PROJECT REPORT

on

Community Action to Reduce the Pollution Load of Persistent Organic Pollutants (POPs) and Other Toxic Effluents into Lagos Lagoon, Lagos State

to

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PROJECT GEF/SGP Focal Area: Persistent Organic Pollutants

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by

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Executive Summary

Persistent Organic Pollutants (POPs) are substances that have low water solubility, persist in the environment, are lypophilic, capable of long-range transport, bio-accumulate in living organisms and may produce toxic effects. Most POPs are organochlorine pesticides (OCPs) and represent long-term dangers as they biomagnifies up the food chain. Humans and particularly breastfed babies are at the top of the food chain. These pesticides have been banned in some developing countries but are still being used e. g. DDT is used to control malaria in some developing countries such as Nigeria. The Lagos lagoon is a large expanse of water that is bound by various anthropogenic activities and human settlements. It is therefore a sink for various wastes including POPs from diverse sources.

Eighteen POPs (OCPs residues) - mecoprop, atrazine, 2, 4 – Dichlorophenoxyacetic acid (2,4-D), carbofuran, dibromochloropropane (DBCP), pentachlorophenol, fenoprop, alachlor, 2,4-Dichlorophenoxybutyric Acid (2,4-DB), metolachlor, lindane, chlorpyrifos, Dichlorodiphenyltrichloroethane (DDT), aldrin, endrin, chlordane, endosulfan, dieldrin were found from the analysed water, sediment, fish, soil, egg and human breast milk (HBM). The water, sediment, fish, soil and egg samples were collected from selected areas Ilaje, Okobaba, Iddo and Apapa communities while Human Breast Milk (HBM) samples were collected from hospital patients in selected areas (Ebute Metta and Ibeshe) of the Lagos Lagoon based on their proximity to anthropogenic activities that could result in the deposition of these pollutants into the lagoon. The analysis was carried out using gas chromatograph with pulsed flame photometric detector (GC-PFPD).

The results of the analysis of the physicochemical properties of the surface water at the various sampling stations revealed that PH, Conductivity, Salinity, Temperature and Dissolved oxygen values ranged from 5 (acidic) at Okobaba to 8.17 (alkaline) at Apapa, 0.51mS/cm at Ilaje to 1.86mS/cm at Apapa, 0.3ppt at Ilaje to 14.47ppt at Apapa, 25.71^{0}C at Okobaba to 28.31^{0}C at Apapa and 9.93ng/l (at Ilaje) to 14.47mg/l at Apapa respectively.

OCPs residue analysis in the water, sediment, fish, soil and egg samples showed that total POPs concentration for all the sampling stations ranged from 2.12 - 5.66µg/L (water), 8.55 - 15.31µg/kg (sediment), 3.83 - 10.96µg/kg (fish), 1500.84 - 2495.73µg/kg (soil) and 3.92 - 9.56µg/kg (egg). The highest concentrations of individual OCPs were 4.53µg/kg (Endosulfan)(Apapa-water), 6.28µg/L (Endrin)(Ilaje-sediment), 5.83µg/kg (Endosulfan)(Ilaje-fish), 1710.06µg/kg (Endosulfan)(Apapa-soil), 4.42µg/kg (Endosulfan)(Ilaje-egg). The

concentration of total POPs at the different sampling station increased in this order; 2.12µg/L (Iddo), 3.88µg/L (Okobaba), 3.96µg/L (Ilaje) and 5.66µg/L (Apapa) for water samples; 8.55µg/kg (Apapa), 8.94µg/kg (Iddo), 14.6µg/kg (Okobaba) and 15.31µg/kg (Ilaje) for Sediment samples; 3.83µg/kg (Iddo), 5.29µg/kg (Apapa) and 10.96µg/kg (Ilaje) and 9.58µg/kg (Okobaba) for Fish samples; 1500.84µg/kg (Iddo), 1592.31µg/kg (Okobaba), 1783.72µg/kg (Apapa) and 2495.75µg/kg (Ilaje) for Soil samples; 3.92µg/kg (Apapa), 4.12µg/kg (Iddo), 7.81µg/kg (Okobaba) and 9.56µg/kg (Iddo) for Egg samples. The mean concentration of total POPs from the four sampling stations in the various media increased in this order; 3.91µg/L (water), 6.36µg/kg (egg), 7.41µg/kg (fish), 11.85µg/kg (sediment) and 1843.16µg/kg (soil).

As for the Human Monitoring investigation (biomonitoring) samples, the total OCPs concentration for all the sampling areas ranged from 1.736 – 2.270ppb. The total mean values of OCP residues from the two areas increased as follows; DBCP, Fenoprop, Alachlor (0.003) < Pentachlorophenol (0.005) < Atrazine (0.010) < 2,4-DB (0.028) < Lindane (0.031) < 2,4 –D (0.032) < Chlorpyrifos (0.057) < Endrin (0.130) < Dieldrin (0.131) < Chlordane (0.150) < Aldrin (0.192) < Endosulfan (0.298) < DDT (0.422) < Metachlor (0.508). Comparison of the results of mean OCPs in Human Breast Milk samples from the two sample areas revealed that samples from Ibeshe were higher than those from Ebute Metta with Lindane, DDT and Chlordane showing significantly higher levels ($p<0.005$) than those from Ebute metta. In addition, comparison of Dieldrin, Aldrin and Endrin residues with maximum residue limits (MRL) set by the FAO/WHO as well as results from other countries showed that the detected levels were within limits. In view of the high levels of POPs found in the environmental samples (water, sediment, fish, soil and egg) obtained from same location in the study, it is not therefore possible for this study to generalize that breast-feeding mothers and breast-fed babies in the study areas are relatively safe from POP/OCPs contamination. This is because a larger sample size is required to establish this. However, due to the fact that the POPs were detected in the few samples is sufficient public health alarm to Lagosians (inhabitants of Lagos metropolis). There is need from continuous monitoring perhaps on a yearly basis to ensure the levels do not get to or exceed the MRL set by the WHO. Furthermore, safety and awareness programmes should be continued in these study areas to guarantee that these OCPs remain below the set limits.

Key words: *Persistent Organic Pollutants, Organochlorine Pesticide residues, Lagos Lagoon, Human breast milk.*

SECTION ONE

1.0 Background of Project

About 80-85% of the industries in Nigeria are located in Lagos State and they all discharge their effluents into the Lagos lagoon. The effluents discharged are mainly untreated, while very few industries have any treatment plants. Lagos Lagoon consists of three (3) main segments namely the *Lagos Harbour Segment*, *the Metropolitan* and *the Epe Division Segment*.

Complex mixtures of domestic and industrial effluents enter Lagos Lagoon daily. In addition to wastewater from industries, there are domestic sewage discharges; garbage and wood shavings from sawmill depots along the shores of the lagoon. The proliferation of urban and industrial activities along the shores of the lagoon has resulted in a complex mix of both domestic and industrial wastes.

Lagos Lagoon is also linked to important large inland rivers and creeks. Its water tends to have restricted circulation and poor tidal flushing with a low tidal range (0.3 - 1m), which exacerbates any pollution problem. Sand and gravel extraction for construction purposes and reclamation of wetlands around the lagoon are common features of the landscape. Lagos Lagoon is a land-based source of nutrients and persistent toxic substances to the coastal zone and as such is an input to the trans-boundary international waters of the Guinea Current Large Marine Ecosystem. Potential cross-border challenges extend beyond pollution to loss of critical habitats and biodiversity. With knock-on effects on human well-being and contributing to poverty by decreasing quality and quantity of coastal fishery, export potential and water-related health risks particularly amongst over 5 million poor local residents living along the Lagoon corridor. Lagoon receives wastewater from an estimated 2000 major industrial users, including small industrial users, commercial establishments, and domestic sources. On the basis of the available data, the Lagoon is subject to an industrial wastewater pollution load of 6.2 Mt of pollutant per sq. km per annum.

SECTION TWO

2.0 Introduction

Persistent Organic Pollutants (POPs) are chemical substances that persist in the environment, bioaccumulate through the food web and pose a risk of causing adverse effects to human health and the environment (UNEP, 2011). **Most POPs are organochlorine pesticides (OCPs), namely, aldrin, endrin, chlordane, dichoro diphenyl trichloroethane (DDT), heptachlor, mirex, toxaphene and hexachlorobenzene**. These are among the first set of pesticides used and still in use in Nigeria despite their ban in developed countries due to the associated problems of bioaccumulation, environmental persistence, and potency. The chemical stability, high lipid solubility and toxicity to man and animals have led governments and researchers to be concerned with their presence in the environment. Most water bodies in Nigeria, especially Lagos serve as a sink for the disposal of waste from about 2000 medium and large scale industries located in the metropolis (Anetekhai *et al.,*

2007). OCPs residue reaches the aquatic environment through direct run-off, leaching, equipment washing and careless disposal of empty containers etc. (Miliadis*, et al.,* 1993).

OCPs portend long-term dangers as they biomagnifies up the food chain. Humans and particularly breastfed babies are at the top of the food chain. Human milk as well as blood has been used as markers of exposure of humans to certain POPs. These human sample media can show comparable temporal trends in a particular population because they integrate environmental exposure as well as dietary exposure related to different consumption habits. Furthermore, they provide relevant information on POPs transfer to infants and potential health effects. Human milk has been used on a global basis for monitoring of human body burdens of POPs for several decades. This has led to the prescription of tolerances such as maximum residue level (MRL) and no observable adverse effect level (NOAEL) for various pesticides in food and water, especially by the Codex Alimentarius Commission (CODEX, 2004). There is evidence of organochlorine pesticide residues in sediments, water and biota, crops, meat and human fluids (Osafo and Frimpong, 1998; Ntow, 2001; Kalantari and Ebodi, 2006; Khalid *et al*., 2007; Darko and Acquaah, 2007). Increased accumulation of these chemicals in the food chain may pose serious health hazards in the general populace (Jayashree and Vasudevan, 2007). For example, exposure to organochlorine compounds has been reported to affect thyroid function in preschool children (Natural Health News, 2008). Low sperm count in males, birth defects, increase in testicular cancer and other reproductive and development effects (Weltman and Norback, 1983) have also been reported as a result of organochlorine contamination.

There is general consensus that human breast milk is the best food for infants, especially in the first six months of life. Not only is breastfeeding important for the infant's growth and development because of the high quality and easy digestion of the nutrients in human breast milk, but it is also important because body contact strengthens mother-and-child bonding and boosts the child's psychological and social development. It is based on this knowledge that the Ministry of Health, the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) promote, encourage, support and protect breastfeeding. In view of the sound evidence of POPs toxicity, and seeking to promote chemical safety, WHO has called for international action in the control and reduction of such substances in the different environmental compartments. The purpose here therefore, as recommended by WHO, has been to investigate human exposure through the body burden of contaminants in newborns, using breast milk as a tool. An important concept in human milk studies is also that they reflect the integration of all contamination at a high trophic level. Thus, human milk samples reflect the intake in different regions, the extent of contamination and different consumption habits.

SECTION THREE

3.0 Goal of the project:

The goal of the project is to generate national and global environmental benefits in a sustainable and cost-effective manner through engagement with businesses in the Lagoon watershed. This project explored the enabling conditions (removing market barriers) for private sector investment to engage in commercial activities that will decrease pollutant inputs to Lagos Lagoon. In addition the project

facilitated dialogue between Federal, State and Local Governments, the private sector and the host communities. In the context of the Stockholm Convention every effort will be made to engage with companies operating in all the relevant private organizations, community based organizations (CBOs), local Fishermen and farmers, academia and regulatory authorities. An important aspect of this study is to protect public health.

3.1 Objectives:

- To provide baseline data on POPs contaminant levels at key inputs, within and at the output of Lagos Lagoon
- To characterize the Lagoon's current chemical and eco-toxicological status;
- To use the information as a baseline to evaluate future projections and ecological quality using BAT/BEP and related risk reduction methods;
- To determine spatial distribution of POPs concentrations in the water and depositional sediments in relation to key sources, pathways, and loadings to the Lagoon;
- To strengthen NGO's institutional capacity in research, sampling and analysis of POPs contaminants;
- To determine POPs contaminant levels in chicken eggs, mothers' milk as well as fish to give a preliminary assessment of exposure levels.
- To facilitate dialogue between the private and public sectors the strategy to achieve eco-efficiency and implement pollution prevention and cleaner production in industries in the Lagos Lagoon catchment area.

SECTION FOUR

4.0 SUMMARY DESCRIPTION OF PROJECT ACTIVITIES

4.1: *Project Planning*

Since 2011, the Steering Committee (SC) of NASPIN comprising of FOTE, NEST and SRADev Nigeria inaugurated the Project Implementation Team (PIT) to undertake the execution of the project from among the members of the network with specific roles defined. There were series of meetings (21/07/11, 02/09/11) between PIT members and the SC where the action/implementation plans were finalized. Key stakeholders in the project were identified. Prior to finalization, the implementation plan were shared with the general members of NASPIN at its meeting of 15/09/10 held at the Lagos Airport Hotel, Ikeja. After clearly defining roles and actions of members, NASPIN approved the project implementation plan for the execution of the project.

Pre-project consultations with key stakeholders in the Lagos Lagoon catchment area were held on 07/10/10. These stakeholders were: Ilaje Community Development Association, and the Ilaje Fishermen Association, Women groups and Youth association, etc at the palace of the *Baale* (see Annex 1) and the University of Lagos (department of Fisheries). Further consultation was also held with Epe community led by FOTE 15/10/10. NASPIN team also held a briefing meeting with the General Manager, Lagos State Environmental Protection Agency (LASEPA) who pledged his total support for the initiated and assured the full cooperation with NASPIN. Other consultations held are identified and assessable hospitals/Primary Health Care, Lagos State Ministry of Health, Ministry of Environment Lagos State (waste water management office) between April-June 2013. NASPIN team

also visited Prof. P.C Nwilo (Coordinator of the Guinea Current Large Marine Ecosystem (GCLME)/UNILAG Regional Centre for Environmental Information Management System), Chemistry department of UNILAG between October 1-12, 2011.

Following our extensive project implementation plan, the GEF/SGP project monitoring team (Mrs Ronke Olubamise/Mr Paul Okunola) was received by NASPIN Coordinator on 29/09/10 and they were briefed on the state of preparedness and plans. The group led by NASPIN coordinator on 30/09/10 later paid a visit to Prof. L.O. Chukwu of the Department of Fisheries, University of Lagos to assert its readiness to cooperate with NASPIN in the project analysis plan.

4.2: *Desk Research and Scenario Development*

Preliminary Baseline data and scenario were developed through literature review and consultation with key stakeholders in the Lagos lagoon catchment area resulting in a series of possible/probable scenarios for the phase-out and destruction of POPs within the catchment area, undertaken by SRADev Nigeria. The research desktop study provided details of location of industries along the lagoon and the pollution pathway within the lagoon catchment area, this component provided the required framework for the implementation of the project activities. *A detail report of this activity is in Annex 2.*

4.3*: Site Reconnaissance Survey/Sampling Assessment*

NASPIN project team (composed of NGOs members, UNILAG team, MDS- environmental consultant, public health scientist, chemists etc) planned site visits to survey the project sites in line with desktop research and scenario development activity and sampling undertaken by the team led by Sustainable Environment Development Initiative (SEDI) and SRADev Nigeria, members of the NASPIN, at different times. The sampling techniques used was previously determined and agreed by an expert group in conjunction with stakeholders' communities members identified in Ilaje, Okobaba sawmill and Epe communities. Sampling points were established with the aid of Global Positioning System (GPS). Competent laboratories were used for sample analysis.

PIT Team site visit

Site visit to Fishermen at Ilaje community

Interaction with fishing members

LMDGP project at Ilaje

			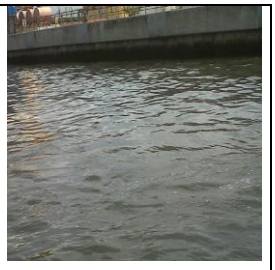
Sampling point identified in Ilaje	Okobaba sampling point identified	Iddo sampling point identified	Apapa sampling point identified

Plate 1: NASPIN site survey visit and identification of sampling points

4.4: Multi-stakeholder Project inception Sensitization Workshop

Pre-workshop stakeholder consultation was further undertaken with key stakeholder like the Ilaje community chiefs, LASEPA etc. NASPIN team paid a courtesy visit to the General Manager, LASEPA on the 31/10/11. The stakeholders identified from all consultation and project activities were invited to a one-day sensitization workshop coordinated held at the HMMC Conference Centre, 321 Herbert Macaulay Way, Sabo, Yaba, Lagos on October 11, 2011. Various media created both pre and post workshop awareness on the project. At the workshop, the proposed implementation plan was presented and discussed among all the stakeholders' for increased participation and involvement. Participants cut across representatives of Fishermen Association, Sawmillers' Association, academia, NGOs, some industries, the Manufacturer Association of Nigeria, the Press and the Lagos State Environmental Protection Agency (LASEPA). *Annex 3 presents a detail report of the activity.*

Plate 2: NASPIN project inception workshop showing cross section of experts and community members

4.5: *Establishment of collaborations and partnerships in the Project*

Since the commencement of the project, NASPIN project implementation team (PIT) forged formidable linkages and collaborations with other NGOs especially those not previously working in POPs chemical management issues. The Steering committee at inception of the project communicated details and had briefing sessions with Engr. A. Ajani of UNIDO to see how the project can link into the on-going GEF POP contaminated site project of UNIDO and it is agreed that the outcome/report of this project would be incorporated into the data base unit of the GEF project set up at the University of Lagos. Discussion on this has also been held with Prof. Nwilo of this unit. Further strong partnerships/linkages were brokered with the GCLME, LASEPA, University of Lagos, Federal Ministry of Environment (POPs desk office), key stakeholders groups identified in the communities like the Fishermen association, Lagos Sawmillers Association, private sector

laboratories, university research students, health institutions *(PHC, General hospitals etc).* This will facilitate effective implementation of future projects in this regard.

4.6: *Project Model Development*

From the literature review and extensive scenario development reports (Annex 2), as much information on the local environment, location of industrial and commercial activities, industrial and municipal discharges, hydrography, and sedimentology, in addition to tributary discharge, outflow to the coastal zone will ultimately help the regulators, academic institutions, various experts of interest and the general public have a good understanding of the local ecology towards evaluating future projections and ecological quality programmes on the extent of exposure to POPs in the Lagos Lagoon catchment area and establish strategies for decreasing pollutant discharges and emissions through best available technology/best applied practice (BAT/BEP) and new approaches such as: (a) low-cost constructed wetlands for pollution reduction; (b) water and contaminant recycling and reuse strategies; (c) use of modern technologies; (d) reuse of sewage water in agriculture; and (e) adoption/use of ISO 14001 certification standards.

4.7: *Sampling, Analysis and Capacity Strengthening*

Towards achieving this objective, NGO experts carrying out various aspects of the project developed a sampling protocol or plan with the PIT. The protocol team carried out a detail site survey of the project site based on the information gathered from the project model developed, with a view to identifying and planning a sampling programme to match the properties and anticipated environmental behaviour of the POPs and their metabolites in *water, sediment, fish, chicken eggs* and milk from breast-feeding mothers. Two main aspects of this investigation were **environmental/community monitoring** to characterize the current chemical and eco-toxicological status and determine spatial distribution of POPs in the segments of Lagos lagoon and **Human exposure investigation.** *A detail description of these activities is presented in the sections 5 and 6 below.*

On capacity strengthening component of the project, the PIT recognized this as a key important component of this project from inception, as such at a project review meeting on 04/02/12. NGOs with specific expertise were mandated to lead the specific activities required and other NGO members drafted as team members of the various activities in other to build their capacity. For this activity specifically, Sustainable Environmental Development Initiative (NGO based in Benin), led the team on Environmental Sampling and Analysis. Other NGOs respectively led various aspects are: NEST, Ibadan – Capacity building/Strengthening; SRADev Nigeria – Literature review and Human exposure monitoring; PAVE, Lagos – Workshop Coordination, FOTE, Lagos – Overall Project Management. All teams were strictly guided by a respective Term of Reference (TOR) jointly developed and agreed by NASPIN *(See Annex 4).*

SECTION FIVE

5.0 ENVIRONMENTAL SAMPLING/COMMUNITY MONITORING AND HUMAN EXPOSURE INVESTIGATION OF POPs

5.1 Specific Objective

The objective of this activity was to determine the contamination level of POPs in water, sediment, fish, soil and eggs from selected areas of the Lagos Lagoon close to significant anthropogenic activities which could inadvertently lead to deposition of POPs residue in the water body. An important aspect of this study is to protect public health.

5.2 Description of Study and Sampling Area

Isebor *et al.,* (2006) described the Lagos Lagoon as a brackish coastal water body found on the Western part of Nigeria with latitudes 6º26' - 6º30'N and longitudes 3º23' - 4º20'E, and cuts across the southern part of the metropolis, linking the Atlantic ocean (in the west and south), Lekki and Kuramo Lagoon (in the east). The lagoon is shallow, with an average depth of about 1.5m. Shoals of sand due to sediment deposit are scattered in the lagoon and are usually exposed during low tides. Apart from marine transportation and fishing, complex mixtures of domestic and industrial effluents enter the Lagos Lagoon daily.

5.3 Description of Sampling Stations/Points

Four sampling stations based on criteria of proximity to point of effluent discharge from factories and degree of human activities in the area along the lagoon was selected (see plate 1 above). Actual sampling was done in the month of September 2012.

Sampling Station	Description	Coordinates
A	**Ilaje community** (municipal waste is visible seen dumped into the water	N06^{0}31.324^1
B	**Oko-Oba**(Surface water was visibly oily and use of wood preservatives was observed)	N06^{0}29.323^1
C	**Iddo** (Effluents from domestic and near industrial activities visible - FRIGOGLASS, Coca Cola bottling etc)	N06^{0}27.322^1
D	**Apapa** (Folawiyo Tank Farm, Surface water is visibly oily and close to industries - Oil and gas, transportation and haulage, shipping, food)	N06^{0}25.321^1

Table 1: Sampling stations and their coordinates

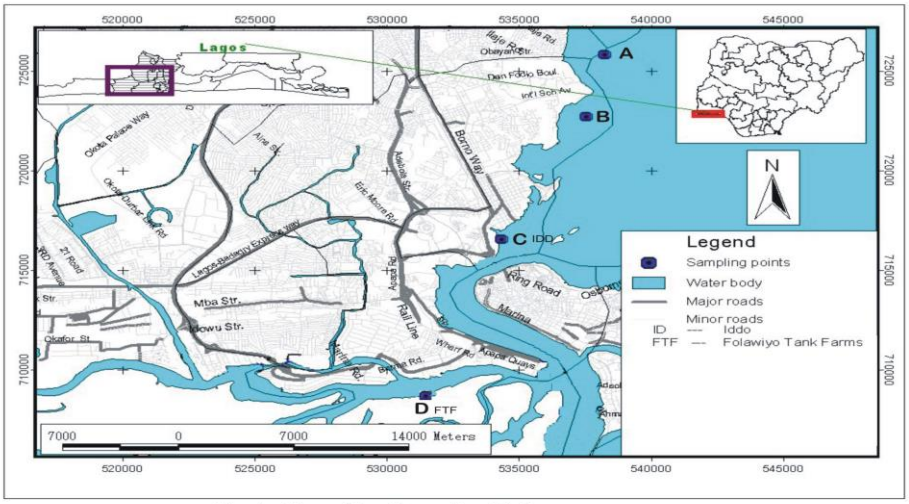

Fig. 1: Map of the Sampling Stations

5.4 Sampling, Sample Preparation and Analysis

Water samples were collected at each sampling station at a depth of 2m below the water surface with a pre-cleaned 1litre glass bottles. Surface sediment samples were collected with a stainless steel eckman bottom sampler (Topouoglu et al., 2002). The top 20cm of the bottom sediments were carefully removed wrapped in a foil paper before being stored in glass vials. Surface soil samples were collected from communities around the sampling stations using a soil auger at a depth of 15cm. The soil samples were wrapped in foil paper before storage in glass vials. Fish samples were collected from the sampling stations, wrapped with foil paper and put in polyethylene bags. Egg samples from free range roosters/hens were collected from communities near the sampling stations. They were wrapped with polyethylene bags and stored in plastic vials. All samples (water, sediments, fish, soil and eggs) were transported to the laboratory in ice coolers. In the laboratory, they were at -20^{o}C until extraction. Samples at each sampling station were collected as composites of 3 sampling areas per station. The samples were extracted and cleanup by modified standard methods of ASTM (2002) and EPA (1980) and other standard methods. POPs Organochlorine pesticides (OCPs) residues were analyzed by Hewlett Packard Gas Chromatograph 6890 with a Pulse Flame Photometric Detector (PFPD) and HP ChemStation Software.

5.5 Results for Environmental Sampling

The results of the detection of POPs in water, sediment, fish, soil and eggs are shown in Table 2. The values shown indicate the range, mean and standard deviation of the concentration of POPs in the various samples collected. The total POPs concentration for all the sampling stations ranged from 2.12 - 5.66µg/L **(water)**, 8.55 - 15.31µg/kg **(sediment)**, 3.83 - 10.96µg/kg **(fish)**, 1500.84 - 2495.73µg/kg **(soil)** and 3.92 - 9.56µg/kg **(egg)**.

The highest concentrations of individual POPs were 4.53µg/kg (Endosulfan) **(Apapa-water)**, 6.28µg/L (Endrin) **(Ilaje-sediment)**, 5.83µg/kg (Endosulfan) **(Ilaje-fish)**, 1710.06µg/kg (Endosulfan) **(Apapa-soil)**, 4.42µg/kg (Endosulfan) **(Ilaje-egg)**. The mean concentration of sum POPs for Ilaje, Okobaba, Iddo and Apapa sample stations were 0.23±0.69µg/L, 0.23±0.69µg/L, 0.13±0.28µg/L and

0.33±1.08µg/L **(water)**, 0.85±1.58µg/kg, 0.81±1.41µg/kg, 0.50±0.96µg/kg and 0.48±0.96µg/kg **(sediment)**, 0.65±1.47µg/kg, 0.56±1.10µg/kg, 0.22±0.42µg/kg and 0.31±0.51µg/kg **(fish)**, 138.65±548.66µg/kg, 88.46±352.82µg/kg, 83.38±334.64 µg/kg and 99.10±402.15µg/kg **(soil)** and 0.53±1.08µg/kg, 0.43±0.83µg/kg, 0.23±0.33 µg/kg, and 0.22±0.30µg/kg **(eggs)** respectively.

The concentration of total POPs at the different sampling stations increased in this order; 2.12µg/L **(Iddo)**, 3.88µg/L **(Okobaba)**, 3.96µg/L **(Ilaje)** and 5.66µg/L **(Apapa)** for water samples; 8.55µg/kg **(Apapa)**, 8.94µg/kg **(Iddo)**, 14.6µg/kg **(Okobaba)** and 15.31µg/kg **(Ilaje)** for sediment samples; 3.83µg/kg **(Iddo)**, 5.29µg/kg **(Apapa),** 9.58µg/kg **(Okobaba)** and 10.96µg/kg **(Ilaje)** for Fish samples; 1500.84µg/kg **(Iddo)**, 1592.31µg/kg **(Okobaba)**, 1783.72µg/kg **(Apapa)** and 2495.75µg/kg **(Ilaje)** for Soil samples and 3.92µg/kg **(Apapa)**, 4.12µg/kg **(Iddo)**, 7.81µg/kg **(Okobaba)** and 9.56µg/kg **(Iddo)** for egg samples.

The concentration of total POPs in the various media increased in this order; 3.91µg/L **(water)**, 6.36µg/kg **(egg)**, 7.41µg/kg **(fish)**, 11.85µg/kg **(sediment)** and 1843.16µg/kg **(soil)**. Table 3 shows POPs in water samples and World Health Organization (WHO) guideline limits for water quality. The total concentration of POPs in the sampling stations is shown in Figures 2-6.

Table 2: Total OCPs concentrations in water, sediment, fish, egg and soil from selected areas of the Lagos lagoon

Compound	Range	Water (µg/L) Mean ± SD	Range	Sediment (µg/kg) Mean ± SD	Range	Fish (µg/kg) Mean ± SD	Range	Soil (µg/kg) Mean ± SD	Range	Egg (µg/kg) Mean ± SD
Mecoprop			0.058-0.061	0.059±0.001			0.044-0.058	0.055±0.007	ND-0.002	0.002±0.001
Atrazine	0.058-0.059	0.058±0.000	0.214-0.218	0.216±0.002	0.058-0.059	0.058±0.000	0.200-0.214	0.210±0.007	0.070-0.073	0.071±0.001
2, 4-D	0.056-0.057	0.057±0.001	0.211-0.215	0.213±0.002	0.056-0.057	0.057±0.001	0.200-0.211	0.208±0.005	0.068-0.071	0.069±0.001
Carbofuran	0.01-0.011	0.011±0.001	0.097-0.101	0.099±0.002	0.010-0.011	0.010±0.001	0.083-0.097	0.094±0.007	0.022-0.025	0.023±0.002
DBCP	0.073-0.074	0.074±0.001	0.228-0.234	0.232±0.003	0.073-0.074	0.074±0.001	0.214-0.228	0.225±0.007	0.085-0.088	0.086±0.001
Pentachlorophenol	0.077	0.077±0.000	0.257-0.260	0.259±0.001	0.077	0.077±0.000	0.243-0.257	0.254±0.007	0.088-0.091	0.089±0.002
Fenoprop	0.027	0.027±0.000	0.180-0.181	0.181±0.001	0.027-0.028	0.028±0.001	0.178-0.180	0.180±0.001	0.153-0.154	0.153±0.001
Alachlor	0.016-0.097	0.055±0.039	0.037-0.059	0.042±0.011	0.186-3.632	2.033±1.439	1.046-2.412	1.728±0.613	0.009-0.084	0.032±0.035
2,4-DB	0.004-0.005	0.005±0.001	0.218-0.220	0.219±0.001	.0004-0.040	0.014±0.018	0.220	0.220±0.000	0.177-0.148	0.155±0.014
Metolachlor	0.069	0.069±0.000	0.083-0.084	0.084±0.001	0.068-0.069	0.069±0.001	0.083	0.083±0.000	0.069-0.083	0.073±0.007
Lindane	0.085	0.085±0.000	0.116-0.425	0.266±0.170	0.129-0.804	0.313±0.000	1.998-36.664	19.732±20.43	0.608-0.820	0.730±0.091
Chlorpyrifos	0.079	0.079±0.000	0.108	0.108±0.000	0.078-0.079	0.079±0.252	0.011-1.081	0.327±0.505	0.079-0.108	0.086±0.015
DDT	0.073	0.073±0.000	0.625-2.646	1.683±1.074	0.673	0.673±0.096	9.766-12.291	11.384±1.148	0.258-0.450	0.364±0.080
Aldrin	0.055-0.093	0.072±0.016	0.633-1.401	0.942±0.341	0.370-0.932	0.666±0.038	1.153-16.333	7.643±7.589	0.021-0.715	0.347±0.354
Endrin	0.116-0.169	0.120±0.046	4.124-6.278	5.061±1.072	0.039-0.250	0.148±0.096	3.444-95.398	35.854±43.29	1.105-1.919	1.368±0.378
Chlordane	0.103-0.135	0.122±0.015	0.061-0.064	0.208±0.290	0.103-0.192	0.148±0.038	1.319-3.080	2.020±0.769	0.175-0.398	0.313±0.097
Endosulfan	1.2-4.534	2.889±1.361	0.156-0.334	0.243±0.090	1.088-5.832	2.945±2.121	1423.69-2335.22	1742.635 ±413.141	0.581-4.423	2.331±1.910
Dieldrin	0.013-0.060	0.034±0.020	1.020-2.573	1.737±0.772	0.023-0.026	0.024±0.002	14.741-27.758	20.307±5.453	0.064-0.070	0.066±0.005
Sum POPs	2.120-5.662	3.905±1.500	8.545-15.307	11.849±3.832	3.828-10.959	7.414±4.296	1500.84-2495.73	1843.157 ±492.985	3.921-9.562	6.355±2.994

Internal Standard	0.060	0.060±0.000	0.060	0.060±0.000	0.060-0.061	0.060±0.001	0.060	0.060±0.000	0.060	0.060±0.000

Compound	WHO guideline limits (µg/L)	POPs in water sample (µg/L)
Mecoprop	0.01	ND
Atrazine	0.01	0.058±0.000
2, 4-D	0.5	0.057±0.001
Carbofuran	0.1	0.011±0.001
DBCP	0.02	0.074±0.001
Pentachlorophenol	0.01	0.077±0.000
Fenoprop	0.2	0.027±0.000
Alachlor	0.1	0.055±0.039
2,4-DB	1.0	0.005±0.001

Table 3: Show POPs in water samples and World Health Organization (WHO) guideline limits for water quality

ND – Not detected

Metolachlor	.01	0.069±0.000
Lindane	0.01	0.085±0.000
Chlorpyrifos	1.0	0.079±0.000
DDT	0.011	0.073±0.000
Aldrin	0.03	0.072±0.016
Endrin	0.6	0.120±0.046
Chlordane	0.014	0.122±0.015
Endosulfan	0.6	2.889±1.361
Dieldrin	0.03	0.034±0.020

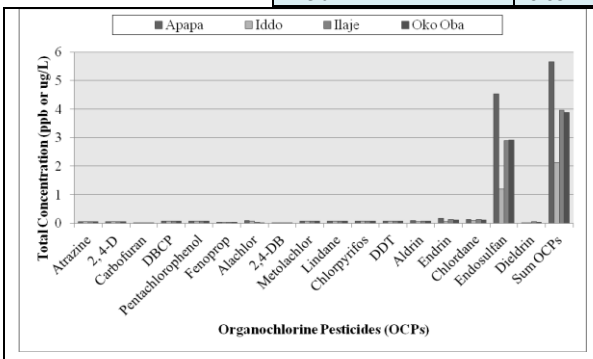

Fig. 2: Total Concentrations of POPs in water samples at different sampling stations

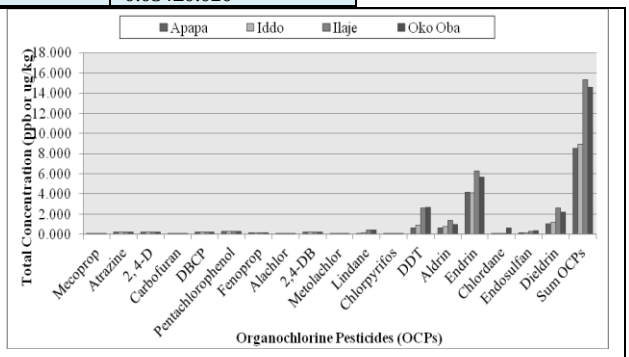

Fig. 3: Total Concentrations of POPs in sediment samples at different sampling stations

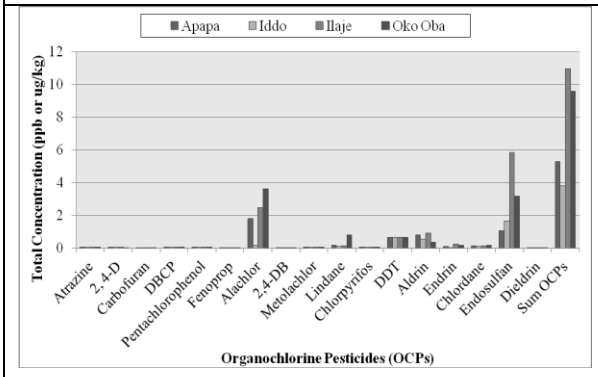

Fig. 4: Total Concentrations of POPs in fish samples at different sampling stations

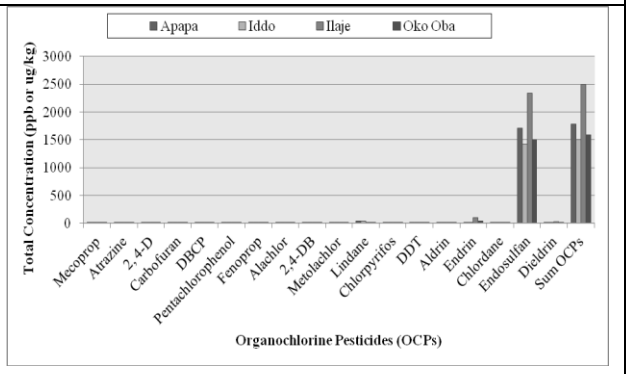

Fig. 5: Total Concentrations of POPs in soil samples at different sampling stations

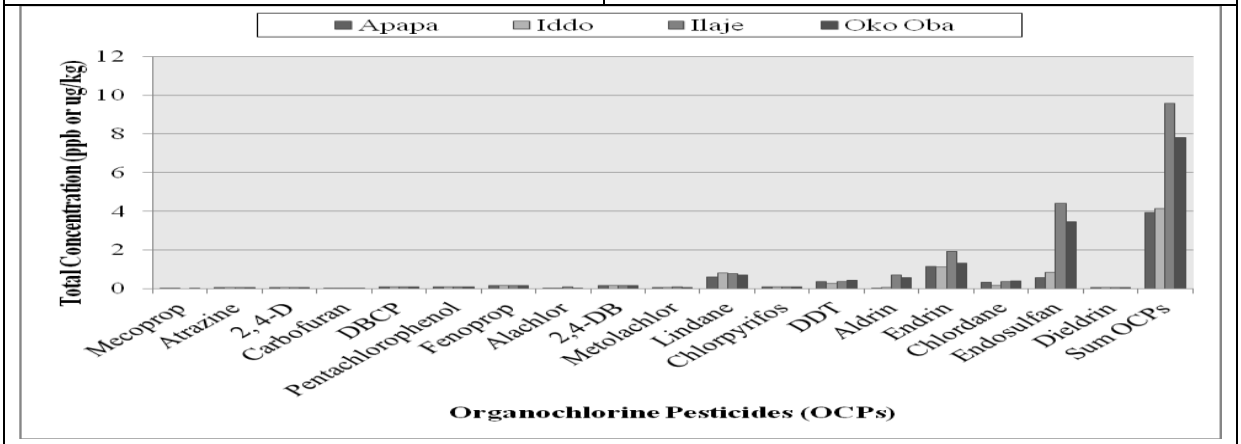

Fig. 6: Total Concentrations of POPs in egg samples at different sampling stations

SECTION SIX

6.0 HUMAN EXPOSURE INVESTIGATION OF POPs

Human exposure will be through localized use in the household and from the diet; human breast milk will be collected and analyzed for POPs and metabolites with the consent of and in collaboration with the health authorities using appropriate ethical methodologies for involving human subjects directly.

6.1 SPECIFIC OBJECTIVE

To provide an overview of exposure levels in communities around the Lagos lagoon and hence determine trends in exposure levels for more reliable and comparable data on concentrations of POPs in human milk for further improvement of health risk assessment.

6.2 METHODOLOGY

6.2.1 Study Population and Sample Collection

Healthy breast-feeding volunteers not older than 30 years of ages were selected at random from health centres in two distinct geographical areas (Ebute-Metta and Ibeshe) but with close proximity to the Lagos lagoon.

Table 4: Coordinates for Hospital Locations

S/N	HOSPITAL	LOCATION	COORDINATES	
			N	E
1.	Ebute Metta Comprehensive health centre	Cemetry Street, Ebute Metta, Lagos.	$06^0$29'17.8''	$003^0$23'05.2''
2.	Ibeshe Primary Health Care	Ibeshe, Ikorodu.	$06^0$33'29.2''	$003^0$28'31.1''
3.	*CMS PHC	Bariga, Lagos.	$06^0$32'09.4''	$003^0$23'24.0''

NOT DONE

6.2.2 Visit/Training of field collaborators

Since all biological samples of human origin, including milk should be regarded as infected, necessary precaution procedures were applied in both sampling and handling of all samples. Trained personnel are just as crucial at the sampling stage as in the laboratory. Therefore, standardized protocols, equipment and education of field personnel as well as laboratory personnel were implemented.

After selecting the hospitals per location, approvals were sort from the appropriate local governments and the State Ministry of Health. The study coordinator visited the hospitals selected on the clinic days to inform the Chief Nurse about proposed study details and the training it involves, the selection of breast milk donors and the implementation of the questionnaire, as well as to clarify any doubts that may arise when the procedures are implemented. Upon approval of the nurse to conduct the study, repeated visits were made to the hospitals on appointed clinic days to brief and select the volunteers.

6.2.3 Selection of donors and implementation of questionnaire

The potential donors through the guidance of the nurse were identified and recruited at the hospital. Primarily, they were selected to must meet the following selection criteria based on WHO sampling protocol:

- *Primiparas* (a woman who has given birth to one child or who is giving birth for the first time);
- Mothers not older than 30 years of age;
- Both mother and child must be apparently healthy, and pregnancy had to be normal;
- The mother must be breastfeeding only one child (e.g.: no twins);
- Only mothers that have lived at least ten years in the area must be included;
- Only mothers that are exclusively or primarily breastfeeding must be included;
- The mother must not live in the vicinity of incinerators, paper mills, metal factories and chemicals factories;
- The mother must be available for the extraction of the sample between the **third** and **eighth** week postpartum.

The mothers that met all these requirements were invited to participate in the study by signing the Consent Agreement (Annex 5). Before the milk was collected, the donors were interviewed by the professional to provide information about her housing and feeding habits, in accordance with the Individual Questionnaire (Annex 6).

6.2.4 Sample collection, preparation and extraction:

The collection of breast milk was coordinated by a public health professional at hospitals or primary health care facilities within the project location identified.

Four (4) breast milk samples were collected from four (4) nursing mothers using the WHO, 1989 protocol for breast milk sample collection. The milk samples (100ml each) were collected manually and directly into chemically clean sample glass vials with Teflon-lined caps and immediately stored in ice coolers for transportation to the analytical laboratory. The collected samples were sent fast to the laboratory for analysis. In the laboratory, the samples were stored at -4^{o}C until analysis. This is the recommended temperature at which all microbial actions in biological samples are ceased (Kiriluk, *et a*l., 1996). At the laboratory, samples collected were prepared, extracted and cleaned up by standard laboratory methods ready for analysis.

POPs/OCPs residue analysis was done according to the manual of analytical methods for the analysis of pesticide residues in human samples, EPA-600/8-80-038 (USEPA, 1980). The residues were analyzed by Hewlett Packard Gas Chromatograph 6890 with a Pulse Flame Photometric Detector (PFPD) and HP ChemStation Software.

Sign post of the PHC at Ebute metta

Field Coordinator with Staff Nurse at Ibeshe PHC, Ikorodu

Volunteer mothers during the briefing sessions at Ibeshe PHC

Cross section of mothers at Ebuta Metta PHC

Questionnaire administration for one of the young mothers at Ebute Metta PHC

Questionnaire administration for another young donor at Ebute Metta PHC

Plate 3: Showing photographs during the consultation and sample collection

6.2.5 Study Ethical Consideration

Prior to sample collection, the study ethical considerations were communicated to the government officials (*Lagos State Ministry of Health)* and the volunteers. That the human milk samples to be collected and the questionnaires would be used specifically for the purposes of this research, and shall not be employed for other purposes. Any data provided by mothers that may permit their personal identification, were maintained confidential and shall not be disclosed. This ethical information was conveyed to the mothers during sampling.

Other ethical issues include ensuring that participants are able to provide informed consent and recognize their rights to withdraw at any stage. Participation in the study was voluntary and mother's decision not to participate or to quit the study after being enrolled was guaranteed. Anonymity was ensured as far as possible, unless informants give permission for use of their name, in which case they were asked to sign the consent. Generally, no foreseeable risk to mothers was envisaged, since all the precautions were taken to protect personal safety during the phases of the study.

6.2.6 Sample Quantification and Statistical Analysis

The quantities of residues in the samples were determined using an external standard method. An organo chlorine standard mixture with known concentrations was run and the detector response for each compound was determined. The areas of the corresponding peak in the samples were compared with that of the known standards (Table 5).

The results of OCPs residues in the various samples were analyzed and presented using Microsoft Excel 2007. The means of the OCPs were subjected to One-way analysis of variance (ANOVA) using SPSS version 16.0. Significant difference was determined at 5% confidence level ($P<0.05$). OCP residue values are presented in parts per billion and correct to 3 decimal places.

Table 5: Calibration curve for correlated coefficient of the selected intermediate standards

S/N	POPs (OCP)	Correlation Coefficient
1.	Mecoprop	0.99989
2.	Pentachlorophenol	0.99908
3.	2, 4, DB	0.99952
4.	DDT	0.99969
5.	Endrin	0.99984
6.	Dieldrin	0.99616
Average		**0.99903**

6.3 RESULTS FOR HUMAN EXPOSURE INVESTIGATION

The results of the detection of OCPs in human breast milk are shown in Table 6, Fig. 7. The total OCPs concentration for all the sampling areas ranged from 1.736 – 2.270ppb. Within the limits of quantification with values presented in 3 decimal places, Mecoprop and Carbofuran residues were nil while 16 other OCPs residues were detected in HBM from both areas. The total mean values of OCP residues from the two areas increased as follows; DBCP, Fenoprop, Alachlor (0.003) < Pentachlorophenol (0.005) < Atrazine (0.010) < 2,4-DB (0.028) < Lindane (0.031) < 2,4 –D (0.032) < Chlorpyrifos (0.057) < Endrin (0.130) < Dieldrin (0.131) < Chlordane (0.150) < Aldrin (0.192) < Endosulfan (0.298) < DDT (0.422) < Metachlor (0.508).

Table 6: POPs (OCPs) residues in Human Breast Milk from selected hospitals around the Lagos lagoon

Organochlorine Pesticide Residues (POPs)	Ebute Metta 1	Ebute Metta 2	Ibeshe 1	Ibeshe 2	Total Mean
Mecoprop	0.000	0.000	0.000	0.000	0.000
Atrazine	0.020	0.007	0.008	0.006	0.010
2, 4-D	0.083	0.031	0.005	0.007	0.032
Carbofuran	0.000	0.001	0.000	0.000	0.000
DBCP	0.003	0.004	0.002	0.003	0.003
Pentachlorophenol	0.005	0.006	0.004	0.006	0.005
Fenoprop	0.002	0.003	0.003	0.003	0.003
Alachlor	0.003	0.002	0.004	0.004	0.003

2,4-DB	0.025	0.028	0.024	0.034	0.028
Metolachlor	0.452	0.530	0.398	0.651	0.508
Lindane	0.024	0.027	0.037	0.035	0.031
Chlorpyrifos	0.044	0.046	0.074	0.062	0.057
DDT	0.347	0.368	0.483	0.491	0.422
Aldrin	0.137	0.214	0.224	0.191	0.192
Endrin	0.113	0.121	0.134	0.153	0.130
Chlordane	0.124	0.137	0.172	0.166	0.150
Endosulfan	0.238	0.287	0.352	0.313	0.298
Dieldrin	0.116	0.135	0.129	0.145	0.131
Total OCPs	1.736	1.947	2.053	2.270	
Internal Standard	1.048	1.024	0.988	0.999	

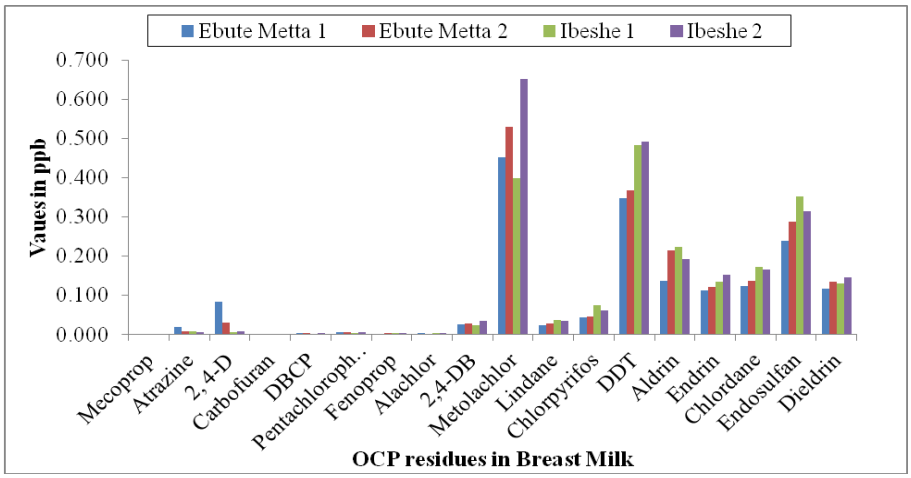

Fig. 7: Concentrations of Organochlorine Pesticide Residues in Human Breast Milk Samples from Ebute Metta and Ibeshe Areas

Comparison of the results of mean OCPs in HBM samples from the two sample areas (Table 7, Fig. 8) revealed that residues HBM samples from Ibeshe were generally higher than those from Ebute Metta with Lindane, DDT and Chlordane showing significantly higher levels ($p<0.005$) than those from Ebute metta. In addition, comparison of Dieldrin, Aldrin and Endrin residues with maximum residue limits (MRL) set by the FAO/WHO as well as results from other countries showed that the detected levels were within limits (Table 8).

Table 7: Mean concentration of OCP residues from Ebute Metta and Ibeshe sample areas

OCP Residues	**Ebute Metta**		**Ibeshe**	
	Mean Values	**Std. Dev.**	**Mean Values**	**Std. Dev.**
Mecoprop	0.000	0.000	0.000	0.000
Atrazine	0.014	0.009	0.007	0.001
2, 4-D	0.057	0.037	0.006	0.001
Carbofuran	0.001	0.001	0.000	0.000

DBCP	0.004	0.001	0.003	0.001
Pentachlorophenol	0.006	0.001	0.005	0.001
Fenoprop	0.003	0.001	0.003	0.000
Alachlor	0.003	0.001	0.004	0.000
2,4-DB	0.027	0.002	0.029	0.007
Metolachlor	0.491	0.055	0.525	0.179
Lindane	0.026	0.002	0.036	0.001
Chlorpyrifos	0.045	0.001	0.068	0.008
DDT	0.358	0.015	0.487	0.006
Aldrin	0.176	0.054	0.208	0.023
Endrin	0.117	0.006	0.144	0.013
Chlordane	0.131	0.009	0.169	0.004
Endosulfan	0.263	0.035	0.333	0.028
Dieldrin	0.126	0.013	0.137	0.011

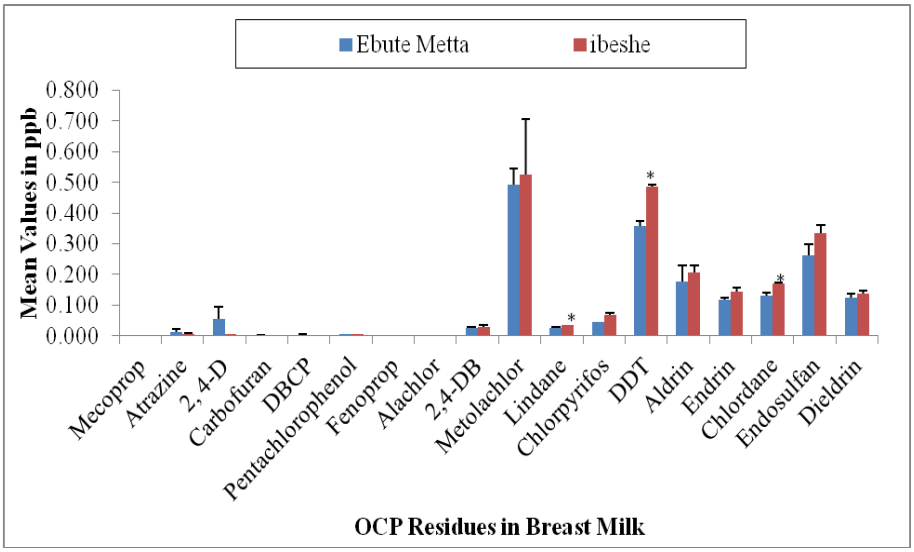

*Fig.8. Comparison of mean concentrations of OCP residues from Ebute metta and Ibeshe sample areas. *represents significant difference at p<0.05*

Table 8: Comparison of OCPs in Human Milk samples from Lagos and Other Countries (µg/g Lipid)

Country	**Dieldrin**	**Aldrin**	**Endrin**	***Reference***
Indonesia	0.0400	ND	ND	*Burke et al, 2003*
Japan	0.0050	ND	ND	*Nakai, et al, 2004*
Libya (Rural)	0.0192	0.0122	0.0181	*Al-Targi, et al, 2011*
Libya (Urban)	0.0090	0.0030	ND	*Al-Targi, et al, 2011*
Ebute Metta	0.0001	0.0002	0.0001	*This present study*
Ibeshe	0.0001	0.0002	0.0001	*This present study*

MRL	0.0060	0.0060	0.0008	*FAO/WHO, 2000*

7.0 GENERAL DISCUSSION (Environmental Sampling and Human Exposure Investigation)

This study is intended to support the development and implementation of risk management strategies that will ensure the safety of the Lagos Lagoon through a scientific basis for the control of POPs constituents present in the Lagoon.

The results showed that Apapa had the highest concentration of endosulfan in water samples (Fig. 2). This could be as a result of a higher concentration of industrial activities at this location. Sediment samples had relatively high concentrations of DDT, Andrin, Endrin and Dieldrin in all the sampling stations (Fig. 3). This indicates the indiscriminate use of these harmful POPs which are broad spectrum insecticides and also used for wood protection. The high concentrations of endosulfan, alachlor, aldrin, DDT and lindane in fish samples (Fig. 4) indicates that large quantities of these substances are used, and which are subsequently absorbed by fish and other aquatic organisms in the water body. These ultimately on the long-term could result in damage to vital organs in humans. A high concentration of endosulfan was observed in soil samples in all the stations (fig. 5). This indicates high pesticide which is absorbed in soil and which is deleterious to human health. Eggs had relatively high concentrations of endosulfan, chlordane, endrin, aldrin, DDT and lindane (Fig. 6). This concentration indicates the presence of these substances in levels that could be injurious to human health. Mecoprop which is mainly used as an herbicide was not recorded for water and fish samples.

In comparison with WHO guidelines for water quality, it was observed that most of the POPs were above the recommended maximum limits. This reveals pollution which is in accordance with Nwankwoala and Osibanjo (1992), who reported a general contamination of African inland surface waters by a broad spectrum of Organochlorine pesticides (OCPs). This view is also supported by Ize-iyamu *et al*., 2007 who discovered that pesticides were bio-accumulated at the bottom of the Lagoon.

The results of the concentration of total OCPs in the Human Breast Milk (HBM) samples were found to be within the MRL set by the FAO/WHO, 2000. In addition, some of the 16 detected OCPs such as Dieldrin, DDT, Endrin and Chlordane have also been reported in HBM samples from Ghana (Tutu, *et al,* 2011) and Libya (Al-Targi, *et al*, 2011). The higher concentrations of OCP residues in HBM samples from *Ibeshe* compared to *Ebute Metta* could be a reflection of the kind of anthropogenic activities going on at such area which exposes breast-feeding mothers to OCPs, and the fact that more agricultural activities in Ikorodu area compared to Ebute Metta further explains the trend.

Comparison of the results of OCPs residue analysis in HBM samples in this study with analyses of OCP residues in sediment, water, soil, egg and fish samples from previous studies at selected areas around the Lagos lagoon showed that the detected POPs (OCPs) are the same as those detected from those studies, an indication that environmental pollution also responsible for human exposure in the area. However, the levels detected in this study are much lower than those detected in the previous studies especially when compared with the results from the soil and sediment samples. This

could be attributed to the fact that the levels detected in those media are not high enough for significant uptake through food such as fish or crops planted in such areas hence, the OCPs cannot be significantly biomagnified up the food chain.

One key limitation of the project, which is insufficient funds to undertake wider analysis of more samples across the entire study area, could also be a likely reason why OCPs levels were seemingly seen to be low from the few samples. Therefore, the scope of sampling in this study is insufficient to infer that POPs levels are generally within MRL (in other word safe limits) in breast milk samples in communities around the Lagos lagoon.

8.0 CONCLUSION AND RECOMMENDATIONS

From this project, it has shown that water, sediment, fish, soil and egg samples collected from the Lagos Lagoon are contaminated with varying amounts of persistent organic pollutants (POPs). Thus investigations of exact sources and point of entry of these residues as well as awareness programmes of the harmful effects of these pesticides especially in fish and eggs which serve as food are recommended.

Although this study (which could be due to the small sample size) has shown that breast-feeding mothers and breast-fed babies in the study areas are relatively safe from POP/OCPs contamination. However, due to the fact that the OCPs were detected at all and that the same POPs found in the various environmental media were also found in reasonable levels in HBM is sufficient public health alarm to Lagosians, therefore is need for an immediate wider population survey among the populace by the appropriate government agencies (ministry of health and environment) in other to establish the exact exposure, to be followed by continuous monitoring perhaps on a yearly basis to ensure the levels do not get to or exceed the MRL set by the WHO. Furthermore, safety and awareness programmes should be continued in these study areas and other high risk zones to guarantee that these POPs remain below the set limits.

There is very urgent need for regular surveillance and policing of the lagoon and enforcement of relevant legislation against polluters of the lagoon by the Lagos State Environmental Protection Agency (LASEPA). There is need for the neighboring communities and inhabitants to become more vigilant and aware of the need to protect the Lagoon. Further studies of pesticide residues in blood serum of the inhabitants of communities surrounding these selected areas are recommended.

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Annex 1:

ANNEX 1

MINUTES OF THE CONSULTATIVE MEETING BETWEEN NASPIN AND THE ILAJE COMMUNITY DEVELOPMENT ASSOCIATION ON 07/10/10 AT THE PALACE OF THE *BAALE* OF ILAJE

The meeting started around 11:00am with the introduction of participant. Miss Folake Salawu introduced the NASPIN team. She highlighted the reason for the meeting.

Mr. Leslie Adogame (NASPIN) introduced the purpose of the meeting and he laid emphasis on the POPs in the Lagos lagoon and the effect on mankind. He said these POPs are discharged into the lagoon through industrial and other means and that one of the reason for the meeting is to brief the community of the NGO project and explore areas of collaboration, they are identified as one of the key stakeholder. He also explained the stages at which the project will be carried out. He further explained that two workshops will hold, one before the sampling and the other after the sampling must have been carried out and the reason for the second workshop is to let the community to be aware of the type of POPs found along there coastal line. He also highlighted the benefit of the project with regards to enhancing the health status of the community.

The Baale of the Ilaje community, Chief Kayode Adetiwa who on behalf of the community welcome members of NASPIN to the community, He noted two key issues which were the fear of government involvement and the end result of the project not affecting the means of livelihood of the people living in the community. He said there will be a need for him to consult with his people before he can give his consent. He requested the team of NASPIN to come back on 14th October 2010 for further discussion.

The team also met with the fishermen association in the community and they pledge their support for the proposed project.

ATTENDANCE:

- Mr. Leslie Adogame
- Engineer Chikwendu
- Mr. Olusanya Stephen
- Miss Folake Salawu
- Chief KayodeAdetiwa - Baale
- Chief Israel ElebiEmayo
- Chief Ajodun Farojoye
- Chief C.A. Okungbure
- Representatives of Women and Youth groups.

ANNEX 2: ***Desk Research and Scenario Development Report***

Annex 3: PROJECT INCEPTION WORKSHOP REPORT

Annex 4: NASPIN JOINT TERM OF REFERENCE

TERMS OF REFERENCE

GEF/SGP PROJECT: COMMUNITY ACTION TO REDUCE THE POLLUTION LOAD OF POPs AND OTHER TOXIC EFFLUENTS (PTS) INTO LAGOS LAGOON.

These TORs have been developed as guide and mandate for individuals or organizations (NGOs) who would be mandated to executing key aspects of the project for successful implementation and tracking of performance.

A) Project Manager

1) Coordinates the Project Implementation Team (PIT)
2) Assign Roles to team members
3) Effective Consultation with Team members and identified stakeholders
4) Devise Action/Implementation plan and ensure strict adherence
5) Approve all Interim and Final Reports and circulation among stakeholders
6) Establish collaborations, linkages and partnerships with NGOs, IGO's (UNIDO, GCLME, ASPetc), Universities, communities, governments for networking, participation and contribution on issues concerning PTS and POPs.
7) Liaison with SGP and responsible for submission of the quarterly reports
8) Monitors the performance of all aspects of the project
9) On behalf of NASPIN, oversee the financial management of the project.
10) Upon approval of steering committee be responsible for the recruitment of consultants and other project staffs.
11) Brief from time to time NASPIN on the progress of the project.

B) Desk Research and Scenario Development

1) Desk Research/Literature review on the Lagos Lagoon with reference to POPs within the catchment area (**experience with subject matter is a prerequisite**)
2) Develop a Project Model with information on the local environment, location of industries and commercial activities, industrial and municipal discharges, hydrograph, sedimentology, tributary discharge, outflow to the coastal zone, vegetation and wetlands coverage as well as the local ecology
3) Research and submit a detail and current literature on the status of:
   - POPs in Nigeria, Lagos and its lagoon.
   - Pollution sources including small industrial users, commercial establishments and domestic sources
   - Identify coastal communities, industries bordering the lagoon catchment areas
   - Document Legal and Regulatory frameworks
   - BAT/BEP and new approaches etc.
4) Written report (12 font, Times New Roman, single line spacing) that meets international standards with footnotes and verifiable references

C) Site Reconnaissance Survey/ Sampling Assessment, Sampling, Analysis and Capacity Strengthening

1) Undertake Site visit and survey
2) Recommend and ensure appropriate sampling methods/techniques are followed throughout project cycle
3) Identify sampling points and adopt an internationally accepted Sampling techniques
4) Submit for approval a sampling protocol report prior to sampling
5) Project site feasibility confirmed
6) Provide regularly such report/information to the project manager for appropriate reporting to SGP
7) Plan and integrate NGO member's capacity building/training within this component as well as other aspects of the project.

8) Written report (12 font, Times New Roman, single line spacing) that meets international standards (footnotes and verifiable references)

D) Stakeholder Sensitization and Project Dissemination Workshop/Dialogue Reports

1) Plan in collaboration with the steering committee the workshops
2) Take full responsibility for Community Mobilisation, Roles/Participation components of the project
3) Submit an action plan for approval of the steering committee
4) Identify coastal communities, industries bordering the lagoon catchment areas (CDAs, Waste mgt companies, local fishermen and farmers, Unilag etc)
5) Select, recommend and invite relevant stakeholders
6) Identify and recommend relevant speakers and subject matters
7) Liaise with the Press for extensive pre- and post workshop publicity
8) Provide regularly such report/information to the project manager for appropriate reporting to SGP
9) Written Report (12 font, Times New Roman, single line spacing) and Communiqué of workshop proceedings.

E) Human Exposure Investigation/Community Monitoring

1) Plan a community mobilization/participation strategy for human exposure investigation in line with the overall project goal spread across three (3) main segments namely the **Lagos Harbour Segment**, the **Metropolitan** and the **Epe Division Segment**.
2) Submit an action plan for approval of the steering committee
3) Identify appropriate experts and laboratories for samples analysis and interpretation
4) Coordinate the collection and analysis of Human breast milk for POPs and metabolites in collaboration with health authorities
5) Coordinate the collection and analysis fish that are sold in markets, chicken eggs from free range hens
6) Provide regularly such report/information to the project manager for appropriate reporting to SGP
7) Written Report (12 font, Times New Roman, single line spacing*).*

F) Monitoring and Evaluation *(Note that this responsibility according to the proposal MOA is to be carried out by a reps of Lagos State Ministry of Environment, NESREA, LASEPA and the industry - Manufacturers Association of Nigeria (MAN)*

1) Provide feedback to Project Manager from monitoring project implementation. (Note 3 reports are expected: inception, midterm & final).
2) Provide stage to stage evaluation on progress towards project outputs and results.
3) Provide Written final M&E Report (12 font, Times New Roman, single line spacing).

Annex 5: **CONSENT AGREEMENT**

DONOR'S CONSENT AGREEMENT

I, _____

Freely accept to participate in the of study "Levels Persistent Organic Pollutants in Breast Milk", to be conducted by ***SRADev Nigeria*** *and the NASPIN Program, under the coordination of the investigators Leslie Adogame (e-mail: ane_adogame@hotmail.com) and Pat Udaze (e-mail: patudaze@yahoo.com), address: No 18 Olorunlogbon Street, Anthony village, Lagos, who may be contacted any time during the research.*

Purpose of the study: The study is aimed at quantifying the levels of Persistent Organic Pollutants in human milk to estimate the levels of human exposure to POPs and the environmental pollution caused by these agents. POPs bio-accumulate in animal fat; as human breast milk is rich in fat, the dosing of these substances reflects the degree of exposure of the general population, without requiring invasive and painful extractions.

Study Rationale: The study gives a general view of the exposed population's levels of exposure in the country. This information and the knowledge developed enables government agencies to adopt measures to control the environmental pollution caused by these contaminants and to reduce the health hazards for the general population.

Participation: Once my participation is accepted, 100 ml of breast milk will be extracted in private. In addition, I will answer a questionnaire on my personal habits, data on pregnancy, medicines, my work and my feeding habits. As in any study, unforeseeable risks may arise, but all the precautions will be taken to protect my personal safety during the phases of the study herein.

Benefits: The information obtained in this study can be of scientific use and it may be useful for others. In addition, the presence of these agents in question at hazardous levels in breast milk will be included in the donor mother's data, attaching due health care measures, and provisions aimed at reducing environmental pollution.

Privacy: Any personal information obtained in the investigation herein shall be confidential and shall only be disclosed with my authorization. The scientific data and the medical information derived from the study herein can be presented at conferences and published in journals without my identification. I hereby state that my participation in this study is voluntary and that I am aware that my decision not to participate or to quit the study after being enrolled will not entail any problems to the **SRADev Nigeria** involved. I can terminate my participation in the study at any time and for any reason, needing no justifications.

Signature of donor mother: ……. Signature of witness: ……

Date: _____ / ____ / Investigator Identification code:_____

Annex 6: QUESTIONNAIRE

Questionnaire

<table>
<tr><td colspan="4">For donors of breast milk for the analysis of Persistent Organic Pollutants. CONFIDENTIAL!</td></tr>
<tr><td>1. State:</td><td>2. Area (region within the state):</td><td colspan="2">3. Sample identification code:</td></tr>
<tr><td>4. Date of mother's birth: DD/MM/YY</td><td>5. Mother's age in years:</td><td>6. Mother's height in cm:</td><td>7. Mother's weight before pregnancy in kg:</td></tr>
<tr><td>8. Mother's current weight in kg:</td><td colspan="3">9. Area of residence in the last 10 years: Urban Rural</td></tr>
<tr><td>10. Previous area of residence:</td><td>Years</td><td>Urban</td><td>Rural</td></tr>
<tr><td>11. Child's age in weeks at start of sampling:</td><td>12. Child's sex:
Boy
Girl</td><td>13. Child's birth weight in grams:</td><td>14. Child's weight at sampling in grams:</td></tr>
<tr><td rowspan="2">15. Mother's feeding habits before pregnancy:</td><td>Varied diet</td><td>Vegetarian, but includes milk and eggs</td><td>Only vegetarian</td></tr>
<tr><td colspan="3">Others …….. Description:</td></tr>
<tr><td colspan="4">16. How often (as an average) did the mother consume fish during pregnancy?

Never Less than once a week Once a week

Twice a week More than twice a week Every day</td></tr>
<tr><td colspan="4">17. How often (as an average) did the mother consume sea food during pregnancy?

Never Less than once a week Once a week

Twice a week More than twice a week Every day</td></tr>
<tr><td colspan="4">18. How often (as an average) did the mother consume milk before pregnancy?

Never Less than once a week Once a week

Twice a week More than twice a week Every day

Type of milk: .....
Daily consumption: Less than 250 ml 250 – 499 ml 500 ml or more</td></tr>
<tr><td colspan="4">19. How often (as an average) did the mother consume other dairy products (e.g. butter, yoghurt) before pregnancy?</td></tr>
</table>

Never Less than once a week Once a week

Twice a week More than twice a week Every day

Type of product: .....

20. How often (as an average) did the mother consume meat before pregnancy?
Never Less than once a week Once a week

Twice a week More than twice a week Every day

Describe the **type of meat** more frequently consumed by the mother: .....

21. How often (as an average) did the mother consume eggs before pregnancy?
Never Less than once a week Once a week

Twice a week More than twice a week Every day

22. Mother's smoking habits:
She does not smoke Former smoker Current smoker

If she smokes cigarettes, how many a day? .....

23. Did the mother work before pregnancy? YES NO

If the answer is yes, describe the type of job (function, activities, contact with hazardous goods, etc.) and duration in years: ……...

24. Types of past jobs:	a.....	Never worked	**25.** Duration in years

25. Was the donor herself breastfed? Yes No I don't know

If the answer is yes, how long? …….

26. Was the donor's house **treated with DDT** to kill mosquitoes?
Yes No I don't know
If the answer is yes, when? ……..

27. Medicines used during the sampling period, for how long and at what dosages (including vitamins and natural supplements):
_____
_____
_____
_____

Questionnaire completed by:	Date:	Signature: