	29	29	29	12
DRY SEASON I BAP	Pearson Correlation	-.284	-.012	-.032	.401*	-.218	-.327	-.404*	.130	.083	-.033	.075	-.319	-.278
	Sig. (2-tailed)	.143	.951	.871	.034	.266	.089	.033	.509	.677	.869	.705	.098	.381
	N	28	28	28	28	28	28	28	28	28	28	28	28	12
Wet season EXP	Pearson Correlation	-.152	.057	.027	-.294	-.083	.235	-.006	.402	.393	.285	.007	.254	.731*
	Sig. (2-tailed)	.500	.800	.906	.184	.712	.291	.984	.063	.070	.198	.976	.254	.016
	N	22	22	22	22	22	22	22	22	22	22	22	22	10
Dry season II EXP	Pearson Correlation	.216	-.170	-.137	-.236	.220	.248	-.082	.031	-.255	-.351	-.188	-.188	-.320
	Sig. (2-tailed)	.333	.450	.542	.291	.324	.271	.716	.890	.252	.109	.450	.454	.367
	N	22	22	22	22	22	22	22	22	22	22	22	22	10
Short rain season EXP	Pearson Correlation	.312	.249	.236	-.379	.242	.458*	-.199	.148	.201	.347	.194	-.048	-.300
	Sig. (2-tailed)	.129	.229	.251	.062	.244	.021	.339	.482	.336	.234	.353	.827	.400
	N	25	25	25	25	25	25	25	25	25	25	25	25	10
Dry season I EXP	Pearson Correlation	-.120	.004	-.024	.208	-.160	-.098	.024	-.117	-.237	-.182	-.184	-.393*	-.151
	Sig. (2-tailed)	.538	.982	.902	.288	.407	.646	.903	.547	.217	.402	.330	.035	.824
	N	29	29	29	29	29	29	29	29	29	29	29	29	13

		WET SEASON BAP	DRY SEASON II BAP	SHORT RAIN BAP	DRY SEASON I BAP	Wet season EXP	Dry season II EXP	Short rain season EXP	Dry season I EXP
Ph	Pearson Correlation	-.519*	-.263	-.464*	-.284	-.152	.216	.312	[illegible]
	Sig. (2-tailed)	.013	.262	.011	.143	.500	.333	.129	[illegible]
	N	22	20	29	28	22	22	25	[illegible]
N%	Pearson Correlation	-.220	-.018	.185	-.012	.057	-.170	.249	[illegible]
	Sig. (2-tailed)	.325	.940	.338	.951	.800	.450	.229	[illegible]
	N	22	20	29	28	22	22	25	[illegible]
OC%	Pearson Correlation	-.237	-.024	.181	-.032	.027	-.137	.236	[illegible]
	Sig. (2-tailed)	.288	.919	.405	.871	.906	.542	.251	[illegible]
	N	22	20	29	28	22	22	25	[illegible]
P%	Pearson Correlation	.125	.132	.117	.401*	-.294	-.236	-.379	[illegible]
	Sig. (2-tailed)	.580	.579	.546	.034	.184	.291	.062	[illegible]
	N	22	20	29	28	22	22	25	[illegible]
K a%	Pearson Correlation	-.156	-.070	.000	-.218	-.083	.220	.242	[illegible]
	Sig. (2-tailed)	.488	.770	.999	.266	.712	.324	.244	[illegible]
	N	22	20	29	28	22	22	25	[illegible]
Ca a%	Pearson Correlation	-.383	-.050	-.362	-.327	.235	.248	.458*	[illegible]
	Sig. (2-tailed)	.078	.835	.053	.089	.291	.271	.021	[illegible]
	N	22	20	29	28	22	22	25	[illegible]
Mg a %	Pearson Correlation	-.380	-.015	-.477**	-.404*	-.006	-.082	-.199	[illegible]
	Sig. (2-tailed)	.073	.949	.009	.033	.984	.716	.339	[illegible]
	N	22	20	29	28	22	22	25	[illegible]
Mn a%	Pearson Correlation	.281	.220	.347	.130	.402	.031	.148	[illegible]
	Sig. (2-tailed)	.205	.352	.065	.509	.063	.890	.482	[illegible]
	N	22	20	29	28	22	22	25	[illegible]
Cu ppm	Pearson Correlation	.212	.384	.334	.083	.393	-.255	.201	[illegible]
	Sig. (2-tailed)	.343	.095	.076	.677	.070	.252	.336	[illegible]
	N	22	20	29	28	22	22	25	[illegible]
Fe ppm	Pearson Correlation	.585**	.089	.224	-.033	.285	-.351	.347	[illegible]
	Sig. (2-tailed)	.008	.708	.243	.869	.198	.109	.234	[illegible]
	N	22	20	29	28	22	22	25	[illegible]
Zn PPM	Pearson Correlation	-.058	.028	.334	.075	.007	-.188	.194	[illegible]
	Sig. (2-tailed)	.798	.906	.078	.705	.976	.450	.353	[illegible]
	N	22	20	29	28	22	22	25	[illegible]
Na a %	Pearson Correlation	-.189	-.097	-.198	-.319	.254	-.188	-.048	[illegible]
	Sig. (2-tailed)	.400	.684	.308	.098	.254	.454	.827	[illegible]
	N	22	20	29	28	22	22	25	[illegible]
Ec mS/cm	Pearson Correlation	-.250	.128	-.377	-.278	.731*	-.320	-.300	[illegible]
	Sig. (2-tailed)	.488	.728	.227	.381	.016	.367	.400	[illegible]
	N	10	10	12	12	10	10	10	[illegible]
WET SEASON BAP	Pearson Correlation	1.000	.470	.775**	.736**	.122	-.011	-.020	[illegible]
	Sig. (2-tailed)	.	.088	.000	.000	.587	.967	.934	[illegible]
	N	22	18	22	20	22	17	20	[illegible]
DRY SEASON II BAP	Pearson Correlation	.470	1.000	.520*	.817**	.147	.010	.232	[illegible]
	Sig. (2-tailed)	.088	.	.023	.008	.567	.967	.367	[illegible]
	N	18	20	18	18	16	19	18	[illegible]
SHORT RAIN BAP	Pearson Correlation	.775**	.520*	1.000	.848**	.142	-.204	.108	[illegible]
	Sig. (2-tailed)	.000	.023	.	.000	.528	.378	.614	[illegible]
	N	22	18	29	27	22	21	25	[illegible]
DRY SEASON I BAP	Pearson Correlation	.736**	.817**	.848**	1.000	-.378	.089	-.168	[illegible]
	Sig. (2-tailed)	.000	.008	.000	.	.103	.708	.444	[illegible]
	N	20	18	27	28	20	20	23	[illegible]
Wet season EXP	Pearson Correlation	.122	.147	.142	-.378	1.000	-.350	.134	[illegible]
	Sig. (2-tailed)	.587	.567	.528	.103	.	.169	.574	[illegible]
	N	22	18	22	20	22	17	20	[illegible]
Dry season II EXP	Pearson Correlation	-.011	.010	-.204	.089	-.350	1.000	.308	[illegible]
	Sig. (2-tailed)	.967	.967	.378	.708	.169	.	.202	[illegible]
	N	17	19	21	20	17	22	19	[illegible]
Short rain season EXP	Pearson Correlation	-.020	.232	.108	-.168	.134	.308	1.000	[illegible]
	Sig. (2-tailed)	.934	.367	.614	.444	.574	.202	.	[illegible]
	N	20	18	25	23	20	19	25	[illegible]
Dry season I EXP	Pearson Correlation	.304	.183	.148	.358	-.201	.408	-.099	[illegible]
	Sig. (2-tailed)	.181	.504	.450	.083	.382	.087	.645	[illegible]
	N	21	19	28	28	21	21	24	[illegible]

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Table 4.5.4A: Correlation of sediment physico-chemical parameters and phosphorus levels in water

Correlations

		Ph	N%	OC%	P%	K%	Ca%	Mg %	Mn%	Cu	Fe	Zn
Ph	Pearson Correlation	1.000	-.120	-.142	-.744**	-.076	.204	-.084	-.230	-.152	-.302	-.045
	Sig. (2-tailed)	.	.528	.454	.000	.690	.280	.659	.222	.421	.105	.814
	N	30	30	30	30	30	30	30	30	30	30	30
N%	Pearson Correlation	-.120	1.000	.997**	-.023	-.061	.005	.069	.152	.683**	.028	.387*
	Sig. (2-tailed)	.528	.	.000	.903	.750	.978	.718	.421	.000	.884	.046
	N	30	30	30	30	30	30	30	30	30	30	30
OC%	Pearson Correlation	-.142	.997**	1.000	.005	-.052	-.005	.095	.150	.692**	.031	.357
	Sig. (2-tailed)	.454	.000	.	.978	.783	.979	.618	.428	.000	.870	.053
	N	30	30	30	30	30	30	30	30	30	30	30
P%	Pearson Correlation	-.744**	-.023	.005	1.000	.216	-.120	.243	.181	.156	.145	-.111
	Sig. (2-tailed)	.000	.903	.978	.	.247	.528	.196	.337	.410	.444	.559
	N	30	30	30	30	30	30	30	30	30	30	30
K%	Pearson Correlation	-.076	-.061	-.052	.216	1.000	.737**	-.009	.421*	.127	.032	.161
	Sig. (2-tailed)	.690	.750	.783	.247	.	.000	.962	.020	.505	.866	.396
	N	30	30	30	30	30	30	30	30	30	30	30
Ca%	Pearson Correlation	.204	.005	-.005	-.120	.737**	1.000	-.129	.210	.094	.095	.179
	Sig. (2-tailed)	.280	.978	.979	.528	.000	.	.497	.266	.622	.618	.344
	N	30	30	30	30	30	30	30	30	30	30	30
Mg %	Pearson Correlation	-.084	.069	.095	.243	-.009	-.129	1.000	-.165	.001	-.147	-.017
	Sig. (2-tailed)	.659	.718	.618	.196	.962	.497	.	.385	.996	.437	.927
	N	30	30	30	30	30	30	30	30	30	30	30
Mn%	Pearson Correlation	-.230	.152	.150	.181	.421*	.210	-.165	1.000	.324	.823**	.192
	Sig. (2-tailed)	.222	.421	.428	.337	.020	.266	.385	.	.081	.000	.310
	N	30	30	30	30	30	30	30	30	30	30	30
Cu	Pearson Correlation	-.152	.683**	.692**	.156	.127	.094	.001	.324	1.000	.270	.377*
	Sig. (2-tailed)	.421	.000	.000	.410	.505	.622	.996	.081	.	.150	.040
	N	30	30	30	30	30	30	30	30	30	30	30
Fe	Pearson Correlation	-.302	.028	.031	.145	.032	.095	-.147	.823**	.270	1.000	.085
	Sig. (2-tailed)	.105	.884	.870	.444	.866	.618	.437	.000	.150	.	.654
	N	30	30	30	30	30	30	30	30	30	30	30
Zn	Pearson Correlation	-.045	.387*	.357	-.111	.161	.179	-.017	.192	.377*	.085	1.000
	Sig. (2-tailed)	.814	.046	.053	.559	.396	.344	.927	.310	.040	.654	.
	N	30	30	30	30	30	30	30	30	30	30	30
Na %	Pearson Correlation	.085	-.114	-.114	.156	.897**	.856**	-.182	.139	.187	.144	.110
	Sig. (2-tailed)	.656	.550	.549	.401	.000	.000	.336	.463	.322	.449	.563
	N	30	30	30	30	30	30	30	30	30	30	30
Ec mS/cm	Pearson Correlation	-.100	.261	.251	.414*	.604**	.170	-.190	.496*	.301	-.173	.170
	Sig. (2-tailed)	.635	.207	.226	.040	.001	.417	.363	.011	.144	.408	.416
	N	25	25	25	25	25	25	25	25	25	25	25
WET SEASON TRP	Pearson Correlation	-.136	.242	.233	.078	.295	-.039	-.218	.411*	.140	-.148	.104
	Sig. (2-tailed)	.473	.198	.215	.682	.113	.838	.247	.024	.461	.435	.585
	N	30	30	30	30	30	30	30	30	30	30	30
DRY SEASON II TRP	Pearson Correlation	-.174	-.057	-.072	.164	.294	-.063	-.206	.474*	-.031	-.086	-.027
	Sig. (2-tailed)	.376	.773	.716	.406	.129	.750	.293	.011	.875	.662	.891
	N	28	28	28	28	28	28	28	28	28	28	28
SHORT RAIN TRP	Pearson Correlation	-.256	.023	.031	.397*	.039	-.281	.146	.146	-.066	-.244	-.021
	Sig. (2-tailed)	.173	.903	.871	.030	.843	.132	.435	.433	.808	.193	.911
	N	30	30	30	30	30	30	30	30	30	30	30
DRY SEASON ITRP	Pearson Correlation	.114	-.008	-.018	-.159	.049	.224	.005	.140	-.020	-.003	.050
	Sig. (2-tailed)	.549	.966	.925	.400	.798	.234	.980	.460	.916	.988	.785
	N	30	30	30	30	30	30	30	30	30	30	30
WET SEASON THP	Pearson Correlation	-.188	-.375*	-.383*	-.033	-.038	.026	.111	.104	-.192	.154	-.028
	Sig. (2-tailed)	.320	.041	.037	.863	.842	.892	.560	.584	.310	.417	.884
	N	30	30	30	30	30	30	30	30	30	30	30
DRY SEASON II THP	Pearson Correlation	.037	.104	.101	-.086	.313	.032	-.254	.325	-.009	-.078	-.043
	Sig. (2-tailed)	.846	.583	.597	.652	.092	.867	.175	.079	.961	.681	.822
	N	30	30	30	30	30	30	30	30	30	30	30
SHORT RAIN THP	Pearson Correlation	-.173	.131	.141	.231	-.032	-.260	-.089	-.087	.176	.070	.121
	Sig. (2-tailed)	.360	.490	.456	.220	.865	.164	.640	.726	.351	.716	.524
	N	30	30	30	30	30	30	30	30	30	30	30
DRY SEASON I THP	Pearson Correlation	.236	-.012	-.026	-.119	.244	.364*	-.330	.001	-.108	-.029	.088
	Sig. (2-tailed)	.209	.948	.894	.530	.193	.048	.087	.994	.861	.878	.642
	N	30	30	30	30	30	30	30	30	30	30	30
WET SEASON TP	Pearson Correlation	.019	-.237	-.249	.080	.540**	.504**	-.218	.386*	.079	.127	-.079
	Sig. (2-tailed)	.921	.207	.184	.676	.001	.004	.249	.030	.677	.503	.677
	N	30	30	30	30	30	30	30	30	30	30	30
DRY SEASON II TP	Pearson Correlation	-.086	-.046	-.064	.100	.367	.019	-.232	.465**	-.025	-.150	.001
	Sig. (2-tailed)	.816	.813	.736	.598	.053	.922	.217	.010	.897	.430	.996
	N	30	30	30	30	30	30	30	30	30	30	30
SHORT RAIN TP	Pearson Correlation	-.016	.037	.031	.193	.166	-.139	-.071	.316	-.051	-.241	-.014
	Sig. (2-tailed)	.927	.847	.869	.307	.381	.463	.709	.089	.788	.199	.940
	N	30	30	30	30	30	30	30	30	30	30	30
DRY SEASON I TP	Pearson Correlation	.023	-.062	-.066	-.049	.204	.649**	-.151	-.074	-.079	.000	.225
	Sig. (2-tailed)	.904	.747	.733	.812	.280	.002	.425	.696	.679	.999	.231
	N	30	30	30	30	30	30	30	30	30	30	30

		Na %	Ec mS/cm	WET SEASON TRP	DRY SEASON II TRP	SHORT RAIN TRP	DRY SEASON ITRP	WET SEASON THP	DRY SEASON II THP	SHORT RAIN THP	DRY SEA[illegible]N I THP
Ph	Pearson Correlation	.085	-.100	-.136	-.174	-.256	.114	-.188	.037	-.173	36
	Sig. (2-tailed)	.656	.635	.473	.376	.173	.549	.320	.846	.360	09
	N	30	25	30	28	30	30	30	30	30	30
N%	Pearson Correlation	-.114	.261	.242	-.057	.023	-.008	-.375*	.104	.131	12
	Sig. (2-tailed)	.550	.207	.198	.773	.903	.966	.041	.583	.490	48
	N	30	25	30	28	30	30	30	30	30	30
OC%	Pearson Correlation	-.114	.251	.233	-.072	.031	-.018	-.383*	.101	.141	26
	Sig. (2-tailed)	.549	.226	.215	.716	.871	.925	.037	.597	.456	84
	N	30	25	30	28	30	30	30	30	30	30
P%	Pearson Correlation	.156	.414*	.078	.164	.397*	-.159	-.033	-.086	.231	19
	Sig. (2-tailed)	.401	.040	.682	.406	.030	.400	.863	.652	.220	30
	N	30	25	30	28	30	30	30	30	30	30
K%	Pearson Correlation	.897**	.604**	.295	.294	.039	.049	-.038	.313	-.032	44
	Sig. (2-tailed)	.000	.001	.113	.129	.843	.798	.842	.092	.865	93
	N	30	25	30	28	30	30	30	30	30	30
Ca%	Pearson Correlation	.856**	.170	-.039	-.063	-.281	.224	.026	.032	-.260	64*
	Sig. (2-tailed)	.000	.417	.838	.750	.132	.234	.892	.867	.164	48
	N	30	25	30	28	30	30	30	30	30	30
Mg %	Pearson Correlation	-.182	-.190	-.218	-.206	.146	.005	.111	-.254	-.089	30
	Sig. (2-tailed)	.336	.363	.247	.293	.435	.980	.560	.175	.640	87
	N	30	25	30	28	30	30	30	30	30	30
Mn%	Pearson Correlation	.139	.496*	.411*	.474*	.146	.140	.104	.325	-.087	01
	Sig. (2-tailed)	.463	.011	.024	.011	.433	.460	.584	.079	.726	94
	N	30	25	30	28	30	30	30	30	30	30
Cu	Pearson Correlation	.187	.301	.140	-.031	-.066	-.020	-.192	-.009	.176	08
	Sig. (2-tailed)	.322	.144	.461	.875	.808	.916	.310	.961	.351	61
	N	30	25	30	28	30	30	30	30	30	30
Fe	Pearson Correlation	.144	-.173	-.148	-.086	-.244	-.003	.154	-.078	.070	29
	Sig. (2-tailed)	.449	.408	.435	.662	.193	.988	.417	.681	.716	78
	N	30	25	30	28	30	30	30	30	30	30
Zn	Pearson Correlation	.110	.170	.104	-.027	-.021	.050	-.028	-.043	.121	88
	Sig. (2-tailed)	.563	.416	.585	.891	.911	.785	.884	.822	.524	42
	N	30	25	30	28	30	30	30	30	30	30
Na %	Pearson Correlation	1.000	.142	-.078	-.110	-.242	.174	-.021	-.039	-.102	06
	Sig. (2-tailed)	.	.497	.688	.578	.198	.358	.912	.839	.591	00
	N	30	25	30	28	30	30	30	30	30	30
Ec mS/cm	Pearson Correlation	.142	1.000	.813**	.863**	.546**	.050	-.162	.750**	.041	04
	Sig. (2-tailed)	.497	.	.000	.000	.005	.814	.440	.000	.847	19
	N	25	25	25	23	25	25	25	25	25	25
WET SEASON TRP	Pearson Correlation	-.078	.813**	1.000	.738**	.485**	.320	-.223	.888**	.148	40
	Sig. (2-tailed)	.688	.000	.	.000	.010	.085	.237	.000	.441	36
	N	30	25	30	28	30	30	30	30	30	30
DRY SEASON II TRP	Pearson Correlation	-.110	.863**	.738**	1.000	.866**	.014	-.062	.523**	-.070	17
	Sig. (2-tailed)	.578	.000	.000	.	.000	.942	.756	.004	.723	53
	N	28	23	28	28	28	28	28	28	28	28
SHORT RAIN TRP	Pearson Correlation	-.242	.546**	.485**	.866**	1.000	-.054	-.172	.114	.107	03
	Sig. (2-tailed)	.198	.005	.010	.000	.	.777	.364	.549	.575	88
	N	30	25	30	28	30	30	30	30	30	30
DRY SEASON ITRP	Pearson Correlation	.174	.050	.320	.014	-.054	1.000	.176	.177	-.342	20
	Sig. (2-tailed)	.358	.814	.085	.942	.777	.	.351	.350	.086	84
	N	30	25	30	28	30	30	30	30	30	30
WET SEASON THP	Pearson Correlation	-.021	-.162	-.223	-.062	-.172	.176	1.000	-.079	-.430*	86
	Sig. (2-tailed)	.912	.440	.237	.756	.364	.351	.	.677	.018	14
	N	30	25	30	28	30	30	30	30	30	30
DRY SEASON II THP	Pearson Correlation	-.039	.750**	.888**	.523**	.114	.177	-.079	1.000	-.049	82
	Sig. (2-tailed)	.839	.000	.000	.004	.549	.350	.677	.	.802	10
	N	30	25	30	28	30	30	30	30	30	30
SHORT RAIN THP	Pearson Correlation	-.102	.041	.148	-.070	.107	-.342	-.430*	-.049	1.000	47
	Sig. (2-tailed)	.591	.847	.441	.723	.575	.086	.018	.802	.	06
	N	30	25	30	28	30	30	30	30	30	30
DRY SEASON I THP	Pearson Correlation	.306	.104	-.040	.117	.103	-.320	-.286	.182	.047	1.00
	Sig. (2-tailed)	.100	.619	.836	.553	.588	.084	.114	.310	.806	
	N	30	25	30	28	30	30	30	30	30	30
WET SEASON TP	Pearson Correlation	.467**	.512**	.138	.822**	-.036	.074	.275	.228	-.408*	77
	Sig. (2-tailed)	.009	.008	.474	.004	.853	.698	.142	.226	.025	48
	N	30	25	30	28	30	30	30	30	30	30
DRY SEASON II TP	Pearson Correlation	-.039	.864**	.789**	.878**	.580**	.082	-.012	.625**	-.066	88
	Sig. (2-tailed)	.839	.000	.000	.000	.001	.669	.951	.000	.643	74
	N	30	25	30	28	30	30	30	30	30	30
SHORT RAIN TP	Pearson Correlation	-.137	.567**	.580**	.701**	.779**	-.066	-.170	.389*	.029	88
	Sig. (2-tailed)	.469	.003	.001	.000	.000	.721	.370	.033	.880	12
	N	30	25	30	28	30	30	30	30	30	30
DRY SEASON I TP	Pearson Correlation	.566**	-.180	-.024	-.244	-.100	.600**	.189	-.046	-.263	74
	Sig. (2-tailed)	.001	.383	.902	.210	.600	.000	.318	.808	.129	88
	N	30	25	30	28	30	30	30	30	30	30

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 4.5.5A: Correlation of sediment physico-chemical parameters and phosphorus levels in soil

Correlations

		Ph	N%	OC%	P%	K%	Ca%	Mg %	Mn%	Cu	Fe	Zn	Na %	DRY SEASON II SAP	SHORT RAIN SAP	DRY SEASON I SAP
Ph	Pearson Correlation	1.000	-.120	-.142	-.744**	-.076	.204	-.084	-.230	-.152	-.302	-.045	.085	.234	.115	-.019
	Sig. (2-tailed)		.528	.454	.000	.690	.280	.659	.222	.421	.105	.814	.656	.251	.561	.923
	N	30	30	30	30	30	30	30	30	30	30	30	30	26	28	27
N%	Pearson Correlation	-.120	1.000	.997**	-.023	-.061	.005	.069	.152	.693**	.028	.367*	-.114	-.038	.011	.388*
	Sig. (2-tailed)	.528		.000	.903	.750	.978	.716	.421	.000	.884	.046	.550	.854	.958	.045
	N	30	30	30	30	30	30	30	30	30	30	30	30	26	28	27
OC%	Pearson Correlation	-.142	.997**	1.000	.005	-.052	-.005	.095	.150	.692**	.031	.357	-.114	-.041	.030	.397*
	Sig. (2-tailed)	.454	.000		.978	.783	.979	.618	.428	.000	.870	.053	.549	.842	.879	.040
	N	30	30	30	30	30	30	30	30	30	30	30	30	26	28	27
P%	Pearson Correlation	-.744**	-.023	.005	1.000	.218	-.120	.243	.181	.156	.145	-.111	.159	-.090	-.089	-.002
	Sig. (2-tailed)	.000	.903	.978	.	.247	.528	.196	.337	.410	.444	.559	.401	.662	.651	.993
	N	30	30	30	30	30	30	30	30	30	30	30	30	26	28	27
K%	Pearson Correlation	-.076	-.061	-.052	.218	1.000	.737**	-.009	.421*	.127	.032	.161	.697**	.208	.111	.132
	Sig. (2-tailed)	.690	.750	.783	.247	.	.000	.962	.020	.505	.866	.396	.000	.308	.572	.513
	N	30	30	30	30	30	30	30	30	30	30	30	30	26	28	27
Ca%	Pearson Correlation	.204	.005	-.005	-.120	.737**	1.000	-.129	.210	.094	.095	.179	.856**	.321	-.008	.140
	Sig. (2-tailed)	.280	.978	.979	.528	.000	.	.497	.266	.622	.618	.344	.000	.110	.970	.485
	N	30	30	30	30	30	30	30	30	30	30	30	30	26	28	27
Mg %	Pearson Correlation	-.084	.069	.095	.243	-.009	-.129	1.000	-.165	.001	-.147	-.017	-.182	.254	.186	.361
	Sig. (2-tailed)	.659	.716	.618	.196	.962	.497	.	.385	.998	.437	.927	.335	.211	.344	.064
	N	30	30	30	30	30	30	30	30	30	30	30	30	26	28	27
Mn%	Pearson Correlation	-.230	.152	.150	.181	.421*	.210	-.165	1.000	.324	.623**	.192	.139	-.133	-.286	-.151
	Sig. (2-tailed)	.222	.421	.428	.337	.020	.266	.385	.	.081	.000	.310	.463	.517	.140	.452
	N	30	30	30	30	30	30	30	30	30	30	30	30	26	28	27
Cu	Pearson Correlation	-.152	.693**	.692**	.156	.127	.094	.001	.324	1.000	.270	.377*	.187	-.125	-.111	.092
	Sig. (2-tailed)	.421	.000	.000	.410	.505	.622	.998	.081	.	.150	.040	.322	.542	.573	.647
	N	30	30	30	30	30	30	30	30	30	30	30	30	26	28	27
Fe	Pearson Correlation	-.302	.028	.031	.145	.032	.095	-.147	.623**	.270	1.000	.085	.144	-.135	-.281	-.209
	Sig. (2-tailed)	.105	.884	.870	.444	.866	.618	.437	.000	.150	.	.654	.449	.510	.148	.295
	N	30	30	30	30	30	30	30	30	30	30	30	30	26	28	27
Zn	Pearson Correlation	-.045	.367*	.357	-.111	.161	.179	-.017	.192	.377*	.085	1.000	.110	.092	.227	.304
	Sig. (2-tailed)	.814	.046	.053	.559	.396	.344	.927	.310	.040	.654	.	.563	.654	.246	.124
	N	30	30	30	30	30	30	30	30	30	30	30	30	26	28	27
Na %	Pearson Correlation	.085	-.114	-.114	.159	.697**	.856**	-.182	.139	.187	.144	.110	1.000	.151	-.053	.015
	Sig. (2-tailed)	.656	.550	.549	.401	.000	.000	.335	.463	.322	.449	.563	.	.463	.790	.940
	N	30	30	30	30	30	30	30	30	30	30	30	30	26	28	27
DRY SEASON II SAP	Pearson Correlation	.234	-.038	-.041	-.090	.208	.321	.254	-.133	-.125	-.135	.092	.151	1.000	.630**	.534**
	Sig. (2-tailed)	.251	.854	.842	.662	.308	.110	.211	.517	.542	.510	.654	.463	.	.001	.006
	N	26	26	26	26	26	26	26	26	26	26	26	26	26	25	25
SHORT RAIN SAP	Pearson Correlation	.115	.011	.030	-.089	.111	-.008	.186	-.286	-.111	-.281	.227	-.053	.630**	1.000	.480*
	Sig. (2-tailed)	.561	.958	.879	.651	.572	.970	.344	.140	.573	.148	.246	.790	.001	.	.013
	N	28	28	28	28	28	28	28	28	28	28	28	28	25	28	26
DRY SEASON I SAP	Pearson Correlation	-.019	.388*	.397*	-.002	.132	.140	.361	-.151	.092	-.209	.304	.015	.534**	.480*	1.000
	Sig. (2-tailed)	.923	.045	.040	.993	.513	.485	.064	.452	.647	.295	.124	.940	.006	.013	.
	N	27	27	27	27	27	27	27	27	27	27	27	27	25	26	27

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 4.5.6A: Correlation of sediment physico-chemical parameters and phosphorus levels in sediments

Correlations

		Ph	N%	OC%	P%	K%	Ca%	Mg %	Mn%	Cu	Fe	Zn	Na %	Ec mS/cm	WET SEASON BAP	DRY SEASON II BAP	SHORT RAIN BAP	DRY SEASON I BAP	Wet season EXP	Dry season II EXP	Short rain season EXP	Dry season I EXP
Ph	Pearson Correlation	1.000	-.120	-.142	-.744**	-.078	.204	-.064	-.230	-.152	-.302	-.045	.085	-.100	-.329	-.123	-.225	-.218	-.330	.379	.128	-.0
	Sig. (2-tailed)	.	.528	.454	.000	.680	.280	.859	.222	.421	.105	.814	.656	.635	.078	.518	.232	.253	.133	.082	.549	.5
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30	30	22	22	25	[illegible]
N%	Pearson Correlation	-.120	1.000	.997**	-.023	-.061	.005	.069	.152	.993**	.028	.367*	-.114	.261	-.080	.067	-.022	.012	-.127	-.061	.033	.0
	Sig. (2-tailed)	.528	.	.000	.903	.750	.978	.716	.421	.000	.884	.046	.550	.207	.675	.723	.908	.949	.574	.718	.874	.5
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30	30	22	22	25	[illegible]
OC%	Pearson Correlation	-.142	.997**	1.000	.005	-.052	-.006	.095	.150	.992**	.031	.357	-.114	.251	-.074	.092	-.023	-.008	-.109	-.118	-.001	.0
	Sig. (2-tailed)	.454	.000	.	.978	.783	.979	.618	.428	.000	.870	.053	.549	.226	.696	.629	.903	.967	.628	.601	.997	.6
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30	30	22	22	25	[illegible]
P%	Pearson Correlation	-.744**	-.023	.005	1.000	.218	-.120	.243	.181	.156	.145	-.111	.159	.414*	.149	.101	.053	.057	.330	-.282	-.045	-.1
	Sig. (2-tailed)	.000	.903	.978	.	.247	.528	.196	.337	.410	.444	.559	.401	.040	.431	.594	.783	.766	.133	.204	.830	.5
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30	30	22	22	25	[illegible]
K%	Pearson Correlation	-.078	-.061	-.052	.218	1.000	.737**	-.009	.421*	.127	.032	.161	.697**	.604**	.243	.058	.070	.040	.417	.034	.340	-.0
	Sig. (2-tailed)	.680	.750	.783	.247	.	.000	.962	.020	.505	.866	.396	.000	.001	.196	.760	.713	.834	.053	.880	.096	.8
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30	30	22	22	25	[illegible]
Ca%	Pearson Correlation	.204	.005	-.006	-.120	.737**	1.000	-.129	.210	.094	.085	.179	.856**	.170	.080	-.111	.108	-.037	.255	-.048	.339	-.0
	Sig. (2-tailed)	.280	.978	.979	.528	.000	.	.497	.266	.622	.618	.344	.000	.417	.673	.559	.570	.846	.252	.833	.098	.8
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30	30	22	22	25	[illegible]
Mg %	Pearson Correlation	-.064	.069	.095	.243	-.009	-.129	1.000	-.165	.001	-.147	-.017	-.162	-.180	-.124	.011	-.098	-.210	.390	-.225	-.350	.2
	Sig. (2-tailed)	.859	.716	.618	.196	.962	.497	.	.385	.998	.437	.927	.335	.363	.515	.954	.615	.266	.073	.313	.088	.2
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30	30	22	22	25	[illegible]
Mn%	Pearson Correlation	-.230	.152	.150	.181	.421*	.210	-.165	1.000	.324	.823**	.192	.139	.498*	.301	.008	.463**	.363*	.327	.188	.220	-.0
	Sig. (2-tailed)	.222	.421	.428	.337	.020	.266	.385	.	.081	.000	.310	.463	.011	.106	.973	.010	.049	.137	.403	.291	.8
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30	30	22	22	25	[illegible]
Cu	Pearson Correlation	-.152	.993**	.992**	.156	.127	.094	.001	.324	1.000	.270	.377*	.187	.301	-.032	.115	.061	.147	-.158	.039	-.012	.0
	Sig. (2-tailed)	.421	.000	.000	.410	.505	.622	.998	.081	.	.150	.040	.322	.144	.866	.544	.749	.437	.486	.862	.958	.6
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30	30	22	22	25	[illegible]
Fe	Pearson Correlation	-.302	.028	.031	.145	.032	.085	-.147	.823**	.270	1.000	.086	.144	-.173	-.093	.099	.279	.024	.404	-.064	-.086	-.1
	Sig. (2-tailed)	.105	.884	.870	.444	.866	.618	.437	.000	.150	.	.654	.449	.409	.626	.601	.135	.902	.062	.780	.747	.3
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30	30	22	22	25	[illegible]
Zn	Pearson Correlation	-.045	.367*	.357	-.111	.161	.179	-.017	.192	.377*	.086	1.000	.110	.170	-.008	-.178	.231	.154	-.067	-.211	.185	-.0
	Sig. (2-tailed)	.814	.046	.053	.559	.396	.344	.927	.310	.040	.654	.	.563	.418	.965	.353	.219	.417	.768	.345	.361	.8
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30	30	22	22	25	[illegible]
Na %	Pearson Correlation	.085	-.114	-.114	.159	.697**	.856**	-.162	.139	.187	.144	.110	1.000	.142	-.051	-.025	.012	-.179	.188	-.048	.425*	-.1
	Sig. (2-tailed)	.656	.550	.549	.401	.000	.000	.335	.463	.322	.449	.563	.	.497	.788	.895	.951	.343	.403	.832	.034	.4
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30	30	22	22	25	[illegible]
Ec mS/cm	Pearson Correlation	-.100	.261	.251	.414*	.604**	.170	-.180	.498*	.301	-.173	.170	.142	1.000	.439*	-.038	.120	.459*	-.098	.258	.408	.2
	Sig. (2-tailed)	.635	.207	.226	.040	.001	.417	.363	.011	.144	.409	.418	.497	.	.028	.858	.567	.021	.735	.288	.074	.2
	N	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	18	18	20	[illegible]
WET SEASON BAP	Pearson Correlation	-.329	-.080	-.074	.149	.243	.080	-.124	.301	-.032	-.093	-.008	-.051	.439*	1.000	.182	.880**	.679**	.122	-.072	.053	[illegible]
	Sig. (2-tailed)	.078	.675	.696	.431	.196	.673	.515	.106	.866	.626	.965	.788	.028	.	.392	.000	.000	.587	.750	.800	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30	30	22	22	25	[illegible]
DRY SEASON II BAP	Pearson Correlation	-.123	.067	.092	.101	.058	-.111	.011	.008	.115	.099	-.178	-.025	-.038	.182	1.000	.052	-.244	.192	.005	.200	[illegible]
	Sig. (2-tailed)	.518	.723	.629	.594	.760	.559	.954	.973	.544	.601	.353	.895	.858	.392	.	.783	.194	.392	.984	.338	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30	30	22	22	25	[illegible]
SHORT RAIN BAP	Pearson Correlation	-.225	-.022	-.023	.053	.070	.108	-.098	.463**	.061	.279	.231	.012	.120	.880**	.052	1.000	.848**	.142	-.174	.108	[illegible]
	Sig. (2-tailed)	.232	.908	.903	.783	.713	.570	.615	.010	.749	.135	.219	.951	.567	.000	.783	.	.000	.526	.438	.614	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30	30	22	22	25	[illegible]
DRY SEASON I BAP	Pearson Correlation	-.218	.012	-.008	.057	.040	-.037	-.210	.363*	.147	.024	.154	-.179	.459*	.679**	-.244	.848**	1.000	-.241	.022	-.135	[illegible]
	Sig. (2-tailed)	.253	.949	.967	.766	.834	.846	.266	.049	.437	.902	.417	.343	.021	.000	.194	.000	.	.280	.923	.518	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30	30	22	22	25	[illegible]
Wet season EXP	Pearson Correlation	-.330	-.127	-.109	.330	.417	.255	.390	.327	-.158	.404	-.067	.188	-.098	.122	.192	.142	-.241	1.000	-.350	.134	[illegible]
	Sig. (2-tailed)	.133	.574	.628	.133	.053	.252	.073	.137	.486	.062	.768	.403	.735	.587	.392	.526	.280	.	.188	.574	[illegible]
	N	22	22	22	22	22	22	22	22	22	22	22	22	18	22	22	22	22	22	17	20	[illegible]
Dry season II EXP	Pearson Correlation	.379	-.061	-.118	-.282	.034	-.048	-.225	.188	.039	-.064	-.211	-.048	.258	-.072	.005	-.174	.022	-.350	1.000	.308	[illegible]
	Sig. (2-tailed)	.082	.718	.601	.204	.880	.833	.313	.403	.862	.780	.345	.832	.288	.750	.984	.438	.923	.188	.	.202	[illegible]
	N	22	22	22	22	22	22	22	22	22	22	22	22	18	22	22	22	22	17	22	19	[illegible]
Short rain season EXP	Pearson Correlation	.128	.033	-.001	-.045	.340	.339	-.350	.220	-.012	-.086	.185	.425*	.408	.053	.200	.108	-.135	.134	.308	1.000	[illegible]
	Sig. (2-tailed)	.549	.874	.997	.830	.098	.098	.088	.291	.958	.747	.361	.034	.074	.800	.338	.614	.518	.574	.202	.	[illegible]
	N	25	25	25	25	25	25	25	25	25	25	25	25	20	25	25	25	25	20	19	25	[illegible]
Dry season I EXP	Pearson Correlation	-.024	.013	.001	-.115	-.080	-.077	.224	-.025	.023	-.164	-.007	-.158	.221	.356	-.006	.251	.329	-.201	.406	-.099	1.0
	Sig. (2-tailed)	.903	.949	.913	.551	.843	.692	.243	.896	.905	.395	.969	.412	.300	.058	.985	.189	.082	.382	.087	.646	[illegible]
	N	29	29	29	29	29	29	29	29	29	29	29	29	24	29	29	29	29	21	21	24	[illegible]

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 4.5.7A: Correlation between water phosphorus and Water physico-chemical parameters

Correlations

		MEAN TRP	MEAN THP	MEAN TP	MEAN TDS	MEAN COND	MEAN WATER PH
MEAN TRP	Pearson Correlation	1.000	136	.775**	.595**	.695**	.862**
	Sig. (2-tailed)		.475	.000	.001	.000	.000
	N	30	30	30	30	30	30
MEAN THP	Pearson Correlation	.136	1.000	.263	.575**	.331	.103
	Sig. (2-tailed)	.475	.	.160	.001	.074	.589
	N	30	30	30	30	30	30
MEAN TP	Pearson Correlation	.775**	.263	1.000	.550**	.954**	.745**
	Sig. (2-tailed)	.000	.160	.	.002	.000	.000
	N	30	30	30	30	30	30
MEAN TDS	Pearson Correlation	.595**	.575**	.550**	1.000	.413*	.591**
	Sig. (2-tailed)	.001	.001	.002	.	.023	.001
	N	30	30	30	30	30	30
MEAN COND	Pearson Correlation	.695**	.331	.954**	.413*	1.000	.564**
	Sig. (2-tailed)	.000	.074	.000	.023	.	.001
	N	30	30	30	30	30	30
MEAN WATER PH	Pearson Correlation	.862**	.103	.745**	.591**	.564**	1.000
	Sig. (2-tailed)	.000	.589	.000	.001	.001	.
	N	30	30	30	30	30	30

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 4.5.8A: Correlation of sediment physico-chemical parameters and water physico-chemical parameters

Correlations

		Ph	N%	OC%	P%	K%	Ca%	Mg %	Mn%	Cu	Fe	Zn	Na %	Ec mS/cm	MEAN TDS	MEAN COND	MEAN WATER PH
Ph	Pearson Correlation	1.000	-.120	-.142	-.744**	-.076	.204	-.084	-.230	-.152	-.302	-.045	.085	-.100	.626**	-.699**	-.303
	Sig. (2-tailed)	.	.528	.454	.000	.690	.280	.659	.222	.421	.105	.814	.656	.635	.000	.000	.104
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30
N%	Pearson Correlation	-.120	1.000	.997**	-.023	-.061	.005	.069	.152	.693**	.028	.367*	-.114	.261	.697**	-.018	.046
	Sig. (2-tailed)	.528	.	.000	.903	.750	.978	.716	.421	.000	.884	.046	.550	.207	.000	.923	.811
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30
OC%	Pearson Correlation	-.142	.997**	1.000	.005	-.052	-.005	.095	.150	.692**	.031	.357	-.114	.251	.683**	.009	.049
	Sig. (2-tailed)	.454	.000	.	.978	.783	.979	.618	.428	.000	.870	.053	.549	.228	.000	.962	.798
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30
P%	Pearson Correlation	-.744**	-.023	.005	1.000	.218	-.120	.243	.181	.156	.145	-.111	.159	.414*	-.548**	.979**	.143
	Sig. (2-tailed)	.000	.903	.978	.	.247	.528	.196	.337	.410	.444	.559	.401	.040	.002	.000	.451
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30
K%	Pearson Correlation	-.076	-.061	-.052	.218	1.000	.737**	-.009	.421*	.127	.032	.161	.697**	.604**	-.098	.369*	.039
	Sig. (2-tailed)	.690	.750	.783	.247	.	.000	.962	.020	.505	.866	.396	.000	.001	.607	.045	.840
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30
Ca%	Pearson Correlation	.204	.005	-.005	-.120	.737**	1.000	-.129	.210	.094	.095	.179	.856**	.170	.147	.077	.101
	Sig. (2-tailed)	.280	.978	.979	.528	.000	.	.497	.266	.622	.618	.344	.000	.417	.439	.684	.597
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30
Mg %	Pearson Correlation	-.084	.069	.095	.243	-.009	-.129	1.000	-.165	.001	-.147	-.017	-.182	-.190	.011	.272	-.147
	Sig. (2-tailed)	.659	.716	.618	.196	.962	.497	.	.385	.998	.437	.927	.335	.363	.954	.145	.438
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30
Mn%	Pearson Correlation	-.230	.152	.150	.181	.421*	.210	-.165	1.000	.324	.623**	.192	.139	.498*	-.051	.215	.629**
	Sig. (2-tailed)	.222	.421	.428	.337	.020	.266	.385	.	.081	.000	.310	.463	.011	.790	.254	.000
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30
Cu	Pearson Correlation	-.152	.693**	.692**	.156	.127	.094	.001	.324	1.000	.270	.377*	.187	.301	.432*	.173	.290
	Sig. (2-tailed)	.421	.000	.000	.410	.505	.622	.998	.081	.	.150	.040	.322	.144	.017	.359	.121
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30
Fe	Pearson Correlation	-.302	.028	.031	.145	.032	.095	-.147	.623**	.270	1.000	.085	.144	-.173	-.198	.153	.999**
	Sig. (2-tailed)	.105	.884	.870	.444	.866	.618	.437	.000	.150	.	.654	.449	.409	.294	.418	.000
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30
Zn	Pearson Correlation	-.045	.367*	.357	-.111	.161	.179	-.017	.192	.377*	.085	1.000	.110	.170	.249	-.074	.118
	Sig. (2-tailed)	.814	.046	.053	.559	.396	.344	.927	.310	.040	.654	.	.563	.416	.185	.699	.534
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30
Na %	Pearson Correlation	.085	-.114	-.114	.159	.697**	.856**	-.182	.139	.187	.144	.110	1.000	.142	-.027	.321	.148
	Sig. (2-tailed)	.656	.550	.549	.401	.000	.000	.335	.463	.322	.449	.563	.	.497	.886	.084	.435
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30
Ec mS/cm	Pearson Correlation	-.100	.261	.251	.414*	.604**	.170	-.190	.498*	.301	-.173	.170	.142	1.000	.143	.361	-.162
	Sig. (2-tailed)	.635	.207	.228	.040	.001	.417	.363	.011	.144	.409	.416	.497	.	.494	.076	.439
	N	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
MEAN TDS	Pearson Correlation	.626**	.697**	.683**	-.548**	-.098	.147	.011	-.051	.432*	-.198	.249	-.027	.143	1.000	-.510**	-.185
	Sig. (2-tailed)	.000	.000	.000	.002	.607	.439	.954	.790	.017	.294	.185	.886	.494	.	.004	.328
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30
MEAN COND	Pearson Correlation	-.699**	-.018	.009	.979**	.369*	.077	.272	.215	.173	.153	-.074	.321	.361	-.510**	1.000	.152
	Sig. (2-tailed)	.000	.923	.962	.000	.045	.684	.145	.254	.359	.418	.699	.084	.076	.004	.	.422
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30
MEAN WATER PH	Pearson Correlation	-.303	.046	.049	.143	.039	.101	-.147	.629**	.290	.999**	.118	.148	-.162	-.185	.152	1.000
	Sig. (2-tailed)	.104	.811	.798	.451	.840	.597	.438	.000	.121	.000	.534	.435	.439	.328	.422	.
	N	30	30	30	30	30	30	30	30	30	30	30	30	25	30	30	30

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 4.5.9A: Correlation of phosphorus and pesticide residues in water

Correlations

		MEAN TRP	MEAN THP	MEAN TP	Aldrin	Dieldrin	p,p'-DDT	p,p'-DDE	p,p'-DDD	Endosulphan I	Endosulphan II	Endosulphan sulphate	Endrin	Endrinaldehyde	?-HCH	?-HCH	?-HCH	?-HCH	Methoxychlor	Heptachlor	Heptachlor epoxide
MEAN TRP	Pearson Correlation	1.000	.136	.775**	.558**	-.088	.409*	-.049	.038	-.014	.224	-.035	.065	-.136	.218	.169	.038	-.122	-.120	.043	.060
	Sig. (2-tailed)	.	.475	.000	.001	.643	.025	.799	.843	.940	.235	.854	.731	.474	.247	.372	.843	.520	.528	.820	.754
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
MEAN THP	Pearson Correlation	.136	1.000	.263	.222	.140	-.195	.253	-.015	.268	.020	.284	.012	.132	.113	.315	-.015	-.086	.042	.046	-.120
	Sig. (2-tailed)	.475	.	.160	.236	.460	.303	.177	.938	.152	.918	.128	.948	.486	.552	.090	.938	.617	.826	.808	.529
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
MEAN TP	Pearson Correlation	.775**	.263	1.000	.508**	.037	.282	-.018	.068	.118	.217	.141	.002	-.089	.244	.088	.068	-.055	-.108	.107	-.079
	Sig. (2-tailed)	.000	.160	.	.004	.845	.131	.923	.719	.533	.249	.459	.990	.641	.194	.655	.719	.772	.577	.572	.680
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Aldrin	Pearson Correlation	.558**	.222	.508**	1.000	-.187	-.019	-.085	-.258	-.127	.143	-.102	.059	.047	-.069	-.088	-.258	-.247	-.180	.055	-.085
	Sig. (2-tailed)	.001	.236	.004	.	.305	.919	.724	.154	.488	.436	.579	.748	.799	.707	.641	.154	.172	.323	.765	.645
	N	30	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Dieldrin	Pearson Correlation	-.088	.140	.037	-.187	1.000	.113	-.038	.528**	.211	.066	.381*	-.039	.005	.283	.045	.528**	.419*	-.037	.310	.234
	Sig. (2-tailed)	.643	.460	.845	.305	.	.537	.836	.002	.247	.719	.031	.831	.978	.117	.805	.002	.017	.840	.084	.197
	N	30	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
p,p'-DDT	Pearson Correlation	.409*	-.195	.282	-.019	.113	1.000	-.100	.408*	.279	.178	.114	.180	-.254	.738**	.241	.408*	.158	-.043	.266	.124
	Sig. (2-tailed)	.025	.303	.131	.919	.537	.	.585	.021	.122	.329	.533	.323	.161	.000	.186	.021	.388	.814	.142	.500
	N	30	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
p,p'-DDE	Pearson Correlation	-.049	.253	-.018	-.085	-.038	-.100	1.000	.042	.291	.067	.275	.024	-.038	.197	.001	.042	-.013	-.156	-.015	.314
	Sig. (2-tailed)	.799	.177	.923	.724	.836	.585	.	.819	.107	.835	.128	.895	.835	.280	.998	.819	.942	.393	.934	.080
	N	30	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
p,p'-DDD	Pearson Correlation	.038	-.015	.068	-.258	.528**	.408*	.042	1.000	.190	.126	.248	.182	-.118	.398*	.408*	1.000**	.239	-.080	.104	.452**
	Sig. (2-tailed)	.843	.938	.719	.154	.002	.021	.819	.	.298	.491	.171	.318	.521	.025	.021	.000	.188	.744	.570	.009
	N	30	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Endosulphan I	Pearson Correlation	-.014	.268	.118	-.127	.211	.279	.291	.190	1.000	.109	.430*	-.011	.241	.708**	.278	.190	.053	.198	.348	.221
	Sig. (2-tailed)	.940	.152	.533	.488	.247	.122	.107	.298	.	.553	.014	.950	.183	.000	.123	.298	.774	.277	.051	.224
	N	30	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Endosulphan II	Pearson Correlation	.224	.020	.217	.143	.066	.178	.067	.126	.109	1.000	.048	.024	.057	.151	-.051	.126	.169	-.103	.404*	.360*
	Sig. (2-tailed)	.235	.918	.249	.436	.719	.329	.835	.491	.553	.	.793	.898	.756	.408	.781	.491	.356	.575	.022	.043
	N	30	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Endosulphan sulphate	Pearson Correlation	-.035	.284	.141	-.102	.381*	.114	.275	.248	.430*	.048	1.000	.011	.004	.432*	.045	.248	.178	-.120	.380*	.163
	Sig. (2-tailed)	.854	.128	.459	.579	.031	.533	.128	.171	.014	.793	.	.953	.981	.014	.807	.171	.334	.515	.032	.374
	N	30	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Endrin	Pearson Correlation	.065	.012	.002	.059	-.039	.180	.024	.182	-.011	.024	.011	1.000	.118	.022	-.080	.182	-.063	-.129	-.152	.110
	Sig. (2-tailed)	.731	.948	.990	.748	.831	.323	.895	.318	.950	.898	.953	.	.527	.908	.663	.318	.774	.481	.407	.546
	N	30	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Endrinaldehyde	Pearson Correlation	-.136	.132	-.089	.047	.005	-.254	-.038	-.118	.241	.057	.004	.118	1.000	-.065	-.088	-.118	-.252	.387*	-.029	.075
	Sig. (2-tailed)	.474	.486	.641	.799	.978	.161	.835	.521	.183	.756	.981	.527	.	.722	.633	.521	.165	.028	.876	.683
	N	30	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
?-HCH	Pearson Correlation	.218	.113	.244	-.069	.283	.738**	.197	.398*	.708**	.151	.432*	.022	-.065	1.000	.303	.398*	.236	.046	.560**	.211
	Sig. (2-tailed)	.247	.552	.194	.707	.117	.000	.280	.025	.000	.408	.014	.908	.722	.	.092	.025	.193	.803	.001	.246
	N	30	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
?-HCH	Pearson Correlation	.169	.315	.088	-.088	.045	.241	.001	.408*	.278	-.051	.045	-.080	-.088	.303	1.000	.408*	-.097	-.003	-.095	.003
	Sig. (2-tailed)	.372	.090	.655	.641	.805	.186	.998	.021	.123	.781	.807	.663	.633	.092	.	.021	.599	.989	.603	.987
	N	30	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
?-HCH	Pearson Correlation	.038	-.015	.068	-.258	.528**	.408*	.042	1.000**	.190	.126	.248	.182	-.118	.398*	.408*	1.000	.239	-.080	.104	.452**
	Sig. (2-tailed)	.843	.938	.719	.154	.002	.021	.819	.000	.298	.491	.171	.318	.521	.025	.021	.	.188	.744	.570	.009
	N	30	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
?-HCH	Pearson Correlation	-.122	-.086	-.055	-.247	.419*	.158	-.013	.239	.053	.169	.178	-.063	-.252	.236	-.097	.239	1.000	.104	.546**	.504**
	Sig. (2-tailed)	.520	.617	.772	.172	.017	.388	.942	.188	.774	.356	.334	.774	.165	.193	.599	.188	.	.570	.001	.003
	N	30	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Methoxychlor	Pearson Correlation	-.120	.042	-.108	-.180	-.037	-.043	-.156	-.080	.198	-.103	-.120	-.129	.387*	.046	-.003	-.080	.104	1.000	.128	.065
	Sig. (2-tailed)	.528	.826	.577	.323	.840	.814	.393	.744	.277	.575	.515	.481	.028	.803	.989	.744	.570	.	.483	.765
	N	30	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Heptachlor	Pearson Correlation	.043	.046	.107	.055	.310	.266	-.015	.104	.348	.404*	.380*	-.152	-.029	.560**	-.095	.104	.546**	.128	1.000	.375*
	Sig. (2-tailed)	.820	.808	.572	.765	.084	.142	.934	.570	.051	.022	.032	.407	.876	.001	.603	.570	.001	.483	.	.034
	N	30	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Heptachlor epoxide	Pearson Correlation	.060	-.120	-.079	-.085	.234	.124	.314	.452**	.221	.360*	.163	.110	.075	.211	.003	.452**	.504**	.065	.375*	1.000
	Sig. (2-tailed)	.754	.529	.680	.645	.197	.500	.080	.009	.224	.043	.374	.546	.683	.246	.987	.009	.003	.765	.034	.
	N	30	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 4.5.10A: Correlation of phosphorus in sediments and pesticide residues in water

Correlations

		BAP	EXP	Aldrin	Dieldrin	p,p'-DDT	p,p'-DDE	p,p'-DDD	Endosulphan I	Endosulphan II	Endosulphan sulphate	Endrin	Endrinaldehyde	?-HCH	?-HCH	?-HCH	?-HCH	Methoxychlor	Heptachlor	Heptachlor epoxide
BAP	Pearson Correlation	1.000	-.015	.222	.040	.291	-.030	.273	.262	.579**	.170	.004	-.006	.248	.103	.273	.011	-.279	.236	.198
	Sig. (2-tailed)	.	.936	.239	.835	.119	.875	.144	.162	.001	.368	.983	.973	.186	.587	.144	.955	.135	.209	.294
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
EXP	Pearson Correlation	-.015	1.000	.017	-.004	-.046	.482**	-.101	.084	-.057	.213	.015	-.262	.117	-.046	-.101	.350	-.100	-.051	.053
	Sig. (2-tailed)	.936	.	.930	.982	.811	.007	.596	.658	.764	.258	.938	.162	.539	.810	.596	.058	.601	.790	.783
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Aldrin	Pearson Correlation	.222	.017	1.000	-.187	-.019	-.065	-.258	-.127	.143	-.102	.059	.047	-.069	-.086	-.258	-.247	-.180	.055	-.085
	Sig. (2-tailed)	.239	.930	.	.305	.919	.724	.154	.488	.436	.579	.748	.799	.707	.641	.154	.172	.323	.765	.645
	N	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Dieldrin	Pearson Correlation	.040	-.004	-.187	1.000	.113	-.038	.528**	.211	.068	.381*	-.039	.005	.283	.045	.528**	.419*	-.037	.310	.234
	Sig. (2-tailed)	.835	.982	.305	.	.537	.838	.002	.247	.719	.031	.831	.978	.117	.805	.002	.017	.840	.084	.197
	N	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
p,p'-DDT	Pearson Correlation	.291	-.046	-.019	.113	1.000	-.100	.408*	.279	.178	.114	.180	-.254	.738**	.241	.408*	.158	-.043	.266	.124
	Sig. (2-tailed)	.119	.811	.919	.537	.	.585	.021	.122	.329	.533	.323	.161	.000	.185	.021	.389	.814	.142	.500
	N	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
p,p'-DDE	Pearson Correlation	-.030	.482**	-.065	-.038	-.100	1.000	.042	.291	.087	.275	.024	-.038	.197	.001	.042	-.013	-.156	-.015	.314
	Sig. (2-tailed)	.875	.007	.724	.838	.585	.	.819	.107	.635	.126	.895	.835	.280	.996	.819	.942	.393	.934	.080
	N	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
p,p'-DDD	Pearson Correlation	.273	-.101	-.258	.528**	.408*	.042	1.000	.190	.128	.248	.182	-.118	.396*	.406*	1.000**	.239	-.060	.104	.452**
	Sig. (2-tailed)	.144	.596	.154	.002	.021	.819	.	.298	.491	.171	.318	.521	.025	.021	.000	.188	.744	.570	.009
	N	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Endosulphan I	Pearson Correlation	.262	.084	-.127	.211	.279	.291	.190	1.000	.109	.430*	-.011	.241	.708**	.278	.190	.053	.198	.348	.221
	Sig. (2-tailed)	.162	.658	.488	.247	.122	.107	.298	.	.563	.014	.950	.183	.000	.123	.298	.774	.277	.051	.224
	N	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Endosulphan II	Pearson Correlation	.579**	-.057	.143	.068	.178	.087	.128	.109	1.000	.048	.024	.067	.151	-.051	.128	.169	-.103	.404*	.360*
	Sig. (2-tailed)	.001	.764	.436	.719	.329	.635	.491	.563	.	.793	.898	.756	.408	.781	.491	.355	.575	.022	.043
	N	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Endosulphan sulphate	Pearson Correlation	.170	.213	-.102	.381*	.114	.275	.248	.430*	.048	1.000	.011	.004	.432*	.045	.248	.178	-.120	.380*	.163
	Sig. (2-tailed)	.368	.258	.579	.031	.533	.126	.171	.014	.793	.	.953	.981	.014	.807	.171	.334	.515	.032	.374
	N	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Endrin	Pearson Correlation	.004	.015	.059	-.039	.180	.024	.182	-.011	.024	.011	1.000	.116	.022	-.080	.182	-.053	-.129	-.152	.110
	Sig. (2-tailed)	.983	.938	.748	.831	.323	.895	.318	.950	.898	.953	.	.527	.908	.663	.318	.774	.481	.407	.546
	N	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Endrinaldehyde	Pearson Correlation	-.006	-.262	.047	.005	-.254	-.038	-.118	.241	.067	.004	.116	1.000	-.065	-.088	-.118	-.252	.367*	-.029	.075
	Sig. (2-tailed)	.973	.162	.799	.978	.161	.835	.521	.183	.756	.981	.527	.	.722	.633	.521	.165	.039	.876	.683
	N	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
?-HCH	Pearson Correlation	.248	.117	-.069	.283	.738**	.197	.396*	.706**	.151	.432*	.022	-.065	1.000	.303	.396*	.236	.046	.569**	.211
	Sig. (2-tailed)	.186	.539	.707	.117	.000	.280	.025	.000	.408	.014	.908	.722	.	.092	.025	.193	.803	.001	.246
	N	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
?-HCH	Pearson Correlation	.103	-.046	-.086	.045	.241	.001	.406*	.278	-.051	.045	-.080	-.088	.303	1.000	.406*	-.097	-.003	-.095	.003
	Sig. (2-tailed)	.587	.810	.641	.805	.185	.996	.021	.123	.781	.807	.663	.633	.092	.	.021	.599	.989	.603	.987
	N	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
?-HCH	Pearson Correlation	.273	-.101	-.258	.528**	.408*	.042	1.000**	.190	.128	.248	.182	-.118	.396*	.406*	1.000	.239	-.060	.104	.452**
	Sig. (2-tailed)	.144	.596	.154	.002	.021	.819	.000	.298	.491	.171	.318	.521	.025	.021	.	.188	.744	.570	.009
	N	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
?-HCH	Pearson Correlation	.011	.350	-.247	.419*	.158	-.013	.239	.053	.169	.178	-.053	-.252	.236	-.097	.239	1.000	.104	.546**	.504**
	Sig. (2-tailed)	.955	.058	.172	.017	.389	.942	.188	.774	.355	.334	.774	.165	.193	.599	.188	.	.570	.001	.003
	N	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Methoxychlor	Pearson Correlation	-.279	-.100	-.180	-.037	-.043	-.156	-.060	.198	-.103	-.120	-.129	.367*	.046	-.003	-.060	.104	1.000	.128	.056
	Sig. (2-tailed)	.135	.601	.323	.840	.814	.393	.744	.277	.575	.515	.481	.039	.803	.989	.744	.570	.	.483	.765
	N	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Heptachlor	Pearson Correlation	.236	-.051	.055	.310	.266	-.015	.104	.348	.404*	.380*	-.152	-.029	.569**	-.095	.104	.546**	.128	1.000	.375*
	Sig. (2-tailed)	.209	.790	.765	.084	.142	.934	.570	.051	.022	.032	.407	.876	.001	.603	.570	.001	.483	.	.034
	N	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Heptachlor epoxide	Pearson Correlation	.198	.053	-.085	.234	.124	.314	.452**	.221	.360*	.163	.110	.075	.211	.003	.452**	.504**	.056	.375*	1.000
	Sig. (2-tailed)	.294	.783	.645	.197	.500	.080	.009	.224	.043	.374	.546	.683	.246	.987	.009	.003	.765	.034	.
	N	30	30	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 4.5.11A: Correlation of phosphorus in soil and pesticide residues in water

Correlations

		SAP	Aldrin	Dieldrin	p,p'-DDT	p,p'-DDE	p,p'-DDD	Endosulphan I	Endosulphan II	Endosulphan sulphate	Endrin	Endrinaldehyde	?-HCH	?-HCH	?-HCH	?-HCH	Methoxychlor	Heptachlor	Heptachlor epoxide
SAP	Pearson Correlation	1.000	.216	-.265	-.141	.057	-.326	-.192	-.047	-.350	.011	.231	-.144	-.203	-.326	-.020	.307	.253	.201
	Sig. (2-tailed)	.	.252	.157	.458	.766	.078	.309	.806	.058	.953	.218	.449	.281	.078	.918	.099	.178	.287
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Aldrin	Pearson Correlation	.216	1.000	-.177	-.022	-.063	-.263	-.167	.142	-.089	.051	.048	-.065	-.084	-.263	-.240	-.187	.083	-.090
	Sig. (2-tailed)	.252	.	.348	.906	.740	.160	.379	.455	.639	.788	.802	.732	.661	.160	.201	.323	.662	.637
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Dieldrin	Pearson Correlation	-.265	-.177	1.000	.140	-.152	.573**	.104	.072	.258	.007	-.011	.209	.008	.573**	.390*	-.012	.223	.245
	Sig. (2-tailed)	.157	.348	.	.461	.423	.001	.586	.707	.169	.972	.954	.268	.974	.001	.033	.949	.236	.192
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
p,p'-DDT	Pearson Correlation	-.141	-.022	.140	1.000	-.095	.408*	.468**	.180	.195	.174	-.256	.933**	.255	.408*	.172	-.048	.326	.130
	Sig. (2-tailed)	.458	.906	.461	.	.619	.025	.009	.341	.302	.358	.173	.000	.173	.025	.364	.800	.079	.493
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
p,p'-DDE	Pearson Correlation	.057	-.063	-.152	-.095	1.000	.022	-.134	.045	.045	.061	-.151	-.115	-.126	.022	-.025	-.173	-.287	.247
	Sig. (2-tailed)	.766	.740	.423	.619	.	.907	.480	.812	.813	.670	.426	.544	.506	.907	.895	.360	.124	.189
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
p,p'-DDD	Pearson Correlation	-.326	-.263	.573**	.408*	.022	1.000	.242	.117	.332	.181	-.135	.460*	.407*	1.000**	.261	-.067	.111	.448*
	Sig. (2-tailed)	.078	.160	.001	.025	.907	.	.198	.537	.073	.339	.478	.011	.026	.000	.164	.725	.559	.013
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endosulphan I	Pearson Correlation	-.192	-.167	.104	.468**	-.134	.242	1.000	.059	.075	.097	.162	.509**	.174	.242	.049	.322	.037	.101
	Sig. (2-tailed)	.309	.379	.586	.009	.480	.198	.	.757	.694	.610	.391	.004	.358	.198	.798	.083	.847	.597
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endosulphan II	Pearson Correlation	-.047	.142	.072	.180	.045	.117	.059	1.000	.035	.026	.035	.124	-.075	.117	.187	-.109	.425*	.344
	Sig. (2-tailed)	.806	.455	.707	.341	.812	.537	.757	.	.855	.892	.853	.515	.693	.537	.323	.565	.019	.063
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endosulphan sulphate	Pearson Correlation	-.350	-.089	.258	.195	.045	.332	.075	.035	1.000	.130	-.082	.189	-.087	.332	.117	-.102	.146	.131
	Sig. (2-tailed)	.058	.639	.169	.302	.813	.073	.694	.855	.	.493	.668	.318	.648	.073	.537	.590	.440	.490
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endrin	Pearson Correlation	.011	.051	.007	.174	.061	.181	.097	.026	.130	1.000	.130	.102	-.062	.181	-.030	-.142	-.106	.123
	Sig. (2-tailed)	.953	.788	.972	.358	.670	.339	.610	.892	.493	.	.494	.592	.746	.339	.874	.454	.577	.517
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endrinaldehyde	Pearson Correlation	.231	.048	-.011	-.256	-.151	-.135	.162	.035	-.082	.130	1.000	-.208	-.135	-.135	-.251	.393*	-.110	.029
	Sig. (2-tailed)	.218	.802	.954	.173	.426	.478	.391	.853	.668	.494	.	.271	.478	.478	.181	.032	.563	.880
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	-.144	-.065	.209	.933**	-.115	.460*	.509**	.124	.189	.102	-.208	1.000	.221	.460*	.265	.072	.433*	.121
	Sig. (2-tailed)	.449	.732	.268	.000	.544	.011	.004	.515	.318	.592	.271	.	.240	.011	.157	.704	.017	.524
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	-.203	-.084	.008	.255	-.126	.407*	.174	-.075	-.087	-.062	-.135	.221	1.000	.407*	-.105	.000	-.218	-.047
	Sig. (2-tailed)	.281	.661	.974	.173	.506	.026	.358	.693	.648	.746	.478	.240	.	.026	.580	1.000	.246	.804
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	-.326	-.263	.573**	.408*	.022	1.000**	.242	.117	.332	.181	-.135	.460*	.407*	1.000	.261	-.067	.111	.448*
	Sig. (2-tailed)	.078	.160	.001	.025	.907	.000	.198	.537	.073	.339	.478	.011	.026	.	.164	.725	.559	.013
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	-.020	-.240	.390*	.172	-.025	.261	.049	.187	.117	-.030	-.251	.265	-.105	.261	1.000	.128	.578**	.551**
	Sig. (2-tailed)	.918	.201	.033	.364	.895	.164	.798	.323	.537	.874	.181	.157	.580	.164	.	.508	.001	.002
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Methoxychlor	Pearson Correlation	.307	-.187	-.012	-.048	-.173	-.067	.322	-.109	-.102	-.142	.393*	.072	.000	-.067	.128	1.000	.168	.049
	Sig. (2-tailed)	.099	.323	.949	.800	.360	.725	.083	.565	.590	.454	.032	.704	1.000	.725	.508	.	.374	.798
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Heptachlor	Pearson Correlation	.253	.083	.223	.326	-.287	.111	.037	.425*	.146	-.106	-.110	.433*	-.218	.111	.578**	.168	1.000	.352
	Sig. (2-tailed)	.178	.662	.236	.079	.124	.559	.847	.019	.440	.577	.563	.017	.246	.559	.001	.374	.	.057
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Heptachlor epoxide	Pearson Correlation	.201	-.090	.245	.130	.247	.448*	.101	.344	.131	.123	.029	.121	-.047	.448*	.551**	.049	.352	1.000
	Sig. (2-tailed)	.287	.637	.192	.493	.189	.013	.597	.063	.490	.517	.880	.524	.804	.013	.002	.798	.057	.
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 4.5.12A: Correlation of phosphorus and pesticide residues in soil

Correlations

		Aldrin	Dieldrin	p,p'-DDT	p,p'-DDE	p,p'-DDD	Endosulphan I	Endosulphan II	Endosulphan sulphate	Endrin	Endrinaldehyde	?-HCH	?-HCH	?-HCH	?-HCH	Methoxychlor	Heptachlor	Heptachlor epoxide	MEAN SAP
Aldrin	Pearson Correlation	1.000	-.085	.111	-.177	.184	.325	.244	.364*	-.126	.529**	-.087	-.073	-.138	.062	-.171	-.096	.621**	-.095
	Sig. (2-tailed)	.	.654	.567	.350	.330	.079	.194	.048	.507	.003	.647	.702	.467	.746	.366	.614	.000	.619
	N	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Dieldrin	Pearson Correlation	-.085	1.000	.182	.918**	.115	.577**	.112	.546**	.972**	.366*	.978**	.866**	.864**	.148	.809**	.928**	-.017	.914**
	Sig. (2-tailed)	.654	.	.344	.000	.544	.001	.554	.002	.000	.047	.000	.000	.000	.434	.000	.000	.929	.000
	N	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
p,p'-DDT	Pearson Correlation	.111	.182	1.000	.218	.402*	.258	.201	.436*	.153	.217	.129	.107	.232	.178	.178	.149	.359	.188
	Sig. (2-tailed)	.567	.344	.	.256	.030	.178	.296	.018	.428	.259	.505	.581	.226	.357	.360	.441	.056	.330
	N	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29
p,p'-DDE	Pearson Correlation	-.177	.918**	.218	1.000	.102	.489**	.049	.378*	.945**	.322	.906**	.757**	.708**	-.023	.773**	.936**	-.113	.897**
	Sig. (2-tailed)	.350	.000	.256	.	.593	.006	.798	.039	.000	.083	.000	.000	.000	.905	.000	.000	.553	.000
	N	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
p,p'-DDD	Pearson Correlation	.184	.115	.402*	.102	1.000	.392*	.222	.439*	.011	.186	.107	.151	.270	.695**	.269	.159	.255	.232
	Sig. (2-tailed)	.330	.544	.030	.593	.	.032	.238	.015	.955	.325	.575	.424	.149	.000	.150	.401	.174	.217
	N	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endosulphan I	Pearson Correlation	.325	.577**	.258	.489**	.392*	1.000	.217	.632**	.480**	.298	.625**	.609**	.578**	.441*	.381*	.492**	.161	.474**
	Sig. (2-tailed)	.079	.001	.178	.006	.032	.	.248	.000	.007	.109	.000	.000	.001	.015	.038	.006	.397	.008
	N	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endosulphan II	Pearson Correlation	.244	.112	.201	.049	.222	.217	1.000	.322	.073	.659**	.067	.260	.367*	.145	.125	-.012	.595**	.087
	Sig. (2-tailed)	.194	.554	.296	.798	.238	.248	.	.083	.700	.000	.727	.165	.046	.443	.510	.948	.001	.647
	N	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endosulphan sulphate	Pearson Correlation	.364*	.546**	.436*	.378*	.439*	.632**	.322	1.000	.403*	.460*	.474**	.563**	.531**	.606**	.290	.333	.457*	.357
	Sig. (2-tailed)	.048	.002	.018	.039	.015	.000	.083	.	.027	.011	.008	.001	.003	.000	.120	.072	.011	.052
	N	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endrin	Pearson Correlation	-.126	.972**	.153	.945**	.011	.480**	.073	.403*	1.000	.362*	.963**	.799**	.777**	-.064	.829**	.951**	-.079	.933**
	Sig. (2-tailed)	.507	.000	.428	.000	.955	.007	.700	.027	.	.050	.000	.000	.000	.738	.000	.000	.677	.000
	N	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endrinaldehyde	Pearson Correlation	.529**	.366*	.217	.322	.186	.298	.659**	.460*	.362*	1.000	.304	.410*	.324	-.030	.285	.334	.687**	.370*
	Sig. (2-tailed)	.003	.047	.259	.083	.325	.109	.000	.011	.050	.	.102	.024	.081	.877	.127	.071	.000	.044
	N	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	-.087	.978**	.129	.906**	.107	.625**	.067	.474**	.963**	.304	1.000	.863**	.851**	.122	.803**	.916**	-.073	.901**
	Sig. (2-tailed)	.647	.000	.505	.000	.575	.000	.727	.008	.000	.102	.	.000	.000	.521	.000	.000	.700	.000
	N	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	-.073	.866**	.107	.757**	.151	.609**	.260	.563**	.799**	.410*	.863**	1.000	.840**	.266	.657**	.736**	.145	.742**
	Sig. (2-tailed)	.702	.000	.581	.000	.424	.000	.165	.001	.000	.024	.000	.	.000	.155	.000	.000	.446	.000
	N	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	-.138	.864**	.232	.708**	.270	.578**	.367*	.531**	.777**	.324	.851**	.840**	1.000	.397*	.747**	.730**	.049	.773**
	Sig. (2-tailed)	.467	.000	.226	.000	.149	.001	.046	.003	.000	.081	.000	.000	.	.030	.000	.000	.798	.000
	N	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	.062	.148	.178	-.023	.695**	.441*	.145	.606**	-.064	-.030	.122	.266	.397*	1.000	.074	-.018	.156	.034
	Sig. (2-tailed)	.746	.434	.357	.905	.000	.015	.443	.000	.738	.877	.521	.155	.030	.	.697	.934	.409	.858
	N	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Methoxychlor	Pearson Correlation	-.171	.809**	.178	.773**	.269	.381*	.125	.290	.829**	.285	.803**	.657**	.747**	.074	1.000	.846**	-.058	.950**
	Sig. (2-tailed)	.366	.000	.360	.000	.150	.038	.510	.120	.000	.127	.000	.000	.000	.697	.	.000	.759	.000
	N	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Heptachlor	Pearson Correlation	-.096	.928**	.149	.936**	.159	.492**	-.012	.333	.951**	.334	.916**	.736**	.730**	-.018	.846**	1.000	-.117	.967**
	Sig. (2-tailed)	.614	.000	.441	.000	.401	.006	.948	.072	.000	.071	.000	.000	.000	.934	.000	.	.538	.000
	N	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Heptachlor epoxide	Pearson Correlation	.621**	-.017	.359	-.113	.255	.161	.595**	.457*	-.079	.687**	-.073	.145	.049	.156	-.058	-.117	1.000	-.032
	Sig. (2-tailed)	.000	.929	.056	.553	.174	.397	.001	.011	.677	.000	.700	.446	.798	.409	.759	.538	.	.867
	N	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
MEAN SAP	Pearson Correlation	-.095	.914**	.188	.897**	.232	.474**	.087	.357	.933**	.370*	.901**	.742**	.773**	.034	.950**	.967**	-.032	1.000
	Sig. (2-tailed)	.619	.000	.330	.000	.217	.008	.647	.052	.000	.044	.000	.000	.000	.858	.000	.000	.867	.
	N	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30

* Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4.5.13A: Correlation of phosphorus in water and pesticide residues in soil

Correlations

		MEAN TRP	MEAN THP	MEAN TP	Aldrin	Dieldrin	p,p'-DDT	p,p'-DDE	p,p'-DDD	Endosulphan I	Endosulphan II	Endosulphan sulphate	Endrin	Endrinaldehyde	?-HCH	?-HCH	?-HCH	?-HCH	Methoxychlor	Heptachlor	Heptachlor epoxide
MEAN TRP	Pearson Correlation	1.000	.136	.774**	-.029	-.086	.556**	.004	.205	.048	.115	-.065	-.070	-.045	-.093	-.094	.063	-.072	.038	-.012	.102
	Sig. (2-tailed)	.	.473	.000	.881	.653	.002	.984	.277	.799	.545	.734	.713	.812	.623	.622	.741	.704	.842	.948	.593
	N	30	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
MEAN THP	Pearson Correlation	.136	1.000	.263	-.085	.421*	.089	.380*	-.105	-.037	.028	.231	.447*	.070	.375*	.265	.324	-.077	.298	.345	-.117
	Sig. (2-tailed)	.473	.	.160	.655	.020	.646	.038	.581	.846	.884	.220	.013	.711	.041	.156	.080	.684	.110	.062	.538
	N	30	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
MEAN TP	Pearson Correlation	.774**	.263	1.000	-.058	-.008	.450*	.083	.312	.020	.047	-.041	.050	-.031	-.014	-.184	.044	-.108	.218	.119	-.148
	Sig. (2-tailed)	.000	.160	.	.760	.967	.014	.661	.093	.917	.805	.830	.794	.869	.941	.387	.818	.578	.247	.532	.440
	N	30	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Aldrin	Pearson Correlation	-.029	-.085	-.058	1.000	-.085	.111	-.177	.184	.325	.244	.364*	-.126	.529**	-.087	-.073	-.138	.062	-.171	-.098	.621**
	Sig. (2-tailed)	.881	.655	.760	.	.654	.567	.350	.330	.079	.194	.048	.507	.003	.647	.702	.467	.746	.366	.614	.000
	N	30	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Dieldrin	Pearson Correlation	-.086	.421*	-.008	-.085	1.000	.182	.918**	.115	.577**	.112	.546**	.972**	.366*	.978**	.866**	.864**	.148	.809**	.928**	-.017
	Sig. (2-tailed)	.653	.020	.967	.654	.	.344	.000	.544	.001	.554	.002	.000	.047	.000	.000	.000	.434	.000	.000	.929
	N	30	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
p,p'-DDT	Pearson Correlation	.556**	.089	.450*	.111	.182	1.000	.218	.402*	.258	.201	.436*	.153	.217	.129	.107	.232	.178	.176	.149	.359
	Sig. (2-tailed)	.002	.646	.014	.567	.344	.	.258	.030	.176	.296	.018	.428	.259	.505	.581	.226	.357	.360	.441	.056
	N	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29
p,p'-DDE	Pearson Correlation	.004	.380*	.083	-.177	.918**	.218	1.000	.102	.489**	.049	.378*	.945**	.322	.906**	.757**	.706**	-.023	.773**	.936**	-.113
	Sig. (2-tailed)	.984	.038	.661	.350	.000	.258	.	.593	.008	.798	.039	.000	.083	.000	.000	.000	.905	.000	.000	.553
	N	30	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
p,p'-DDD	Pearson Correlation	.205	-.105	.312	.184	.115	.402*	.102	1.000	.392*	.222	.439*	.011	.186	.108	.151	.270	.695**	.269	.159	.256
	Sig. (2-tailed)	.277	.581	.093	.330	.544	.030	.593	.	.032	.238	.015	.955	.325	.575	.424	.149	.000	.150	.401	.174
	N	30	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endosulphan I	Pearson Correlation	.048	-.037	.020	.325	.577**	.258	.489**	.392*	1.000	.217	.632**	.480**	.298	.625**	.809**	.578**	.441*	.381*	.492**	.161
	Sig. (2-tailed)	.799	.846	.917	.079	.001	.176	.008	.032	.	.248	.000	.007	.109	.000	.000	.001	.015	.038	.008	.397
	N	30	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endosulphan II	Pearson Correlation	.115	.028	.047	.244	.112	.201	.049	.222	.217	1.000	.322	.073	.659**	.067	.260	.367*	.145	.125	-.012	.595**
	Sig. (2-tailed)	.545	.884	.805	.194	.554	.296	.798	.238	.248	.	.083	.700	.000	.727	.165	.046	.443	.510	.948	.001
	N	30	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endosulphan sulphate	Pearson Correlation	-.065	.231	-.041	.364*	.546**	.436*	.378*	.439*	.632**	.322	1.000	.403*	.460*	.474**	.563**	.531**	.606**	.290	.333	.457*
	Sig. (2-tailed)	.734	.220	.830	.048	.002	.018	.039	.015	.000	.083	.	.027	.011	.008	.001	.003	.000	.120	.072	.011
	N	30	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endrin	Pearson Correlation	-.070	.447*	.050	-.126	.972**	.153	.945**	.011	.480**	.073	.403*	1.000	.362*	.963**	.799**	.777**	-.064	.829**	.951**	-.079
	Sig. (2-tailed)	.713	.013	.794	.507	.000	.428	.000	.955	.007	.700	.027	.	.050	.000	.000	.000	.738	.000	.000	.677
	N	30	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endrinaldehyde	Pearson Correlation	-.045	.070	-.031	.529**	.366*	.217	.322	.186	.298	.659**	.460*	.362*	1.000	.304	.410*	.324	-.030	.285	.334	.687**
	Sig. (2-tailed)	.812	.711	.869	.003	.047	.259	.083	.325	.109	.000	.011	.050	.	.102	.024	.081	.877	.127	.071	.000
	N	30	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	-.093	.375*	-.014	-.087	.978**	.129	.906**	.108	.625**	.067	.474**	.963**	.304	1.000	.863**	.851**	.122	.803**	.916**	-.073
	Sig. (2-tailed)	.623	.041	.941	.647	.000	.505	.000	.575	.000	.727	.008	.000	.102	.	.000	.000	.521	.000	.000	.700
	N	30	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	-.094	.265	-.184	-.073	.866**	.107	.757**	.151	.809**	.260	.563**	.799**	.410*	.863**	1.000	.840**	.268	.657**	.736**	.145
	Sig. (2-tailed)	.622	.156	.387	.702	.000	.581	.000	.424	.000	.165	.001	.000	.024	.000	.	.000	.155	.000	.000	.446
	N	30	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	.063	.324	.044	-.138	.864**	.232	.706**	.270	.578**	.367*	.531**	.777**	.324	.851**	.840**	1.000	.397*	.747**	.730**	.049
	Sig. (2-tailed)	.741	.080	.818	.467	.000	.226	.000	.149	.001	.046	.003	.000	.081	.000	.000	.	.030	.000	.000	.798
	N	30	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	-.072	-.077	-.108	.062	.148	.178	-.023	.695**	.441*	.145	.606**	-.064	-.030	.122	.268	.397*	1.000	.074	-.016	.156
	Sig. (2-tailed)	.704	.684	.578	.746	.434	.357	.905	.000	.015	.443	.000	.738	.877	.521	.155	.030	.	.697	.934	.409
	N	30	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Methoxychlor	Pearson Correlation	.038	.298	.218	-.171	.809**	.176	.773**	.269	.381*	.125	.290	.829**	.285	.803**	.657**	.747**	.074	1.000	.846**	-.058
	Sig. (2-tailed)	.842	.110	.247	.366	.000	.360	.000	.150	.038	.510	.120	.000	.127	.000	.000	.000	.697	.	.000	.759
	N	30	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Heptachlor	Pearson Correlation	-.012	.345	.119	-.098	.928**	.149	.936**	.159	.492**	-.012	.333	.951**	.334	.916**	.736**	.730**	-.016	.846**	1.000	-.117
	Sig. (2-tailed)	.948	.062	.532	.614	.000	.441	.000	.401	.008	.948	.072	.000	.071	.000	.000	.000	.934	.000	.	.538
	N	30	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Heptachlor epoxide	Pearson Correlation	.102	-.117	-.148	.621**	-.017	.359	-.113	.256	.161	.595**	.457*	-.079	.687**	-.073	.145	.049	.156	-.058	-.117	1.000
	Sig. (2-tailed)	.593	.538	.440	.000	.929	.056	.553	.174	.397	.001	.011	.677	.000	.700	.446	.798	.409	.759	.538	.
	N	30	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 4.5.14A: Correlation of phosphorus in sediments and pesticide residues in soil

Correlations

		BAP	EXP	Aldrin	Dieldrin	p,p'-DDT	p,p'-DDE	p,p'-DDD	Endosulphan I	Endosulphan II	Endosulphan sulphate	Endrin	Endrinaldehyde	?-HCH	?-HCH	?-HCH	?-HCH	Methoxychlor	Heptachlor	Heptachlor epoxide
BAP	Pearson Correlation	1.000	-.015	-.140	.082	.443*	.135	.128	-.079	.007	.029	.135	-.024	.051	-.106	.052	-.138	.210	.147	-.111
	Sig. (2-tailed)	.	.935	.461	.667	.016	.478	.501	.680	.971	.880	.477	.898	.789	.578	.787	.468	.265	.437	.560
	N	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
EXP	Pearson Correlation	-.015	1.000	-.001	.250	-.002	.079	.212	.321	-.115	.334	.162	-.117	.237	.225	.285	.354	.206	.170	-.139
	Sig. (2-tailed)	.935	.	.994	.183	.992	.680	.261	.083	.546	.072	.393	.540	.207	.232	.126	.055	.276	.368	.463
	N	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Aldrin	Pearson Correlation	-.140	-.001	1.000	-.085	.111	-.177	.184	.325	.244	.364*	-.126	.529**	-.087	-.073	-.138	.062	-.171	-.096	.621**
	Sig. (2-tailed)	.461	.994	.	.654	.567	.350	.330	.079	.194	.048	.507	.003	.647	.702	.467	.746	.366	.614	.000
	N	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Dieldrin	Pearson Correlation	.082	.250	-.085	1.000	.182	.918**	.115	.577**	.112	.546**	.972**	.366*	.978**	.866**	.864**	.148	.809**	.928**	-.017
	Sig. (2-tailed)	.667	.183	.654	.	.344	.000	.544	.001	.554	.002	.000	.047	.000	.000	.000	.434	.000	.000	.929
	N	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
p,p'-DDT	Pearson Correlation	.443*	-.002	.111	.182	1.000	.218	.402*	.258	.201	.436*	.153	.217	.129	.107	.232	.178	.176	.149	.359
	Sig. (2-tailed)	.016	.992	.567	.344	.	.256	.030	.176	.296	.018	.428	.259	.505	.581	.226	.357	.360	.441	.056
	N	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29
p,p'-DDE	Pearson Correlation	.135	.079	-.177	.918**	.218	1.000	.102	.489**	.049	.378*	.945**	.322	.906**	.757**	.708**	-.023	.773**	.936**	-.113
	Sig. (2-tailed)	.476	.680	.350	.000	.256	.	.593	.006	.798	.039	.000	.083	.000	.000	.000	.905	.000	.000	.553
	N	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
p,p'-DDD	Pearson Correlation	.128	.212	.184	.115	.402*	.102	1.000	.392*	.222	.439*	.011	.186	.106	.151	.270	.695**	.269	.159	.255
	Sig. (2-tailed)	.501	.261	.330	.544	.030	.593	.	.032	.238	.015	.955	.325	.575	.424	.149	.000	.150	.401	.174
	N	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endosulphan I	Pearson Correlation	-.079	.321	.325	.577**	.258	.489**	.392*	1.000	.217	.632**	.480**	.298	.625**	.609**	.578**	.441*	.381*	.492**	.161
	Sig. (2-tailed)	.680	.083	.079	.001	.176	.006	.032	.	.248	.000	.007	.109	.000	.000	.001	.015	.038	.006	.397
	N	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endosulphan II	Pearson Correlation	.007	-.115	.244	.112	.201	.049	.222	.217	1.000	.322	.073	.659**	.067	.260	.367*	.145	.125	-.012	.595**
	Sig. (2-tailed)	.971	.546	.194	.554	.296	.798	.238	.248	.	.083	.700	.000	.727	.185	.048	.443	.510	.948	.001
	N	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endosulphan sulphate	Pearson Correlation	.029	.334	.364*	.546**	.436*	.378*	.439*	.632**	.322	1.000	.403*	.460*	.474**	.563**	.531**	.606**	.290	.333	.457*
	Sig. (2-tailed)	.880	.072	.048	.002	.018	.039	.015	.000	.083	.	.027	.011	.008	.001	.003	.000	.120	.072	.011
	N	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endrin	Pearson Correlation	.135	.162	-.126	.972**	.153	.945**	.011	.480**	.073	.403*	1.000	.362*	.963**	.799**	.777**	-.064	.829**	.951**	-.079
	Sig. (2-tailed)	.477	.393	.507	.000	.428	.000	.955	.007	.700	.027	.	.050	.000	.000	.000	.738	.000	.000	.677
	N	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endrinaldehyde	Pearson Correlation	-.024	-.117	.529**	.366*	.217	.322	.186	.298	.659**	.460*	.362*	1.000	.304	.410*	.324	-.030	.285	.334	.687**
	Sig. (2-tailed)	.898	.540	.003	.047	.259	.083	.325	.109	.000	.011	.050	.	.102	.024	.081	.877	.127	.071	.000
	N	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	.051	.237	-.087	.978**	.129	.906**	.106	.625**	.067	.474**	.963**	.304	1.000	.863**	.851**	.122	.803**	.916**	-.073
	Sig. (2-tailed)	.789	.207	.647	.000	.505	.000	.575	.000	.727	.008	.000	.102	.	.000	.000	.521	.000	.000	.700
	N	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	-.106	.225	-.073	.866**	.107	.757**	.151	.609**	.260	.563**	.799**	.410*	.863**	1.000	.840**	.266	.657**	.736**	.145
	Sig. (2-tailed)	.578	.232	.702	.000	.581	.000	.424	.000	.165	.001	.000	.024	.000	.	.000	.155	.000	.000	.446
	N	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	.052	.285	-.138	.864**	.232	.708**	.270	.578**	.367*	.531**	.777**	.324	.851**	.840**	1.000	.397*	.747**	.730**	.049
	Sig. (2-tailed)	.787	.126	.467	.000	.226	.000	.149	.001	.046	.003	.000	.081	.000	.000	.	.030	.000	.000	.798
	N	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	-.138	.354	.062	.146	.178	-.023	.695**	.441*	.145	.606**	-.064	-.030	.122	.266	.397*	1.000	.074	-.016	.156
	Sig. (2-tailed)	.468	.055	.748	.434	.357	.905	.000	.015	.443	.000	.738	.877	.521	.155	.030	.	.697	.934	.409
	N	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Methoxychlor	Pearson Correlation	.210	.206	-.171	.809**	.176	.773**	.269	.381*	.125	.290	.829**	.285	.803**	.657**	.747**	.074	1.000	.846**	-.058
	Sig. (2-tailed)	.265	.276	.366	.000	.360	.000	.150	.038	.510	.120	.000	.127	.000	.000	.000	.697	.	.000	.759
	N	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Heptachlor	Pearson Correlation	.147	.170	-.096	.928**	.149	.936**	.159	.492**	-.012	.333	.951**	.334	.916**	.736**	.730**	-.016	.846**	1.000	-.117
	Sig. (2-tailed)	.437	.368	.614	.000	.441	.000	.401	.006	.948	.072	.000	.071	.000	.000	.000	.934	.000	.	.538
	N	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Heptachlor epoxide	Pearson Correlation	-.111	-.139	.621**	-.017	.359	-.113	.255	.161	.595**	.457*	-.079	.687**	-.073	.145	.049	.156	-.058	-.117	1.000
	Sig. (2-tailed)	.560	.463	.000	.929	.056	.553	.174	.397	.001	.011	.677	.000	.700	.446	.798	.409	.759	.538	.
	N	30	30	30	30	29	30	30	30	30	30	30	30	30	30	30	30	30	30	30

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Table 4.5.15A: Correlation of phosphorus in sediments and pesticide residues in sediments

Correlations

		BAP	EXP	Aldrin	Dieldrin	p,p'-DDT	p,p'-DDE	p,p'-DDD	Endosulphan I
BAP	Pearson Correlation	1.000	-.015	.108	-.035	.271	.258	.045	-.078
	Sig. (2-tailed)	.	.936	.570	.854	.148	.169	.814	.681
	N	30	30	30	30	30	30	30	30
EXP	Pearson Correlation	-.015	1.000	.088	.053	.376*	.004	.066	-.065
	Sig. (2-tailed)	.936	.	.644	.782	.040	.983	.729	.735
	N	30	30	30	30	30	30	30	30
Aldrin	Pearson Correlation	.108	.088	1.000	.400*	.033	.191	.149	.652**
	Sig. (2-tailed)	.570	.644	.	.029	.862	.312	.431	.000
	N	30	30	30	30	30	30	30	30
Dieldrin	Pearson Correlation	-.035	.053	.400*	1.000	.037	.051	.298	-.030
	Sig. (2-tailed)	.854	.782	.029	.	.847	.788	.110	.875
	N	30	30	30	30	30	30	30	30
p,p'-DDT	Pearson Correlation	.271	.376*	.033	.037	1.000	-.026	.259	-.074
	Sig. (2-tailed)	.148	.040	.862	.847	.	.892	.166	.697
	N	30	30	30	30	30	30	30	30
p,p'-DDE	Pearson Correlation	.258	.004	.191	.051	-.026	1.000	.295	.219
	Sig. (2-tailed)	.169	.983	.312	.788	.892	.	.113	.244
	N	30	30	30	30	30	30	30	30
p,p'-DDD	Pearson Correlation	.045	.066	.149	.298	.259	.295	1.000	.018
	Sig. (2-tailed)	.814	.729	.431	.110	.166	.113	.	.927
	N	30	30	30	30	30	30	30	30
Endosulphan I	Pearson Correlation	-.078	-.065	.652**	-.030	-.074	.219	.018	1.000
	Sig. (2-tailed)	.681	.735	.000	.875	.697	.244	.927	.
	N	30	30	30	30	30	30	30	30
Endosulphan II	Pearson Correlation	-.066	.040	.604**	.005	.045	.346	.255	.789**
	Sig. (2-tailed)	.730	.833	.000	.980	.815	.061	.173	.000
	N	30	30	30	30	30	30	30	30
Endosulphan sulphate	Pearson Correlation	.013	-.045	.176	.175	.384*	.224	.098	.271
	Sig. (2-tailed)	.945	.815	.352	.355	.036	.235	.605	.148
	N	30	30	30	30	30	30	30	30
Endrin	Pearson Correlation	-.021	.812**	-.010	.060	.344	.083	.269	-.144
	Sig. (2-tailed)	.912	.000	.956	.754	.063	.663	.150	.448
	N	30	30	30	30	30	30	30	30
Endrinaldehyde	Pearson Correlation	-.188	.295	-.199	-.245	.508**	-.143	.048	-.073
	Sig. (2-tailed)	.320	.114	.292	.191	.004	.450	.808	.702
	N	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	-.013	.061	.095	.082	-.060	-.020	-.025	.067
	Sig. (2-tailed)	.948	.749	.619	.668	.755	.916	.696	.725
	N	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	.016	-.277	.261	.031	.005	.035	.266	.427*
	Sig. (2-tailed)	.933	.139	.163	.871	.979	.854	.153	.019
	N	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	.114	-.258	.336	.150	-.131	.110	.202	.409*
	Sig. (2-tailed)	.549	.169	.070	.430	.490	.563	.284	.025
	N	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	.272	.122	.377*	.147	.317	.192	.429*	.192
	Sig. (2-tailed)	.145	.521	.040	.437	.088	.310	.018	.309
	N	30	30	30	30	30	30	30	30
Methoxychlor	Pearson Correlation	.053	.219	.081	.053	.577**	.113	.694**	.139
	Sig. (2-tailed)	.782	.245	.670	.781	.001	.553	.000	.464
	N	30	30	30	30	30	30	30	30
Heptachlor	Pearson Correlation	.369*	.052	.194	.156	.472**	.033	.206	.275
	Sig. (2-tailed)	.045	.785	.303	.412	.008	.863	.275	.141
	N	30	30	30	30	30	30	30	30
Heptachlor epoxide	Pearson Correlation	.052	.417*	.324	.189	.546**	.100	.516**	.231
	Sig. (2-tailed)	.765	.022	.081	.318	.002	.598	.003	.220
	N	30	30	30	30	30	30	30	30

		Endosulphan II	Endosulphan sulphate	Endrin	Endrinaldehyde	?-HCH	?-HCH	?-HCH	?-HCH	Methoxychlor	Heptachlor	Heptachlor epoxide
BAP	Pearson Correlation	-.066	.013	-.021	-.188	-.013	.016	.114	.272	.053	.369*	.052
	Sig. (2-tailed)	.730	.945	.912	.320	.948	.933	.549	.145	.782	.045	.765
	N	30	30	30	30	30	30	30	30	30	30	30
EXP	Pearson Correlation	.040	-.045	.812**	.295	.061	-.277	-.258	.122	.219	.052	.417*
	Sig. (2-tailed)	.833	.815	.000	.114	.749	.139	.169	.521	.245	.785	.022
	N	30	30	30	30	30	30	30	30	30	30	30
Aldrin	Pearson Correlation	.604**	.176	-.010	-.199	.095	.261	.336	.377*	.081	.194	.324
	Sig. (2-tailed)	.000	.352	.956	.292	.619	.163	.070	.040	.670	.303	.081
	N	30	30	30	30	30	30	30	30	30	30	30
Dieldrin	Pearson Correlation	.005	.175	.060	-.245	.082	.031	.150	.147	.053	.156	.189
	Sig. (2-tailed)	.980	.355	.754	.191	.666	.871	.430	.437	.781	.412	.318
	N	30	30	30	30	30	30	30	30	30	30	30
p,p'-DDT	Pearson Correlation	.045	.384*	.344	.508**	-.060	.005	-.131	.317	.577**	.472**	.546**
	Sig. (2-tailed)	.815	.036	.063	.004	.755	.979	.490	.088	.001	.008	.002
	N	30	30	30	30	30	30	30	30	30	30	30
p,p'-DDE	Pearson Correlation	.346	.224	.083	-.143	-.020	.035	.110	.192	.113	.033	.100
	Sig. (2-tailed)	.061	.235	.663	.450	.916	.854	.563	.310	.553	.863	.598
	N	30	30	30	30	30	30	30	30	30	30	30
p,p'-DDD	Pearson Correlation	.255	.098	.269	.048	-.025	.268	.202	.429*	.694**	.206	.516**
	Sig. (2-tailed)	.173	.605	.150	.808	.896	.153	.284	.018	.000	.275	.003
	N	30	30	30	30	30	30	30	30	30	30	30
Endosulphan I	Pearson Correlation	.789**	.271	-.144	-.073	.067	.427*	.409*	.192	.139	.275	.231
	Sig. (2-tailed)	.000	.148	.448	.702	.725	.019	.025	.309	.464	.141	.220
	N	30	30	30	30	30	30	30	30	30	30	30
Endosulphan II	Pearson Correlation	1.000	.242	.097	.040	.157	.269	.552**	.301	.297	.235	.424*
	Sig. (2-tailed)	.	.198	.608	.835	.409	.151	.002	.107	.111	.211	.019
	N	30	30	30	30	30	30	30	30	30	30	30
Endosulphan sulphate	Pearson Correlation	.242	1.000	.017	.008	-.075	.021	.073	.105	-.024	.119	.112
	Sig. (2-tailed)	.198	.	.929	.968	.692	.911	.703	.580	.900	.530	.556
	N	30	30	30	30	30	30	30	30	30	30	30
Endrin	Pearson Correlation	.097	.017	1.000	.315	.096	-.163	-.016	.032	.279	-.006	.543**
	Sig. (2-tailed)	.608	.929	.	.090	.612	.390	.932	.868	.135	.975	.002
	N	30	30	30	30	30	30	30	30	30	30	30
Endrinaldehyde	Pearson Correlation	.040	.008	.315	1.000	.144	-.160	-.085	.010	.412*	-.029	.293
	Sig. (2-tailed)	.835	.968	.090	.	.446	.398	.657	.957	.024	.880	.116
	N	30	30	30	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	.157	-.075	.096	.144	1.000	.011	.222	.305	-.020	.131	-.017
	Sig. (2-tailed)	.409	.692	.612	.446	.	.954	.239	.101	.917	.489	.930
	N	30	30	30	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	.269	.021	-.163	-.160	.011	1.000	.416*	.265	.233	.397*	.165
	Sig. (2-tailed)	.151	.911	.390	.398	.954	.	.022	.157	.215	.030	.385
	N	30	30	30	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	.552**	.073	-.016	-.085	.222	.416*	1.000	.154	.083	.188	.321
	Sig. (2-tailed)	.002	.703	.932	.657	.239	.022	.	.415	.662	.319	.083
	N	30	30	30	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	.301	.105	.032	.010	.305	.265	.154	1.000	.470**	.709**	.212
	Sig. (2-tailed)	.107	.580	.868	.957	.101	.157	.415	.	.009	.000	.260
	N	30	30	30	30	30	30	30	30	30	30	30
Methoxychlor	Pearson Correlation	.297	-.024	.279	.412*	-.020	.233	.083	.470**	1.000	.490**	.651**
	Sig. (2-tailed)	.111	.900	.135	.024	.917	.215	.662	.009	.	.006	.000
	N	30	30	30	30	30	30	30	30	30	30	30
Heptachlor	Pearson Correlation	.235	.119	-.006	-.029	.131	.397*	.188	.709**	.490**	1.000	.306
	Sig. (2-tailed)	.211	.530	.975	.880	.489	.030	.319	.000	.006	.	.100
	N	30	30	30	30	30	30	30	30	30	30	30
Heptachlor epoxide	Pearson Correlation	.424*	.112	.543**	.293	-.017	.165	.321	.212	.651**	.306	1.000
	Sig. (2-tailed)	.019	.556	.002	.116	.930	.385	.083	.260	.000	.100	.
	N	30	30	30	30	30	30	30	30	30	30	30

* Correlation is significant at the 0.05 level (2-tailed)

** Correlation is significant at the 0.01 level (2-tailed)

Table 4.5.16A: Correlation of phosphorus in water and pesticide residues in sediments

Correlations

		Aldrin	Dieldrin	p,p'-DDT	p,p'-DDE	p,p'-DDD	Endosulphan I	Endosulphan II	Endosulphan sulphate	Endrin	Endrinaldehyde	?-HCH	?-HCH	?-HCH	?-HCH	Methoxychlor	Heptachlor	Heptachlor epoxide	MEAN TRP	MEAN THP	MEAN TP
Aldrin	Pearson Correlation	1.000	.400*	.033	.191	.149	.652**	.604**	.176	-.010	-.199	.095	.261	.336	.377*	.081	.194	.324	.087	.559**	.114
	Sig. (2-tailed)	.	.029	.862	.312	.431	.000	.000	.352	.958	.292	.619	.163	.070	.040	.670	.303	.081	.649	.001	.548
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Dieldrin	Pearson Correlation	.400*	1.000	.037	.051	.296	-.030	.005	.175	.080	-.245	.082	.031	.150	.147	.053	.156	.189	-.015	.305	.031
	Sig. (2-tailed)	.029	.	.847	.788	.110	.875	.980	.355	.754	.191	.666	.871	.430	.437	.781	.412	.318	.937	.101	.870
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
p,p'-DDT	Pearson Correlation	.033	.037	1.000	-.026	.259	-.074	.045	.384*	.344	.508**	-.060	.005	-.131	.317	.577**	.472**	.546**	.371*	.094	.326
	Sig. (2-tailed)	.862	.847	.	.892	.168	.697	.815	.036	.063	.004	.755	.979	.490	.088	.001	.008	.002	.044	.622	.078
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
p,p'-DDE	Pearson Correlation	.191	.051	-.026	1.000	.295	.219	.346	.224	.083	-.143	-.020	.035	.110	.192	.113	.033	.100	.007	.034	.032
	Sig. (2-tailed)	.312	.788	.892	.	.113	.244	.061	.235	.663	.450	.916	.854	.563	.310	.553	.863	.598	.970	.858	.868
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
p,p'-DDD	Pearson Correlation	.149	.296	.259	.296	1.000	.018	.255	.098	.269	.046	-.025	.268	.202	.429*	.694**	.206	.516**	.114	.336	.278
	Sig. (2-tailed)	.431	.110	.168	.113	.	.927	.173	.605	.150	.808	.896	.153	.284	.018	.000	.275	.003	.548	.070	.137
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endosulphan I	Pearson Correlation	.652**	-.030	-.074	.219	.018	1.000	.789**	.271	-.144	-.073	.067	.427*	.409*	.192	.139	.275	.231	-.107	.097	-.083
	Sig. (2-tailed)	.000	.875	.697	.244	.927	.	.000	.148	.448	.702	.725	.019	.025	.309	.464	.141	.220	.573	.609	.663
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endosulphan II	Pearson Correlation	.604**	.005	.045	.346	.255	.789**	1.000	.242	.097	.040	.157	.269	.552**	.301	.297	.235	.424*	.023	.205	-.015
	Sig. (2-tailed)	.000	.980	.815	.061	.173	.000	.	.198	.608	.835	.409	.151	.002	.107	.111	.211	.019	.905	.278	.937
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endosulphan sulphate	Pearson Correlation	.176	.175	.384*	.224	.098	.271	.242	1.000	.017	.008	-.075	.021	.073	.105	-.024	.119	.112	-.042	.084	-.103
	Sig. (2-tailed)	.352	.355	.036	.235	.605	.148	.198	.	.929	.968	.692	.911	.703	.580	.900	.530	.556	.827	.659	.589
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endrin	Pearson Correlation	-.010	.080	.344	.083	.269	-.144	.097	.017	1.000	.315	.096	-.163	-.018	.032	.279	-.006	.543**	-.043	.375*	.024
	Sig. (2-tailed)	.958	.754	.063	.663	.150	.448	.608	.929	.	.090	.612	.390	.932	.868	.135	.975	.002	.821	.041	.902
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endrinaldehyde	Pearson Correlation	-.199	-.245	.508**	-.143	.046	-.073	.040	.008	.315	1.000	.144	-.160	-.085	.010	.412*	-.029	.293	.008	-.248	-.204
	Sig. (2-tailed)	.292	.191	.004	.450	.808	.702	.835	.968	.090	.	.446	.398	.657	.957	.024	.880	.116	.965	.186	.281
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	.095	.082	-.060	-.020	-.025	.067	.157	-.075	.096	.144	1.000	.011	.222	.305	-.020	.131	-.017	-.157	.103	-.164
	Sig. (2-tailed)	.619	.666	.755	.916	.896	.725	.409	.692	.612	.446	.	.954	.239	.101	.917	.489	.930	.408	.586	.386
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	.261	.031	.005	.035	.268	.427*	.269	.021	-.163	-.160	.011	1.000	.416*	.265	.233	.397*	.165	.081	-.035	.041
	Sig. (2-tailed)	.163	.871	.979	.854	.153	.019	.151	.911	.390	.398	.954	.	.022	.157	.215	.030	.385	.671	.855	.831
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	.336	.150	-.131	.110	.202	.409*	.552**	.073	-.018	-.085	.222	.416*	1.000	.154	.083	.188	.321	-.078	.069	-.110
	Sig. (2-tailed)	.070	.430	.490	.563	.284	.025	.002	.703	.932	.657	.239	.022	.	.415	.662	.319	.083	.684	.639	.564
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	.377*	.147	.317	.192	.429*	.192	.301	.105	.032	.010	.305	.265	.154	1.000	.470**	.709**	.212	.240	.296	.261
	Sig. (2-tailed)	.040	.437	.088	.310	.018	.309	.107	.580	.868	.957	.101	.157	.415	.	.009	.000	.260	.201	.112	.163
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Methoxychlor	Pearson Correlation	.081	.053	.577**	.113	.694**	.139	.297	-.024	.279	.412*	-.020	.233	.083	.470**	1.000	.490**	.651**	.186	.148	.185
	Sig. (2-tailed)	.670	.781	.001	.563	.000	.464	.111	.900	.135	.024	.917	.215	.662	.009	.	.006	.000	.325	.435	.327
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Heptachlor	Pearson Correlation	.194	.156	.472**	.033	.206	.275	.235	.119	-.006	-.029	.131	.397*	.188	.709**	.490**	1.000	.306	.331	.026	.335
	Sig. (2-tailed)	.303	.412	.008	.863	.275	.141	.211	.530	.975	.880	.489	.030	.319	.000	.006	.	.100	.074	.890	.070
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Heptachlor epoxide	Pearson Correlation	.324	.189	.546**	.100	.516**	.231	.424*	.112	.543**	.293	-.017	.165	.321	.212	.651**	.306	1.000	.338	.355	.296
	Sig. (2-tailed)	.081	.318	.002	.598	.003	.220	.019	.556	.002	.116	.930	.385	.083	.260	.000	.100	.	.068	.054	.110
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
MEAN TRP	Pearson Correlation	.087	-.015	.371*	.007	.114	-.107	.023	-.042	-.043	.008	-.157	.081	-.078	.240	.186	.331	.338	1.000	.136	.775**
	Sig. (2-tailed)	.649	.937	.044	.970	.548	.573	.905	.827	.821	.965	.408	.671	.684	.201	.325	.074	.068	.	.475	.000
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
MEAN THP	Pearson Correlation	.559**	.305	.094	.034	.336	.097	.205	.084	.375*	-.248	.103	-.035	.069	.296	.148	.026	.355	.136	1.000	.263
	Sig. (2-tailed)	.001	.101	.622	.858	.070	.609	.278	.659	.041	.186	.586	.855	.639	.112	.435	.890	.054	.475	.	.160
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
MEAN TP	Pearson Correlation	.114	.031	.326	.032	.278	-.083	-.015	-.103	.024	-.204	-.164	.041	-.110	.261	.185	.335	.296	.775**	.263	1.000
	Sig. (2-tailed)	.548	.870	.078	.868	.137	.663	.937	.589	.902	.281	.386	.831	.564	.163	.327	.070	.110	.000	.160	.
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4.5.17A: Correlation of phosphorus in soil and pesticide residues in sediments

Correlations

		Ph	N%	OC%	P%	K e%	Ca e%
Ph	Pearson Correlation	1.000	-.326	-.327	-.428*	-.116	.450*
	Sig. (2-tailed)	.	.077	.078	.018	.534	.013
	N	30	30	30	30	30	30
N%	Pearson Correlation	-.326	1.000	.895**	.279	-.008	-.029
	Sig. (2-tailed)	.077	.	.000	.135	.976	.879
	N	30	30	30	30	30	30
OC%	Pearson Correlation	-.327	.895**	1.000	.278	.035	-.018
	Sig. (2-tailed)	.078	.000	.	.139	.855	.926
	N	30	30	30	30	30	30
P%	Pearson Correlation	-.428*	.279	.278	1.000	.112	-.228
	Sig. (2-tailed)	.018	.135	.138	.	.556	.225
	N	30	30	30	30	30	30
K e%	Pearson Correlation	-.116	-.008	.035	.112	1.000	.378*
	Sig. (2-tailed)	.534	.976	.855	.556	.	.040
	N	30	30	30	30	30	30
Ca e%	Pearson Correlation	.450*	-.029	-.018	-.228	.378*	1.000
	Sig. (2-tailed)	.013	.879	.926	.225	.040	.
	N	30	30	30	30	30	30
Mg e %	Pearson Correlation	-.113	.084	.117	.182	.311	.474**
	Sig. (2-tailed)	.553	.821	.537	.336	.094	.008
	N	30	30	30	30	30	30
Mn e%	Pearson Correlation	-.430*	.433*	.444*	.117	.144	-.125
	Sig. (2-tailed)	.015	.017	.014	.538	.448	.509
	N	30	30	30	30	30	30

Further columns (Mg e %, Mn e%, Cu ppm, Fe ppm, Zn PPM, Na e %, Ec mS/cm, Aldrin, Dieldrin, p,p'-DDT, p,p'-DDE, p,p'-DDD, Endosulphan I, Endosulphan II, Endosulphan sulphate, Endrin, Endrin aldehyde) and further rows (Cu ppm, Fe ppm, Zn PPM, Na e %, Ec mS/cm, Aldrin, Dieldrin, p,p'-DDT, p,p'-DDE, p,p'-DDD, Endosulphan I, Endosulphan II, Endosulphan sulphate, Endrin, Endrinaldehyde, α-HCH, β-HCH, γ-HCH, δ-HCH, Methoxychlor, Heptachlor, Heptachlor epoxide): [illegible]

Table 4.5.18A: Correlation of physico-chemical parameters and pesticide residues in water

Correlations

		Aldrin	Dieldrin	p,p'-DDT	p,p'-DDE	p,p'-DDD	Endosulphan I	Endosulphan II	Endosulphan sulphate	Endrin	Endrinaldehyde	?-HCH	?-HCH	?-HCH	?-HCH	Methoxychlor	Heptachlor	Heptachlor epoxide	MEAN TDS	MEAN COND	MEAN WATER PH
Aldrin	Pearson Correlation	1.000	-.177	-.022	-.063	-.263	-.167	.142	-.089	.051	.048	-.065	-.084	-.263	-.240	-.187	.083	-.090	-.045	.215	-.175
	Sig. (2-tailed)	.	.348	.908	.740	.160	.379	.455	.639	.788	.802	.732	.661	.160	.201	.323	.662	.637	.815	.253	.356
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Dieldrin	Pearson Correlation	-.177	1.000	.140	-.152	.573**	.103	.072	.258	.007	-.011	.209	.008	.573**	.380*	-.012	.223	.245	.387*	.006	.420*
	Sig. (2-tailed)	.348		.461	.423	.001	.586	.707	.169	.972	.953	.268	.974	.001	.033	.949	.236	.192	.034	.974	.021
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
p,p'-DDT	Pearson Correlation	-.022	.140	1.000	-.095	.408*	.468**	.180	.195	.174	-.256	.933**	.256	.408*	.172	-.048	.326	.130	-.079	-.105	-.127
	Sig. (2-tailed)	.908	.461		.619	.025	.009	.341	.302	.358	.173	.000	.173	.025	.364	.800	.079	.493	.680	.582	.503
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
p,p'-DDE	Pearson Correlation	-.063	-.152	-.095	1.000	.022	-.134	.045	.045	.081	-.151	-.115	-.126	.022	-.025	-.173	-.287	.247	.257	-.119	-.034
	Sig. (2-tailed)	.740	.423	.619		.907	.479	.812	.813	.670	.426	.544	.508	.907	.895	.360	.124	.189	.170	.531	.859
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
p,p'-DDD	Pearson Correlation	-.263	.573**	.408*	.022	1.000	.242	.117	.332	.181	-.135	.460*	.407*	1.000**	.261	-.087	.111	.448*	.584**	-.014	.494**
	Sig. (2-tailed)	.160	.001	.025	.907		.198	.537	.073	.339	.478	.011	.026	.000	.164	.725	.559	.013	.001	.941	.006
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endosulphan I	Pearson Correlation	-.167	.103	.468**	-.134	.242	1.000	.059	.075	.097	.162	.509**	.174	.242	.049	.322	.037	.101	-.089	.227	-.014
	Sig. (2-tailed)	.379	.586	.009	.479	.198		.757	.694	.610	.391	.004	.358	.198	.798	.083	.847	.597	.639	.229	.940
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endosulphan II	Pearson Correlation	.142	.072	.180	.045	.117	.059	1.000	.035	.028	.035	.124	-.075	.117	.187	-.109	.425*	.344	.584**	.113	.077
	Sig. (2-tailed)	.455	.707	.341	.812	.537	.757		.855	.882	.853	.515	.693	.537	.323	.565	.019	.063	.001	.554	.685
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endosulphan sulphate	Pearson Correlation	-.089	.258	.195	.045	.332	.075	.035	1.000	.130	-.082	.188	-.087	.332	.117	-.102	.146	.131	.486**	.105	.524**
	Sig. (2-tailed)	.639	.169	.302	.813	.073	.694	.855		.493	.668	.318	.648	.073	.537	.590	.440	.480	.007	.580	.003
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endrin	Pearson Correlation	.051	.007	.174	.081	.181	.097	.028	.130	1.000	.130	.102	-.062	.181	-.030	-.142	-.108	.123	.081	.266	-.010
	Sig. (2-tailed)	.788	.972	.358	.670	.339	.610	.882	.493		.494	.592	.746	.339	.874	.454	.577	.517	.672	.152	.959
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endrinaldehyde	Pearson Correlation	.048	-.011	-.256	-.151	-.135	.162	.035	-.082	.130	1.000	-.208	-.135	-.135	-.251	.393*	-.110	.029	-.031	.895**	.169
	Sig. (2-tailed)	.802	.953	.173	.426	.478	.391	.853	.668	.494		.271	.478	.478	.181	.032	.563	.880	.871	.000	.372
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	-.065	.209	.933**	-.115	.460*	.509**	.124	.188	.102	-.208	1.000	.221	.460*	.265	.072	.433*	.121	-.051	-.054	.025
	Sig. (2-tailed)	.732	.268	.000	.544	.011	.004	.515	.318	.592	.271		.240	.011	.157	.704	.017	.524	.791	.779	.894
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	-.084	.008	.256	-.126	.407*	.174	-.075	-.087	-.062	-.135	.221	1.000	.407*	-.105	.000	-.218	-.047	.014	-.020	-.102
	Sig. (2-tailed)	.661	.974	.173	.508	.026	.358	.693	.648	.746	.478	.240		.026	.580	1.000	.248	.804	.942	.916	.593
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	-.263	.573**	.408*	.022	1.000**	.242	.117	.332	.181	-.135	.460*	.407*	1.000	.261	-.087	.111	.448*	.584**	-.014	.494**
	Sig. (2-tailed)	.160	.001	.025	.907	.000	.198	.537	.073	.339	.478	.011	.026		.164	.725	.559	.013	.001	.941	.006
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
?-HCH	Pearson Correlation	-.240	.380*	.172	-.025	.261	.049	.187	.117	-.030	-.251	.265	-.105	.261	1.000	.128	.578**	.561**	.131	-.286	.208
	Sig. (2-tailed)	.201	.033	.364	.895	.164	.798	.323	.537	.874	.181	.157	.580	.164		.500	.001	.002	.489	.126	.275
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Methoxychlor	Pearson Correlation	-.187	-.012	-.048	-.173	-.087	.322	-.109	-.102	-.142	.393*	.072	.000	-.087	.128	1.000	.168	.049	-.155	.311	.456*
	Sig. (2-tailed)	.323	.949	.800	.360	.725	.083	.565	.590	.454	.032	.704	1.000	.725	.500		.374	.798	.413	.094	.011
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Heptachlor	Pearson Correlation	.083	.223	.326	-.287	.111	.037	.425*	.146	-.108	-.110	.433*	-.218	.111	.578**	.168	1.000	.352	.179	-.090	.294
	Sig. (2-tailed)	.662	.236	.079	.124	.559	.847	.019	.440	.577	.563	.017	.248	.559	.001	.374		.057	.344	.638	.115
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Heptachlor epoxide	Pearson Correlation	-.090	.245	.130	.247	.448*	.101	.344	.131	.123	.029	.121	-.047	.448*	.561**	.049	.352	1.000	.436*	.040	.298
	Sig. (2-tailed)	.637	.192	.493	.189	.013	.597	.063	.480	.517	.880	.524	.804	.013	.002	.798	.057		.015	.832	.110
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
MEAN TDS	Pearson Correlation	-.045	.387*	-.079	.257	.584**	-.089	.584**	.486**	.081	-.031	-.051	.014	.584**	.131	-.155	.179	.436*	1.000	.149	.852**
	Sig. (2-tailed)	.815	.034	.680	.170	.001	.639	.001	.007	.672	.871	.791	.942	.001	.489	.413	.344	.015		.433	.000
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
MEAN COND	Pearson Correlation	.215	.006	-.105	-.119	-.014	.227	.113	.105	.266	.895**	-.054	-.020	-.014	-.286	.311	-.090	.040	.149	1.000	.279
	Sig. (2-tailed)	.253	.974	.582	.531	.941	.229	.554	.580	.152	.000	.779	.916	.941	.126	.094	.638	.832	.433		.136
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
MEAN WATER PH	Pearson Correlation	-.175	.420*	-.127	-.034	.494**	-.014	.077	.524**	-.010	.169	.025	-.102	.494**	.208	.456*	.294	.298	.852**	.279	1.000
	Sig. (2-tailed)	.356	.021	.503	.859	.006	.940	.685	.003	.959	.372	.894	.593	.006	.275	.011	.115	.110	.000	.136	
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 4.5.19A: Correlation of physico-chemical parameters and pesticide residues in sediments

Correlations

		Ph	N%	OC%	P%	K%
Ph	Pearson Correlation	1.000	-.120	-.142	-.744**	-.076
	Sig. (2-tailed)		.528	.454	.000	[illegible]
	N	30	30	30	30	30
N%	Pearson Correlation	-.120	1.000	[illegible]**	-.023	-.081
	Sig. (2-tailed)	.528		.000	[illegible]	.750
	N	30	30	30	30	30
OC%	Pearson Correlation	-.142	[illegible]**	1.000	.005	-.052
	Sig. (2-tailed)	.454	.000		.978	.783
	N	30	30	30	30	30
P%	Pearson Correlation	-.744**	-.023	.005	1.000	.218
	Sig. (2-tailed)	.000	[illegible]	.978		.247
	N	30	30	30	30	30
K%	Pearson Correlation	-.076	-.081	-.052	.218	1.000
	Sig. (2-tailed)	[illegible]	.750	.783	.247	
	N	30	30	30	30	30
Ca%	Pearson Correlation	.204	.005	-.005	-.120	.737**
	Sig. (2-tailed)	.280	.978	.979	.528	.000
	N	30	30	30	30	30
Mg %	Pearson Correlation	-.094	[illegible]	[illegible]	.243	-.008
	Sig. (2-tailed)	[illegible]	.716	.814	[illegible]	[illegible]
	N	30	30	30	30	30
Mn%	Pearson Correlation	-.230	.152	.150	.181	.421*
	Sig. (2-tailed)	.222	.421	.428	.337	.020
	N	30	30	30	30	30
Cu	Pearson Correlation	-.152	[illegible]**	[illegible]**	.158	.127
	Sig. (2-tailed)	.421	.000	.000	.410	.505
	N	30	30	30	30	30
Fe	Pearson Correlation	-.302	.028	.031	.145	.032
	Sig. (2-tailed)	.105	[illegible]	.870	.444	[illegible]
	N	30	30	30	30	30
Zn	Pearson Correlation	-.046	.367*	.367	-.111	.161
	Sig. (2-tailed)	.814	.046	.053	[illegible]	[illegible]
	N	30	30	30	30	30
Na %	Pearson Correlation	.085	-.114	-.114	.158	[illegible]**
	Sig. (2-tailed)	[illegible]	.550	.549	.401	.000
	N	30	30	30	30	30
Aldrin	Pearson Correlation	-.262	.041	.040	.091	.142
	Sig. (2-tailed)	.131	.831	.832	[illegible]	.453
	N	30	30	30	30	30
Dieldrin	Pearson Correlation	-.010	-.182	-.185	[illegible]	-.069
	Sig. (2-tailed)	[illegible]	.308	.327	.715	.717
	N	30	30	30	30	30
p,p'-DDT	Pearson Correlation	[illegible]	-.064	-.078	.020	-.066
	Sig. (2-tailed)	[illegible]	.738	[illegible]	.915	.730
	N	30	30	30	30	30
p,p'-DDE	Pearson Correlation	-.030	-.158	-.172	.108	-.108
	Sig. (2-tailed)	.875	.405	.363	.572	.549
	N	30	30	30	30	30
p,p'-DDD	Pearson Correlation	.140	-.247	-.267	-.043	-.056
	Sig. (2-tailed)	.456	.188	.154	.821	.771
	N	30	30	30	30	30
Endosulphan I	Pearson Correlation	.033	.064	.050	-.103	.023
	Sig. (2-tailed)	[illegible]	.736	.793	.587	[illegible]
	N	30	30	30	30	30
Endosulphan II	Pearson Correlation	-.204	.032	.018	.067	-.020
	Sig. (2-tailed)	.280	[illegible]	.852	.726	.919
	N	30	30	30	30	30
Endosulphan sulphate	Pearson Correlation	-.077	[illegible]	[illegible]	-.039	-.140
	Sig. (2-tailed)	[illegible]	.979	[illegible]	.678	.387
	N	30	30	30	30	30
Endrin	Pearson Correlation	-.097	-.176	-.181	-.015	-.160
	Sig. (2-tailed)	[illegible]	.353	.338	.937	.397
	N	30	30	30	30	30
Endrinaldehyde	Pearson Correlation	-.149	.450*	.445*	.084	-.165
	Sig. (2-tailed)	.432	.012	.014	.821	.380
	N	30	30	30	30	30
[illegible]-HCH	Pearson Correlation	[illegible]	.070	.075	.235	-.084
	Sig. (2-tailed)	.121	.715	[illegible]	.211	.825
	N	30	30	30	30	30
[illegible]-HCH	Pearson Correlation	.014	-.209	-.222	.079	-.056
	Sig. (2-tailed)	.942	[illegible]	.239	[illegible]	.771
	N	30	30	30	30	30
[illegible]-HCH	Pearson Correlation	-.262	-.042	-.037	.224	-.277
	Sig. (2-tailed)	.162	.827	.845	.234	.138
	N	30	30	30	30	30
[illegible]-HCH	Pearson Correlation	.212	.009	-.007	.136	-.209
	Sig. (2-tailed)	.261	[illegible]	.970	.472	.267
	N	30	30	30	30	30
Methoxychlor	Pearson Correlation	.100	-.210	.237	-.071	-.140
	Sig. (2-tailed)	[illegible]	[illegible]	[illegible]	.707	.460
	N	30	30	30	30	30
Heptachlor	Pearson Correlation	[illegible]	-.123	-.132	.015	-.162
	Sig. (2-tailed)	[illegible]	.517	[illegible]	[illegible]	.311
	N	30	30	30	30	30
Heptachlor epoxide	Pearson Correlation	.048	-.149	-.172	-.075	-.178
	Sig. (2-tailed)	.811	.430	.360	[illegible]	.345
	N	30	30	30	30	30

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 4.5.20A: Correlation of physico-chemical parameters and pesticide residues in soil

		Ph	N%	OC%	P%	K a%	Ca a%	Mg a %	Mn a%	Cu ppm	Fe ppm	Zn PPM	Na a %	Ec mS/cm	Aldrin	Dieldrin	p,p'-DDT	p,p'-DDE	p,p'-DDD	Endosulphan I	Endosulphan II	Endosulphan sulphate	Endrin	Endrin aldehyde
Ph	Pearson Correlation	1.000	-.328	-.327	-.426*	-.118	.450*	-.113	-.438*	.072	-.393*	-.014	.048	.530**	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	.	.077	.078	.019	.534	.013	.553	.015	.704	.031	.943	.800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
N%	Pearson Correlation	-.328	1.000	.985**	.279	-.008	-.029	.084	.433*	.288	.147	.487*	-.142	.039	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	.077	.	.000	.136	.970	.879	.821	.017	.152	.437	.010	.380	.839	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
OC%	Pearson Correlation	-.327	.985**	1.000	.278	.035	-.018	.117	.444*	.282	.135	.448*	-.132	.035	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	.078	.000	.	.138	.855	.926	.537	.014	.143	.478	.013	.486	.855	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
P%	Pearson Correlation	-.426*	.279	.278	1.000	.112	-.228	.142	.117	-.139	.177	.027	.174	-.344	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	.019	.136	.138	.	.555	.225	.336	.538	.465	.349	.909	.358	.183	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
K a%	Pearson Correlation	-.118	.008	.035	.112	1.000	.378*	.311	.144	-.098	.218	.060	.380*	-.184	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	.534	.970	.855	.555	.	.040	.094	.448	.605	.247	.751	.032	.330	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Ca a%	Pearson Correlation	.450*	-.029	-.018	-.228	.378*	1.000	.474**	-.126	.008	.074	-.008	.197	.681**	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	.013	.879	.926	.225	.040	.	.008	.509	.965	.698	.650	.298	.000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Mg a %	Pearson Correlation	-.113	.084	.117	.142	.311	.474**	1.000	-.024	-.288	.140	.201	.113	.284	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	.553	.821	.537	.336	.094	.008	.	.900	.106	.460	.288	.551	.116	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Mn a%	Pearson Correlation	-.438*	.433*	.444*	.117	.144	-.126	-.024	1.000	.447*	.358	.452*	.037	-.307	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	.015	.017	.014	.538	.448	.509	.900	.	.013	.051	.012	.847	.099	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Cu ppm	Pearson Correlation	.072	.288	.282	-.139	-.098	.004	-.288	.447*	1.000	.210	.818**	.072	.095	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	.704	.152	.143	.465	.605	.983	.106	.013	.	.266	.000	.706	.617	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Fe ppm	Pearson Correlation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Zn PPM	Pearson Correlation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Na a %	Pearson Correlation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Ec mS/cm	Pearson Correlation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Aldrin	Pearson Correlation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Dieldrin	Pearson Correlation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
p,p'-DDT	Pearson Correlation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29
p,p'-DDE	Pearson Correlation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
p,p'-DDD	Pearson Correlation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endosulphan I	Pearson Correlation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endosulphan II	Pearson Correlation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endosulphan sulphate	Pearson Correlation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endrin	Pearson Correlation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Endrin aldehyde	Pearson Correlation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
α-HCH	Pearson Correlation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
β-HCH	Pearson Correlation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
γ-HCH	Pearson Correlation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
δ-HCH	Pearson Correlation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Methoxychlor	Pearson Correlation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Heptachlor	Pearson Correlation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Heptachlor epoxide	Pearson Correlation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sig. (2-tailed)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30