REPORT
OF THE
ENVIRONMENTAL
AND
SOCIO-ECONOMIC
ASSESSMENT
IN IBAA COMMUNITY

KEBETKACHE

Kebetkache Women Development & Resource Centre

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ABOUT KEBETKACHE WOMEN DEVELOPMENT & RESOURCE CENTRE

Kebetkache Women Development & Resource Centre is non-governmental organization registered with the Corporate Affairs Commission (CAC) in Nigeria with IT/CERT N0.15890. Kebetkache is a community action, education and advocacy women's rights organization working on development and social justice issues that affect women and children in Nigeria and around the world. Kebetkache envisions a just society where women's rights and gender equality are mainstreamed irrespective of status, race, background or diversity. Kebetkache's mission is to achieve gender equality, environmental and climate justice through advocacy for good governance, movement building and capacity strengthening.

Kebetkache is committed to supporting women to achieve gender equality. The organization helps women to understand their rights through sensitization, capacity development, research, mentoring, and movement building targeted at increasing their skills and creating opportunities that will help them solve identified problems. The overall change Kebetkache wants to see:

- A sustainable, vibrant, healthy community of women with recognized rights, power and opportunity to participate in the decision-making processes.
    Kebetkache identified the following domains of change:
- Implementation of community driven gender equality strategies.
- Environmental responsive extractive practices with increased participation of women in all decision-making processes.
- A sustainable environment with a remediated ecosystem with vibrant rural health and security.
- Women's rights supported and protected.
- Support peace building processes
    Kebetkache believes that the following action areas are pathways to bringing about the domains of change.
- Build and sustain an active women's environmental justice movement in the Niger Delta region of Nigeria.
- Contributing to movement building for environmental and climate justice at the African regional and global levels.
- Framing and implementation of gender-based, rights-based contextual policies.
- Contribute to public policies that will increasingly reflect gender equality.
- Continuous advocacy to governments at all levels to promote democratization and inclusive governance.
- Build synergy with civil society organizations and social movements.
- Replicate and support successful Kebetkache development approaches.
- Design and develop approaches/strategies for engendering peace and security.
- Design and develop approaches for community capacity development
- Strengthen partnership with government and international development stakeholders.
- Provide tool for engagement and evidence-based advocacy
- Mainstream platforms and mechanisms for income generation and alternative livelihood structures in community.

ACKNOWLEDGMENT

For: Kebetkache

Emem Okon
Executive Director

FOREWORD

An account of the relationship between Ibaa community and Shell Petroleum Development Company (SPDC), Total Energy and their JV partners is characterized by lack of trust. Several years of activities on Ibaa soil marked with agitation for employment, scholarships and other corporate social responsibilities have not meet the expectations of the people. Environmental issues arising from the operation of manifold "8" has often been blamed on sabotage; even the recent discovery of crude oil in water wells in inhabited areas across the pipe line right of way. As such the people have been made to bear the brunt of environmental trade-off without redress by SPDC. The injustices suffered by Samuel Uchechukwu Chukwure's of Omuokpoba-Mgbuosimini -due to obvious environmental wrongs, prompted the search for justice by providing empirical evidence to prove their claim of environmental contamination from SPDC facility by collaborating with Kebetkache Women Development and Resource Centre and Obelle Concern Citizens.

In an attempt to navigate from stalemate to action, F&E global resources was invited to undertake an environmental assessment of the sub-surface crude oil seepage of manifold "8" trunk line. Amidst security considerations, logistic and technical constraints reconnaissance visit were made followed by a-one-day environmental assessment by our study team; the results of which is presented in this report.

This report would have been impossible without the support of Kebetkache Women Development and Resource Centre and Obelle Concern citizens; support of impacted families and other stakeholders in the community. I will not fail to sincerely thank the Paramount Ruler Ibaa community His Royal Highness (HRH) Eze (Dr). Sunday Wobodo Jonah Nyewea-Ali Ibaa/Obelle and his chiefs in Council, along with personnel from the Institute of Pollution Studies (IPS), Rivers State University, RSU; and Prof. S.A. Wemedo Microbiology department and Director School of Basic Studies Rivers State University and Dr. Akinfolarin Lecturer Department of Chemistry RSU.

I would also wish to thank Mr. Tosin Falodun of the National Oil Spill Detection and Response Agency, (NOSDRA). I also appreciate the assistance of Hon. Henry Eferegbo a representative of Obelle Concern Citizens, Princewill Chikakpobi Chukwure, Sunday Jolly Egbunne members of the impacted families and Amusonu Harvest.

It is our hope that the findings of this report will address the issues raised in a way that benefits the impacted families and the entire Ibaa community.

Endwell Anthony Uchendu
Consultant

EXECUTIVE SUMMARY

The inclusion of Ibaa in Shell Petroleum Development Company (SPDC) facility map in the Niger delta is occasioned by the location of the manifold "8" trunk line since early 1980s. It was until January 15th 2016 when crude oil was observed in Samuel Uchechukwu Chukwure's hand dug ground water well and other inhabited area across the trunk line right of way that raised public health concerns. This observation instigated the need to investigate the immediate and remote cause of the incident as SPDC the operators of the facility were alerted. The situation aggravated as the crude oil horizontally spread to nearby wells in Ovuahu Comprehensive High school premises and Sunday J. Egbunne's well. In response, SPDC drilled ground water monitoring wells across the trunk line to inhabited houses close to the area and an alternative source of water was provided Samuel U. Chukwure's compound.

In May 2022, the water wellswere sealed as the impacted family contacted a representative of Kebetkache Women Development and Resource Centre and Obelle Concern Citizens. Reconnaissance visits were made to evaluate the situation and an independence study was commissioned at the request of Kebetkache Women Development and Resource Centre and Obelle Concern Citizens in collaboration with the impacted families.

 An Assessment process involving field work and laboratory analysis covered public health impact and socio-economic studies. Four sampling locations chosen by community members were investigated for soil, groundwater contamination and outdoor air quality; two of the four sites served as reference. Seven groundwater wells were collected in addition to four soil samples and outdoor air were sampled. All samples collected followed standard methods. Medical officers were contacted for review of medical records at the model primary health centre by the public health team. Key informant interview and questionnaires were administered as well as field observation and photographs to elicit information for socioeconomic studies and public health assessment.

The collected samples were analyzed (using GC-FID) for hydrocarbons (TPH, PAH and BTEX), heavy metals (arsenic, iron, nickel, cadmium, and chromium), microbiology, and outdoor air quality(VOCs, particulate matter, CO, NO_2, methane, ozone and SO_2). The hydrocarbons analyzed in water and soils were PAH, TPH, and BTEX. Total volatile organic compound and other criteria outdoor air contaminants were investigated.

The study key findings from field observation and scientific investigation revealed a widespread crude oil contamination in the seven groundwater and four soil samples covering a radius of about 6km. The air quality index (AQI) for $PM_{2.5}$ and CO was unhealthy for sensitive groups while nitrogen (IV) oxides were above permissible limits. VOCs and methane was also detected suggesting the presences of illegal refining activities.

Based on the risk associated with undue exposure to crude oil contamination, it was recommended as an emergency measure that the impacted families and others 1500m across the pipeline right of way be relocated to safe locations within the community, provision of safe drinking water for the community and rectification of the cause of the leakage in addition to other long term remedies.

1.0 Introduction
Background to the study

Niger Delta

The Niger delta is the largest river delta in Africa and the third largest delta in the world. It is located at the southernmost part of Nigeria and covers an area of about70, 000 Km^2 and makes up 7.5 % of Nigeria's land mass. The Niger delta stretches for nearly 150miles from north to south and spreads along the coast for about 200miles,extends over an area of 140,000square miles. The swamp forest and woodland areas occupy about 12percent of the delta's land surface. The Niger delta region is delineated into nine states of Ondo, Edo, Delta, Bayelsa, Rivers, Akwa-Ibom, Cross River, Abia, and Imo States with about 25% of Nigerian population of about 140 million people (NPC, 2006). Niger delta is home to 31 million people of more than 40 ethnic groups (including the Ikwerre people) with about 250 different dialects.

Rivers State

Rivers State occupies a land area of 10,378km with a population of 5,185,420 people. It is situated in the Niger delta region of southern Nigeria (old Eastern region) and located on coordinateN4^0 45' and E6^0 50'. Rivers state was created in 1967 from the former Eastern Region; it has borders with Imo state in the North, Abia state and Akwa-Ibom state to the east, and Bayelsa state and Delta to the west. Port Harcourt metropolis the capital of Rivers state is acclaimed the commercial center of the Nigerian oil and gas industry. It is a diverse state home to many ethnic groups with 28 indigenous languages delineated into 23 local government areas including the present day Emohua local government area of which Ibaa constitutes.

Fig.1: map of the study area showing Ibaa

1.1: Oil exploration and production in the Niger delta

The history of crude oil exploration and production in the Niger delta would be incomplete without a mention of Oloibiri oil field. Oil prospecting in Nigeria dates back to 1908 in Araromi area of the present Ondo state when Nigeria Bitumen corporation- a German company began exploration.

The outbreak of the First World War in 1914 halted the effort, and was restarted in 1938 by Shell D'Arcy which was awarded the sole concessionary rights over the entire Nigerian territory.

However these activities was interrupted by the Second World War but resumed in 1947. After about a decade of intensive exploration, in 1956 crude oil was discovered in commercial quantities at Oloibiri at a production rate of 5100 barrels per day. Exploration and production activities continued until the Nigeria – Biafra civil war broke out in1967. The subsequent two decades witnessed increased exploration activities by other crude oil exploring companies such as Mobil, Gulf, Agip, Safrap (now Elf), Tenneco and Amoseas(now Texaco/ Chevron) in the onshore and offshore areas of Nigeria.

In 1971Nigeria joined the Organization of Petroleum Exploring Countries (OPEC) and established the Nigerian National Petroleum Corporation (NNPC) in 1977. With the establishment of NNPC, Nigerian oil industry began the development of ancillary facilities for pipeline transportation of crude oil from across the different oil wells and flow stations to the refineries and export terminals. This gave rise to the construction of pipeline trunks crisscrossing the Niger delta landscape. The Ibaa trunk line emanated from Obelle flow station and Rumuekpe manifold before it transverse a posterior section of the community as you access Ibaa from East – West road via Rumuji junction. The trunk line has an oil gathering muster point (manifold "8") in Ibaa and receives crude oil from other production platforms and flow stations from Obelle, Rumuekpe and its environs to Bomu manifold trunk line.

SPDC trunk line showing ground water monitoring wells

Aim and Objectives

Based on the agreed study reference with Ketbekache Women Development and Resource Centre, Obelle Concern citizens, and the impacted families; the following objectives were formulated for investigation.
1.   Determine the extent and spread of crude oil seepage in soil and groundwater
2.   Investigate the exposure of the population to petroleum contaminants.
3.   Determine the outdoor air quality
4.   Determine the social implications and health status of the exposed people.

Scope of the investigation

The geographical scope of the study covers areas in and around Ibaa with focus on S. U. Chukwure's residence along the trunk line right of way and its environs. However a distance of about 5.5km from the focus to the palace of the paramount ruler was also investigated as reference.

Technically, assessment of groundwater and soil focused on the areas outside S. U. Chukwure's residence suspected to have been impacted by either horizontal or vertical spread of crude oil seepage.

The impact of pollutants on human health was investigated by air quality measurement and public health assessment by determining the drinking water quality around the community and by a review of human health data from model primary health center. A social assessment of the community was also undertaken.

Description of the study area

The subject of the study is the subsurface crude oil seepage at manifold "8" trunk lines located in Mgbuosimini section of Ibaa community. The manifold and its trunk lines were built in the 1980s when the area was sparsely inhabited. With growing human population the inhabited area currently covers a radius of about 1000m around the manifold. It shares boundary with residential areas immediately across the road to the East, the trunk line has a boundary with Uvuahu Comprehensive High school Ibaa and adjoining residential areas opposite and beside the school fence across the right of way about 500m from the manifold and less than 200m to the school premises.

The area is currently under investigation following the discovery of thick layers of crude oil in hand dug wells located in Samuel U. Chukwure's residence, Sunday J. Egbunne's residence, Ovuahu Comprehensive High school premises and its environs suspected to have emanated from defective pipe joint or internally corroded pipeline at the manifold. The area is drained by a stream whose head emanate from Orashi River and cuts across many settlements through Ibaa before it empties into the New Calabar River at Choba.

Hazardous substance near school fence across the right of way inhabited area along trunk line right of way.

2.0 GEOLOGY

The Niger delta basin is underlain by three formations: the Benin, Agbada and Akata formations. The Benin formation belongs to the Pliocene- Pleistocene age. The Benin formation outcrop is located in the Northeastern coastal belt and dips at a low angle in the South west. The sediment consists of unconsolidated lenticular and predominantly sandy formations with massive gravel and pebble beds giving rise to high- yielding boreholes. The thickness of the outcrop is estimated at 2300m.

The Agbada formation consists of inter bedded sands and marine shales, observed to range in depth from about 300 to5000m. The Akata formation underlines the Agbada formation and has a sequence of similar marine shales and clays with a range in depth of about 700 to 7000m.

The Akata formation is typically shale and clay while the Agbada formation which is fluviatile and fluvio marine are for petroleum accumulation but too deep to be of interest for groundwater abstraction.

The Benin formation occurs at shallower horizons consist of continental deposit of sand and gravel (Murat, 1970) and is thus of greater importance to the ground water and civil engineers. It is a fact that the Benin formations possess excellent water yielding properties even at great depths (Amajor, 1991; Nwankwoala & Ngah, 2014). The Benin formation is laterally extensive and extends to depths of 2000m in places as revealed by well cuttings from logs of crude oil wells spread across the Niger delta. The Benin formation serves as groundwater reservoir in the region. The major body of groundwater in the Niger delta is contained in the extensive sand and gravel layers which are interspersed with shale and clay layers within the formation. Previous research (Etu-Efeotor & Odigi 1983; Amajor, 1989; Eto-Efeotor & Akpokodje, 1990) indicates that the Benin formation is differentiated into three major zones: a northern bordering zone consisting of shallow aquifers of predominantly continental deposit; a transition zone of intermixing marine and continental materials; and a coastal zone of predominantly marine deposit. According to Akpokodje et al., (1996), the hydro - stratigraphic units of the Benin formation consist of four well defined aquifers in the upper 305m with varying thickness. The aquifer vary from shallow unconfined through semi- confined to confined conditions at depths which are separated by discontinuous layers of shales given a representation of interval that consist of a complex; non-uniform, discontinuous and heterogeneous aquifer system.

Aquifers at the northern border are composed of thicker and coarser river sand from the hinter land and characterized by much fewer clay intercalations as observed in a lithologic map, the Benin formation drawn from borehole lithologs in the different zones. Aquifer of thicker and coarser river sand are also reported at shallower depths, so that in most cases an average depth of 60m was adequate to obtain very potable freshwater of reasonable quality and quantity.

A transitional zone lies within the lower section of the meander belt and consist of freshwater swamps. It is characterized by intricate and extensive meandering of rivers and the presence of lowland fresh water swamps. A common feature of the transition zone is the comparatively more frequent presence of clay intercalations and embodiments within the aquifers distributed laterally and vertically within the zone (Nwankwoala & Ngah, 2014). The aquifer in this zone may be shallow, consisting primarily sand and gravel materials, but clay intercalations become more pronounced compared to the northern zone.

The coastal zone borders the Atlantic Ocean and includes the mangrove swamp zone and beach bridges. Due to the nearness of the coastal zone to the ocean and the persistence of sand layers across the region, there is the possibility for marine conditions to penetrate further inland resulting in a more complex zone with compromised water quality.

Groundwater levels

Groundwater aquifers are important resource upon which the people rely for their water consumption and as such should be protected. Aquifers in Ibaa are quite shallow with still water level varying in season. During the rainy season top-most water level occurs at less than 0.6m and 2.5 to 6.5 at the cessation of rains. The people tap the aquifer by constructing hand - dug well of 60cm in diameter to abstract water manually or with pumps in very few cases from confined aquifers. Deeper wells use submersible pumps to extract water from deeper aquifers.

Hydrogeology

The Niger delta is a sedimentary basin where ground water recharge is mostly through infiltration, precipitation and rivers. The most significant aquifers in the Niger delta are the Deltaic and Benin formation. The geological survey of the Niger delta identifies two classes of aquifers: confined and unconfined aquifers. Confined aquifer occurs across the Deltaic formation and Benin formation. This aquifer is characterized by moderately high-yielding artesian flows. At some points, the aquifers are confined by clay bed of about 36m thick (Abam & Nwankwoala,2020). The thickness of the aquifers below the clay is estimated at 100m. Hydrologic connection exists between the confined aquifer along the coastline and the unconfined aquifer of the Benin formation to the north. The aquifer thickness increases towards the continent, while the confining clay thins out. The specific capacity of this formation varies from 90 to$320m^3/d/m$ in areas underlain by the Benin formation, the confined aquifer occurs in the southeastern part of the Niger Delta. These aquifers consist primarily of very-coarse to medium-grained sands. The specific capacity for this formation varies between 140 and $180m^3/d/m$.

Local community

Ibaa people migrated from their ancestralhome in Ekpeye hundreds of years ago to the present settlement. They are predominantly farmers and live in close knit community with their other neighbours. The total population of Ibaa according to the 2006 National Population Census projected to 2023 was 63,055 persons.

The language spoken by Ibaa people is Ikwerre of Igboid language group within the Benue- Congo branch of Africa languages. Ibaa is divided into three sections: Mgbuosimini, Omuosunu, and Mgbuesa which is further subdivided into 6, 10, and 7 villages respectively. Other residents in the area include the Igbos, Efiks/ Ibibios, Ogonis and few ethnic groups in the Niger delta.

Institutional framework

The institutional framework and legislation relevant to environmental management of the petroleum industry in Nigeria have evolved since the inception of oil exploration in the late 50s.

Department of petroleum Resources (DPR) under the supervision of the Federal Ministry of Petroleum Resources regulates and enforces environmental laws in Nigeria. Environmental Guidelines and Standards for Petroleum Industry in Nigeria (EGASPIN) regulations first issued in 1992 and revised in 2002 is the basis for environmental regulation in Nigeria petroleum industry. Federal Ministry of Environmental created in 1999 and her agency National Oil Spill Detection and Response Agency (NOSDRA) in 2006 based their operation on DPR environmental guidelines and standards.

State offices of the Ministries of Environmental and Natural Resources manage environmental issues within their mandate at the state level. Local government authorities have no official role in environmental management or regulation of the oil industry.

Impacts of oil exploration and Production

At the commencement of oil exploration in late 1950s massive production facilities were established by SPDC a Joint Venture (JV) between NNPC, Shell international and Agip. Long before a barrel of crude oil was produced oil exploration and production have impacted the natural environment in many ways as land clearance for seismic lines, establishment of seismic and drilling camps, infrastructure construction, drilling for oil and development of transportation infrastructure. As the facilities begins operation issues of oil spills during oil production and management of production water and drill cuttings, flaring of associated gas also created environmental impacts.

3.0 METHODOLOGY

Community engagement

Before the outset of field work, from the discovery of the floating crude oil in the water wells different levels of engagements were held between the concerned families and representatives of the NGOs. This was followed up with reconnaissance visits to the impacted locations. Channels of communication and interactions with the impacted families intensified leading up to the engagement of study consultants and a consultative meeting with the community leadership and other stakeholders at Aldgate Hotel Port Harcourt, Rivers state capital on the 7th of July, 2022. Activities at the forum were seminar presentation by Dr. William A. Iyama on environmental impact of crude oil pollution and introduction of consultants to the community.

Photograph of His Royal Highness with consultants, NGOs representative, And impacted family members

Field work

One day field work held on 21st of January, 2023was carried-out by our team to gather relevant data covered the entire length of the community from around the SPDC Manifold "8" trunk line to the palace of the paramount ruler. Sampled location determined by the impacted families covered perceived impacted sites. The outset of the field survey was a courtesy visit to the palace of His Royal Highness (HRH) Eze (Dr.) Sunday Wobodo Jonah (JP) Nyeweali Ibaa/Obelle communities and his Council of Chiefs with the community representatives.

Pre-sampling activities were concluded by assigning identification numbers and exact locations by water and soil team.

The first groundwater sample (GW- 001) was collected from the private dug out well with a depthof 5.4m in the residence of the Highness. Composite soil sample were also collected as reference samples in the same premises in Omuobo.

Public health and socioeconomic team commenced their assessment and interviews with questionnaires from the palace with key informants. Measurements of outdoor air quality were taken by the expert. At the close of the session at the palace at Omuobo, the teams dispersed to the second study location at Omuokpogba for groundwater and soil sample (BH-002) collection. Public health team visited the model primary centre for inspection of medical records of previous years and further interviews residents using the exposure and health questionnaires. The socio-economic team continued their interview and information gathering and administered 30 questionnaires to the people. Two separate water samples and one composite soil sample was collected at the third sampling station from SPDC groundwater monitoring boreholes (BH/34) BH-003^A with lockable cover secured wellhead about 4m away from Mr. Sunday Egbunne's dug-out well sealed with concrete by SPDC at the discovery of thick layers of crude oil in the groundwater well. The SPDC ground water monitoring well has a still water level of about 4.54m deep. A second water sample BH-003^{B}was collected from private borehole in Mr. S. Egbunne's residence covered with a heap of sharp sand by SPDC agents about 200m away trunk line.

The fourth sampling location at Mr. S.U. Chukwure's residence about 100m from the trunk line, three groundwater samples (BH-004^{A,B,C}) and one composite soil sample were taken. BH- 004^A was collected from Chukwure's private with a depth of about 80m and 1.5m from building. Sample BH- 004^B was taken from SPDC groundwater monitoring borehole (PTMW 3) 2.5m away from Chukwure's private hand-dug water well sealed by with concrete by SPDC agents in May , 2022. After a very thick layer crude oil was reported in the well in January 2016. Information from Key informant has it that crude oil loading trucks at regular intervals siphon truckloads of crude oil from the well before it was sealed. The third groundwater sample (BH- 004^C) about 50m within the premises of Chukwure's residence was collected from SPDC groundwater borehole installed to provide alternative source of water supply for the impacted residents.

Groundwater field monitoring was done using portable multi-parameter analyzer to determine pH, temperature, electrical conductivity, salinity, dissolved oxygen, turbidity, and total dissolved solids.

SPDC staff bailing crude oil from water well

SPDC staffs pumping crude oil from water well

Methods of Sample Collection

(a) Water samples were collected in accordance with the procedures described in standard methods for water and waste waster analysis (APHA, 1995). The same is accepted and adapted by FEPA and DPR as standards for Nigeria. According to the procedure, 200ml of sterilized sample bottles were used for collecting water samples.

(b) Soil samples were obtained from surface soil (0-1.5cm depths) using auger borer and in accordance with the methods described by Obire and Wemedo, (1996). The soil samples were collected into sterile McCartney bottles.

Groundwater sample collected

Showing measurement of groundwater parameters in the field

Table 3.1: summary of ground water and soil samples identity and description

S/N	Ground water sample ID	Reference/ impacted samples	GPS coordinates	Description of sample location
1.	GW- 001	Reference samples		Omuobo HRH
2.	BH - 002		$N4^09805^,$ $E6^08119^,$	Omuokpogba
3.	BH - 003^{A,B}	Impacted samples	$N4^09428^,$ $E6^07922^,$	Egbunne's residence
4.	BH – 004^{A,B,C}		$N4^09542^,$ $E6^08052^,$	Chukwure'sresidence

Field measurements

At the different groundwater and soil sampling locations field measurements were carried out. In-situ physicochemical parameters such as pH, temperature, turbidity, electrical conductivity were taken using multi-purpose potable water quality checker. Still groundwater depth and air quality characteristics such as volatile organic compounds (VOCs), carbon (II) oxide, oxides of sulphur, oxides of nitrogen and particulate matter ($PM_{2.5}$ and $PM_{10.0}$) were measured using Aeroqualgas/particulate detector (Aeroqual serial 500) and Kestrosel series (4200) respectively.

Well sealed by SPDC in Chukwure's residence   **Well sealed by SPDC in Egbunne's residence**

Research team structure

The study team was structured in line with research mandate. Lead consultant to F&E Global Resources as well as the head of the socio-economics team was the project coordinator. Water and soil team from Institute of Pollution Studies (IPS) Rivers State University was headed by Mr. Hanson Uyi. Public health team was headed by Joseph Igbara from IPS Rivers State University. Air quality group was led by Dr. Akinfolarin Oladapo, department of Chemistry, Rivers State University.

Sample management

Seven ground water and four composite soil samples in plastic water bottles, vial bottles and glass jars were temporarily stored in ice chest before they were transferred to accredited laboratory for analysis. Groundwater and soil sample for hydrocarbon analysis were taken to National Oil Spill Detection and Response Agency (NOSDRA) laboratory in Port Harcourt within 24 hours in ice chest. Groundwater and soil samples for microbial analysis were transported to department of Microbiology Laboratory Rivers State University Port Harcourt for analysis by Prof. S. A. Wemedo within 48 hours.

Analytical measurement

There are no consistent standard on measurement of hydrocarbons as such all hydrocarbons are lumped together to create a single standard and prevents differentiation between hydrocarbon as their toxicity varies. Based on EGASPIN a parameter referred to as mineral oil with no specific carbon range is prescribed. TPH an equivalence of mineral oil is divided into two classes: aliphatic and aromatic compounds to cover the broadest possible range of hydrocarbons analyzed for water (C_5– C_{35})and soil($C_5 - C_{44}$) for comparism with mineral oil for the purpose of this report. Individual parameter (e.g benzene) or groups (e.g BTEX) are also reported.

Contamination assessment criteria

Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (EGASPIN) is responsible for the development of contamination assessment criteria; sets out numerical values above which a sample is deemed to be contaminated.

A substance is considered a pollutant when its concentration is above a harmful threshold. Irrespective of the media or biota affected harm is ultimately defined from anthropocentric point of view although the screening levels for a given parameter may vary between nations. EGASPIN proposed two options for pollution incidents. One of which is an approach based on "intervention values and target values". According to EGASPIN intervention values are those values that "indicate the quality for which the functionality of the soil for human, animal and plant life are or threatened with being seriously impaired. Concentration above the intervention values represents a serious contamination". Target values are those values which "indicate the soil quality required for sustainability or expressed in terms of remedial policy, the soil quality required for the full restoration of the

soil's functionality for human, animal and plant life. The target values thus indicate the soil quality levels ultimately aimed for"(UNEP, 2011). For the purpose of this report EGASPIN standards were used.

Table 3.2: EGASPIN target and Intervention values for groundwater and soil

Substance	Groundwater		Soil	
	Target value	Intervention value	Target value	Intervention value
Aromatic compound				
Benzene	0.2	30	0.05	1
Ethylbenzene	0.2	150	0.05	50
Toluene	0.2	1000	0.05	130
Xylene	0.2	70	0.05	25
Mineral oil	50	600	50	5000

3.12: Standards for groundwater

EGASPIN has set out safety limits for groundwater pollution based on intervention and target values. This is applicable in this study as residents use untreated ground water for drinking. Other recommended drinking water standards are WHO guidelines on drinking water which has become the universal benchmark for setting drinking water standards based on associated risk with consumption; and Nigerian national drinking water standards developed by the Ministry of Health.

Air quality standards

Air quality defines the healthfulness of the air based on the quantity of polluting gases and particulates it contains. Air pollutants are classified into three: the first category is mainly the primary pollutants emitted by industrial machines, automobiles, artisanal refining and other combustion processes. Substances included in this category are carbon monoxide (CO), nitrogen (IV) oxide (NO2), sulphur (IV) oxide (SO2), total hydrocarbons (HC), and suspended particulates matter (SPM). The second group comprises trace in the atmospheric while the third category has the hydrocarbon species particularly, methane and the BTEX group.

Air quality samples are graded on a scale of 0-500ppm indicating how many parts per million (PPM) contains thesepollutants. A sample of 0-50(ppm) indicate good air quality, 50-100(ppm) represents moderate air quality; 100-200ppm signals unhealthy; 200-300ppm very unhealthy and 300-500ppm shows hazardous air quality.

Records of air quality for a particular industrial site or urban area is monitored and kept on a dayto day basis by federal, state and local government in the United States of America and many advanced countries (Encarta, 2005).There is no air quality monitoring programme in federal, state and local government in Nigeria. All air quality limits are based on international standard. However, air quality measurements are usually influenced by meteorological and atmospheric conditions.

Challenges and constraints

For better understanding of field situations by the reading public, challenges encountered in course of the study are summarized here.

Youth restiveness and inter-cult clashed has been a major security constraint in the Niger delta over the past decade. With no cover from the security agents, the team relied on the representatives of the impacted families for security. The services of a plumber were employed to enable the team access groundwater at the impacted locations. There was no recourse to international or local safety and security regulations during the field survey.

A major scientific constraint was the unavailability or complete dart of empirical data from previous studies. A situation that would not favour comparism of field data with baseline studies. However, the report relied on EGASPIN, Nigerian Institute for Standards (NIS), and WHO standards in assessing the extent of exposure of residents to contaminants.

Technically, to overcome the challenges associated with accessing groundwater from nonfunctional or abandoned boreholes and SPDC groundwater monitoring wells. Submersible pumps (groundwater pumping sumo) and electric power generator were hired. The unavailability of GC- online sampling equipment for BTEX concentration in outdoor air at the time of sampling posed a technical constraint.

A study of this magnitude would be difficult to accomplish in one day with available materials and human resources. Also a repeat of the study the next day would raise undue awareness by uninterested members of the community and threaten the fragile peace of the already volatile area. However, with the effort of the team and support by impacted family's stakeholders the study was concluded within the limit of time.

4.0 Assessment of groundwater, soil and outdoor air

As discussed in the preceding chapter, the research investigated 4 sites for groundwater and soil contamination. Groundwater samples were abstracted from hand dug water wells, private boreholes; SPDC intervention water borehole and groundwater monitoring boreholes at different locations and depths. Samples of soil were collected at multiple locations within each site so that composite soil samples were taken. All sites were investigated primarily for hydrocarbon contamination in addition to heavy metals, microorganisms and physicochemical parameters.

The results of investigations from sites were presented in the following sections. Site specific observations, results and conclusions are presented in tabular form.

Physicochemical characteristics and heavy metal level of groundwater samples

Physicochemical Characteristics depicts the physical and chemical status of an environmental media for which significant deviation from permissible standards reflects the presence of contaminants or pollutants and impair the local ecosystem. Measures parameters are compared with NIS and WHO (2011) standards to assess their conformity. The ground water temperature in BH-003[A] to BH-004[C] exceeded the standards while those of GW-001 and BH-002 were within limits. Also majority of the water samples had PH values below the standards and as such were acidic. Other measured physicochemical parameters were within permissible limits except for nickel which exceeded the limits in all samples and lead which had high levels in BH-004[A] and BH-004[B]. The high concentrations of lead and nickel in the above samples may be attributed to the presence of crude oil in the wells. Water sample whose measured parameter exceeds recommended limits are not safe for human consumption.

Table.4.1:Physicochemical characteristics and heavy metal level of groundwater samples

S/N	Parameters	Reference samples		Impacted sample					Standards	
		GW-001	BH-002	BH-003^A	BH-003^B	BH-004^A	BH-004^B	BH-004^C	NIS	WHO (2011)
1.	Tempt 0^C	26.20	26.23	31.18	32.00	30.76	32.97	31.58	25-30	25-30
2.	pH	5.48	4.07	5.33	6.63	3.67	5.74	5.98	6.5-8.5	6.5-8.5
3.	TDS(mg/l)	48.0	51.00	11.00	225.00	65.00	205.00	11.60	-	500
4.	_	23.0	103.00	23.00	488.00	175.00	484.00	21.00	-	500
5.	DO(mg/l)	7.0	5.48	5.77	5.45	5.98	0.33	6.10	-	10
6..	Salinity	0.01	0.02	0.02	0.22	0.08	0.41	0.04	-	-
7.	Turbidity(NTU)	2.3	2.0	915	1.3	6.8	230.00	1.10	-	5
8.	NO_3- (mg/l)	4.45	5.60	5.90	5.40	7.05	5.9	4.50	10	250
9.	PO_4^{3-} (mg/l)	0.40	0.53	0.34	0.65	0.20	0.40	0.80	0.2	5
10.	Cl^-(mg/l)	70.91	52.34	42.51	61.26	216.00	85.14	58.40	-	-
11.	Arsenic	0.137	0.121	0.151	0.515	0.537	0.521	0.337	-	-
12.	Cadmium	0.003	0.016	0.007	0.018	0.023	0.016	0.007	-	0.03
13.	Nickel	0.246	0.343	0.280	0.244	0.246	0.243	0.246	-	0.01
14.	Iron	1.125	1.024	1.410	1.341	1.225	1.294	1.125	-	-
15.	Chromium	0.556	0.490	0.519	0.164	0.156	0.150	0.156	-	-
16	Lead	0.01	0.003	0.000	0.002	0.096	0.005	0.013	-	0.003

Hydrocarbon Concentration in Ground Water

The results of laboratory investigation for hydrocarbons in groundwater samples were presented in Table 4.2. All water samples analyzed were contaminated with hydrocarbons that ranged from 1.5195 to 28,134.6mg/l for total petroleum hydrocarbon (TPH) and 0.00 to 363.15 mg/l for polycyclic aromatic hydrocarbons (PAH).

The lowest hydrocarbon concentration were reported in SPDC owned borehole drilled as an alternative source of water for the impacted families. Chukwure's private borehole about 500m from the manifold recorded the highest hydrocarbon contamination. SPDC groundwater monitoring borehole within Chukwure's residence also had the presence of hydrocarbon. The only dug-out well water sample investigated estimated at a distance of over 5.5km from SPDC manifold downstream the community extreme had the second highest hydrocarbon observed. Although the concentration of PAH is generally low except for Chukwure's borehole, it is suspected that the aquifer upon which the people depends for their source of ground water has been contaminated by hydrocarbon seepage from the manifold and other illegal crude oil related activities in the area.

Although no geological profile was carried out the presence of hydrocarbons even in the deeper SPDC intervention water borehole and groundwater monitoring boreholes suggest that the area is served by a single aquifer from which both shallow and deep wells abstract water.

This situation portends great public health risk as the population served by the aquifer is unduly exposed to hydrocarbon which may bio accumulate being soluble in fats. It is believed that if the activities that release hydrocarbon into the lithosphere are not checked, the contaminant plume from the seepage would further spread laterally and vertically worsening the already deteriorating water aquifer.

The reported hydrocarbon contamination at some of the sampled location exceeds the EGASPIN recommended standard of 3mg/l for TPH concentration in water.

Table 4.2: Concentration of hydrocarbons in ground water

Sample ID	Reference/impacted samples	Estimated distance to contaminated site	TPH (mg/ml)	PAH (mg/ml)
GW-001		5500m	34.5953	0.01
BH-002	Reference samples	1850m	21.2359	0.01
BH-003^A		800m	24.1928	0.01
BH003^B		800m	2.0955	0.00
BH-004^A	Impacted samples	500m	28,134.6	363.15
BH-004^B		500m	6.8792	0.00
BH-004^C		**600m**	**1.5195**	**0.00**

Concentration of hydrocarbon in soil

All soil samples analyzed were contaminated with hydrocarbons as revealed in Table 4.3. The concentration of TPH ranged from 9.3696mg/kg in S-004 to 28.7185mg/kg in S-001 while PAH concentration was least in S-004 (0.01mg/kg) and highest in S-003 (0.11mg/kg).

This indicates that both impacted and reference sites had hydrocarbons and implies a wide spread hydrocarbon contamination. Hydrocarbon concentration in all the soil samples exceeded EGASPIN standards of 10mg/kg except in sample S-004 which had 9.3696mg/kg. A summary of TPH and PAH contamination in water and soil samples is presented in Table 4.5.

Table 4.3: Concentration of hydrocarbons in soil

Sample ID	Reference/impacted Samples	Estimated distance to contaminated site	TPH (mg/kg)	PAH (mg/kg)
S-001		5500m	28.7185	0.03
S-002	Reference samples	1850m	10.3696	0.04
S-003		800m	10.5695	0.11
S-004	Impacted samples	500m	9.3696	0.01

BTEX concentration in water and soil

BTEX is a group of volatile and moderately soluble aromatic hydrocarbons usually implicated in hydrocarbon contamination in water. It was not detected in water samples except in sample BH-004[A] where concentrations reported far exceeded target and intervention values in ground water. It is suspected that the absence of BTEX in air, soil and the other water samples may be attributed to stringent sampling conditions, their volatility and unavailability of GC- online sampling equipment at the time of sampling.

Table 4.4: BTEX concentration in water

Parameter	GW-001	BH-002	BH-003[A]	BH-003[B]	BH-004[A]	BH-004[B]	BH-004[C]
Benzene	0.00	0.00	0.00	0.00	1015	0.00	0.00
Toluene	0.00	0.00	0.00	0.00	1410	0.00	0.00
Ethyl benzene	0.00	0.00	0.00	0.00	1811	0.00	0.00
Xylene	0.00	0.00	0.00	0.00	1904	0.00	0.00

Table 4.5: Summary of TPH and PAH contamination of soil and water in sampled locations

Sites	Number of soil samples	Number of groundwater samples	Maximum soil TPH(mg/kg)	Maximum water TPH(mg/l)	Number of groundwater with TPH	Maximum PAH in water	Maximum PAH in soil	Number of soil with PAH
1.	1	1	28.718	34.5953		0.01	0.03	
2.	1	1	10.3696	21.2359		0.01	0.04	
3.	1	2	10.5695	24.1928	7	0.01	0.11	4
4.	1	3	9.3696	28,134.6		363.15	0.01	

Microbial population in water

The presence of heterotrophic bacteria and fungi in drinking water does not pose health risk to humans. However a high heterotrophic plate count (HPC) is an indicator for ideal conditions for the growth of microorganisms including pathogenic bacteria such as E.coli.

Water samples analyzed had high heterotrophic bacteria counts above permissible limits as well as total coliform bacteria beyond permissible limit in most water samples while heterotrophic fungal counts were moderate. Though faecal coliform bacteria were not detected, some of the water samples had hydrocarbon utilizing bacteria and fungi which indicate hydrocarbon contamination of groundwater.

Table 4.6: Microbial Populations of Water Samples

S/No.	Sample Code	Total Heterotrophic Bacteria ($\times 10^3$ cfu ml^{-1})	Total Heterotrophic Fungi ($\times 10^2$ cfu ml^{-1})	Hydrocarbon Utilizing Bacteria ($\times 10^2$ cfu ml^{-1})	Hydrocarbon Utilizing Fungi ($\times 10^2$ cfu ml^{-1})	Total Coliform Bacteria(MPN index 100ml^{-1})	Faecal Coliform Bacteria(MPN index 100ml^{-1})
1.	GW-001	0.1	0.1	0(0)	0	0	0
2.	. . . .	0.6	0.4	0.6(4.8)	0	110	0
3	BH –003^A	0.9	0.2	0.2(2)	0	0	0
4.	BH-00 3^B	1.3	0.5	0.5(4)	0	30	0
5.	BH-00 4^A	2.7	1.6	0.4(1)	1.7	230	0
6.	BH-00 4^B	3.3	0.6	6(18)	0.5	480	0
7.	BH-00 4^C	1.0	0.5	0(0)	0	30	0

% Hydrocarbon bacterial degraders in parenthesis

Acceptable limits: Total Heterotrophic Bacteria: 1000 cfu ml^{-1} (unpiped); 100 cfu ml^{-1} (piped) water.
Total Coliform Bacteria:0 - 10 (unpiped); 0-2 coliforms 100ml^{-1} (piped) water
Faecal Coliform Bacteria:0coliforms 100ml^{-1} (unpiped and piped) water.
Source: World Health Organization, 1996.

1.5   : Microbial population in soil

Microbial populations of soil samples are shown in Table4.7 respectively.

Table 4.7: Microbial Populations of Soil Samples

S/No	Sample Code	pH	Total Heterotrophic Bacteria (x10^{5}cfu ml^{-1})	Total Heterotrophic Fungi (x10^{5}cfu ml^{-1})	Hydrocarbon Utilizing Bacteria (x10^{3}cfu ml^{-1})	Hydrocarbon Utilizing Fungi (x10^{3}cfu ml^{-1})
1.	S-001	7.70	29.6	3.3	6.1(0.2)	3.8
2.	S-002	6.50	16.4	2.1	3.4(0.2)	2.6
3.	S-003	6.10	7.8	0.6	1.7(0.2)	2.1
4.	S-004	6.00	4.7	1.0	5.8(1)	4.2

% Hydrocarbon bacterial degraders in parenthesis

Counts of heterotrophic bacteria and fungi, hydrocarbon utilizing bacteria and fungiwere generally high in all the soil samples. Percentagehydrocarbon utilizing bacterial counts were somewhat low with samples S-001, S-002 and S-003 having percentage bacterial hydrocarbon utilizers of >1% while sample SS-004 had 1% hydrocarbon utilizers. Results of microbiological analysis of soils revealed active heterotrophic and hydrocarbon utilizing microbial growth in thesoils. The soils had evidence of crude oil contamination which is gradually being utilized by the hydrocarbon utilizing microorganisms resulting in the low percent utilizers. Hydrocarbon utilizing microorganisms occur naturally in the soil (Atlas, 1981) particularly in areas where petroleum exploration activities are being carried out.

Conclusion

Heterotrophic bacterial counts were high in water samples above permissible limits while heterotrophic fungal counts were moderate in the water samples.

Water samples are of low quality but showed no faecal contamination and likely absence of pathogenic bacteria; most water samples showed absence of crude oil contamination while a few showed evidence of crude oil contamination. Soil samples revealed active heterotrophic and hydrocarbon utilizing microbial growth with evidence of crude oil contamination which is gradually being reduced by the degradative activity of microbes. Hydrocarbon utilizing microorganisms occur in nature and increase in response to crude oil contamination; however numbers of the hydrocarbon utilizers begin to return, at most sites, to background levels as the oil disappear due to biodegradative removal (Atlas, 1981).

Outdoor air

One of the most basic necessities and requirements of human existence is clean air. Air pollution has been a major problem in the recent decades, with negative effects on human health and the environment ((Akinfolarin*et al*., 2017). The sources of pollution vary from small unit of cigarettes and natural sources such as volcanic activities, forest fires to large volume of anthropogenic impact such as emission from motor engines of automobiles and industrial activities (Akinfolarin*et al*., 2017). These activities release some gaseous emissions (sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon dioxide (CO), hydrogen sulphide (H_2S), volatile organic compounds (VOCs) and hydrocarbons) and particulates (smoke, soot, metallic, dust, fumes and aerosols) that contaminate air, and when in high concentrations could threaten the stability of earth systems, thereby driving global climate change, destroying ecosystems and endangering human health (Rai et al., 2011).

Long-term effects of air pollution on the onset of diseases such as cardiovascular dysfunctions, cancer, respiratory infections and inflammations is widely common (Brucker et al., 2014; Rumana et al., 2014; Yamamoto et al., 2014). Air quality assessment is of great importance globally. It measures the level of contaminants in the air and its possible risk to human health and its environment (Weli and Kobak, 2014; Akinfolarin, 2020). Illegal oil refining, oil bunkering business, vehicular emissions, and use of generators have negatively impacted on air quality of Ibaa community and environs.

Observable occurrences reported by residents have shown numerous problems such as oil pipe leakage, crude oil spillages, manifold fires explosion and emissions of offensive gases with adverse environmental consequences in the area. The year, 2016 was the era of seasonal soot precipitation affecting surfaces and causing severe panic among residents (Akinfolarin *et al*., 2017). It has been reported by World Health Organization (WHO) that air pollution contributes to an estimated 7 million deaths worldwide every year (WHO, 2010). The aim of this study is to assess air quality of some selected sites in Ibaa community using air quality index and correlation analysis.

Results and Discussion

The statistical summary of the levels of the air quality parameters for the two study areas namely Omuobo/Omuokpogba Site1(reference) and Shell pipeline/Rumuji (Site 2) is presented in Table 4.8, Table 4.9 shows the National ambient air quality standards (NAAQS). The air quality index indicating value ranges, colour codes and health concerns is presented in Table 4.10 while air quality index of particulate matters and carbon monoxide is presented in Table 4.11 and Table 4.12 being the Pearson correlation coefficient analysis output using some air quality parameters at confidence level of 0.05 (1 tailed).

Table 4.8: Statistical Summary of Air Quality Parameters during Dry Season at the Study Areas

| Parameters	Site1(reference)				IBAA Site 2			
	Mean	Stdev	Max	Min	Mean	Stdev	Max	Min
PM2.5 (µg/m³)	19.33	3.21	23.00	17.00	43.33	43.02	93.00	18.00
PM10 (µg/m³)	66.33	32.93	104.00	43.00	81.67	63.54	155.00	43.00
CO (ppm)	10.13	9.27	18.20	0.00	5.27	4.56	8.00	0.00
SO$_2$ (ppm)	ND	ND	ND	ND	ND	ND	ND	ND
NO$_2$ (ppm)	0.08	0.01	0.09	0.08	0.08	0.00	0.08	0.07
VOCs (ppm)	0.30	0.20	0.50	0.10	0.03	0.06	0.10	0.00
CH$_4$ (ppm)	4.00	2.00	6.00	2.00	1.00	0.00	1.00	1.00
O$_3$ (ppm)	NS	ND	0.00	0.00	ND	ND	0.00	0.00
Rel. Humid (%)	42.83	1.76	44.50	41.00	54.93	5.10	60.00	49.80
Wind Speed (m/s)	2.37	0.49	2.70	1.80	4.77	0.59	5.20	4.10
Temp (^{o}C)	34.97	1.67	36.90	34.00	35.37	1.56	37.00	33.90
Wind Direction	SW				SW			

Site 1 = Omobo/ Omkpoba, Site 2 = Shell pipeline/Rumuji
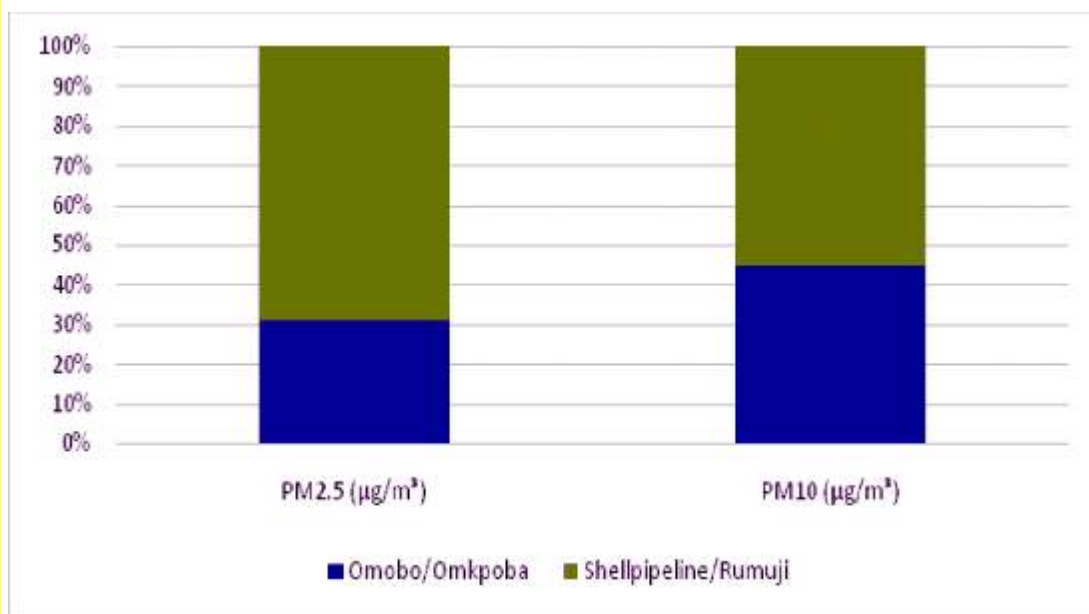
Fig 2: A0 100% Stacked Column chart

Table 4.9: National Ambient Air Quality Standard (NAAQS)

Pollutant	Average time	Standard limits
Particulate matter	1 – hour average	250 µg/m³
Sulphur dioxide	1 – hour average	26 µg/m³
Carbon monoxide	8 – hour average	(10ppm– 20ppm)
Nitrogen dioxide	1 – hour average	(0.04 - 0.06 ppm)

Table 4.10: Air Quality Index Values, Colour Codes and Health Concerns

AQI Range	Levels of health concern	Colours0000000
0-50	Good	Green
51-100	Moderate	Yellow
101-150	Unhealthy for sensitive groups	Orange
151-200	Unhealthy	Red
201-300	Very unhealthy	Purple
301-500	Hazardous	Maroon

Table 4.11: Air Quality Index of Particulate Matters and Carbon Monoxide

	PM$_{2.5}$	AQI	AQI Category	PM$_{10}$ (µg/m³)	AQI	AQI Category	CO (ppm)	AQI	AQI Category
Site 1	19.33	66	Moderate	66.33	56	Moderate	10.13	111	Unhealthy for sensitive groups
Site 2	43.33	120	Unhealthy for sensitive groups	81.67	66	Moderate	5.27	580000	Moderate

Site 1 = Omobo/ Omkpoba, Site 2 = Shell pipeline/Rumuji

Table 4.12: Correlation Analysis of Air Quality Parameters at the Study Area

	PM$_{2.5}$	PM$_{10}$	CO	NO$_2$	VOCs	CH$_4$	RH	WS	Temp
PM$_{2.5}$	1.00								
PM$_{10}$	**0.89**	1.00							
CO	0.05	0.13	1.00						
NO$_2$	-0.52	-0.27	**0.71**	1.00					
VOCs	-0.41	-0.18	-0.21	0.45	1.00				
CH$_4$	-0.35	-0.11	-0.20	0.43	**0.98**	1.00			
RH	**0.72**	0.49	-0.21	**-0.82**	**-0.83**	**-0.80**	1.00		
WS	0.57	0.37	-0.22	**-0.78**	**-0.86**	**-0.85**	**0.97**	1.00	
Temp	-0.45	-0.64	0.14	0.00	-0.53	-0.50	0.10	0.19	1.00

Values in bold are significant at the 0.05 level (1-tailed)

In Table 4.8 It was observed that PM$_{2.5}$ ranged from 17.00 to 23.00µg/m³, and 18.00 to 93.00µg/m³ with mean levels of 19.33 ± 3.21µg/m³ and 43.33 ± 43.02µg/m³, at Sites 1 (Omobo/Omkpoba) and 2 (Shell pipeline/Rumuji) respectively. Likewise, respective values for PM$_{10}$ ranged from 43.00 to 104.00µg/m³ and 43.00 to 155.00 µg/m³ with mean levels of 66.33 ± 32.93 and 81.67 ± 63.54 µg/m³ for Sites 1 and 2. Site 1 which was chosen as control due to lower activities has lesser concentrations compared with Site 2 being the impacted site. However, these values were below the National Ambient Air Quality Standard (NAAQS) of 250 µg/m³ 1 hour daily average.

. The percentage contributions of $PM_{2.5}$ and PM_{10} for Site 1 and Site 2 were 30% and 45% respectively (Fig. 1). The presence and low level could be due to less anthropogenic activities as the study area has been known for illegal artisan oil refinery. Other sources could be vehicular, generator, emissions from electric generating plants, biomass and fossil fuel burning (Gobo *et al.,* 2012).Particulate matters are very dangerous to human health as they can cause asthma and even lung cancer.

They are linked with most of pulmonary and cardiac-associated morbidity and mortality (Sahu*et al*., 2014; Sadeghi*et al*., 2015). Particles of smaller size reach the lower respiratory tract and thus have greater potential for causing the lungs and heart diseases. Moreover, numerous scientific data have demonstrated that fine particle pollutants cause premature death in people with heart and/or lung disease including cardiac dysrhythmias, nonfatal heart attacks, aggravated asthma, and decreased lung functions. Depending on the level of exposure, particulate pollutants may cause mild to severe illnesses. Wheezing, cough, dry mouth, and limitation in activities due to breathing problems are the most prevalent clinical symptoms of respiratory disease resulted from air pollution. (Bentayeb*et al*., 2013; Guillame*et al*., 2013; Gao*et al*., 2014). It can also enhance metal corrosion.
Carbon monoxide ranged from 0.00 to 18.20ppm and 0.00 to 8.00ppm with corresponding mean levels of 10.13±9.27ppm and 5.27±4.56ppm at Site 1 and 2 respectively.

These values were within the set limit of 10 – 20ppm 8-hour average of NAAQS. Carbon monoxide is produce by vehicle and generator emission, fossil fuel burning such as wood or coal especially when combustion is not complete. CO is a toxic non irritating gas with high affinity for oxygen and it reduces the oxygen carrying capacity to vital organs in the body. Recent evidence suggests that exposure to low levels of CO deteriorate lung function in asthmatic adults (Canova *et al*., 2010). Symptoms of CO poisoning may include headache, dizziness, weakness, nausea, vomiting, and finally loss of consciousness. The symptoms are very similar to those of other illnesses, such as food poisoning or viral infections. (Ghorani-Azam*et al*., 2016).

Sulphur dioxide and ozone were not detected. Nitrogen dioxide had mean concentrations of 0.08±0.01ppm and 0.08±0.00ppm at Site 1 and 2 respectively.

These were above the limits of 0.04-0.06ppm of one-hour average of NAAQS. Nitrogen oxides are important ambient air pollutants which may increase the risk of respiratory infections. (Chen *et al*., 2007). Their source could be from motor engines and thus are traffic related air pollutants. Coughing and wheezing are the most common complication of nitrogen oxides toxicity, but the eyes, nose or throat irritations, headache, dyspnea, chest pain, diaphoresis, fever, bronchospasm, and pulmonary edema may also occur if inhaled at high levels (Ghorani-Azam*et al*., 2016).

Methane, CH_4 had mean levels of 4.00±2.00ppm and 1.00±0.00ppm while volatile organic compounds, VOCs had 0.30±0.02ppm and 0.03±0/06ppm at Site 1 and 2 respectively. Methane levels may be caused by fossil fuel production and intensive livestock farming. Methane, when released into the atmosphere before it is burned, is harmful to the environment. It is able to trap heat in the atmosphere, therefore, contributes to climate change (Akinfolarin, 2020). VOCs such as benzene, toluene, ethylbenzene, and xylene are classified as carcinogen compounds and are thought to be responsible for incidence and progression of cancer in human.
The presence of VOCs may suggest oil spillage or illegal artisanal refinery activities from unknown point around the location. Some VOCs are harmful by themselves, including some that cause cancer. (Kansal 2009).

The meteorological factors measured are indicative of dry season with low mean levels of relative humidity 42.83±1.76% and 54.93±5.10%, high temperature of 34.97±1.67 $^{\circ}$C and 35.37±1.56°C at Site 1(reference) and 2 respectively with wind speed above 2.00m/s blowing from the direction of South West.

The air quality index (AQI) (Table 4.11) for $PM_{2.5}$ was "moderate" at Site 1 and "unhealthy for sensitive groups" at Site 2 while $PM_{10}$was "moderate" at both Sites 1 and 2. The AQI for Carbon monoxide indicated "unhealthy for sensitive groups" at Site 1 and "moderate" at Site 2. Some scientific data have demonstrated that fine particle pollutants cause premature death in people with heart and/or lung disease including cardiac dysrhythmias, nonfatal heart attacks, aggravated asthma, and decreased lung functions. Depending on the level of exposure, particulate pollutants may cause mild to severe illnesses. Wheezing, cough, dry mouth, and limitation in activities due to breathing problems are the most prevalent clinical symptoms of respiratory disease resulted from air pollution. (Bentayeb*et al*., 2013; Guillam*et al*., 2013; Gao*et al*., 2014).

The Pearson correlation coefficient matrix output from Table 5 indicates there is a strong significant positive association between $PM_{2.5}$ with PM_{10} (r = 0.89) and Relative humidity (r = -0.72), between NO_2 and CO (r = 0.71), and very strong between CH_4 and VOCs (r = 0.98) and between wind speed, WS and relative humidity, RH (r = 0.97). A strong but negative correlation was observed between RH with NO_2 (r = - 0.82), VOCs (r = -0.83) and CH4 (r = - 0.80). Also negative between WS with NO_2 (r = - 0.78), VOCs (r = - 0.86) and CH_4 (r = - 0.85). Based on these associations, it could be deduced that positive correlation indicates increase in the levels of $PM_{2.5}$ leads to/or can be accounted for increase with PM_{10} with low relative humidity indicative of dry season. Very strong positive correlation between CH_4 and VOCs could indicate same source from oil spillage and illegal artisanal refineries (Akinfolarin, 2020). Positive association between CO and NO_2 could indicate same source f rom motor engines which are traffic related air pollutants (Ghorani-Azam*et al*., 2016). High temperature and increasing wind speed (WS) could cause dispersion and re-suspension of NO_2, VOCs and CH_4 in air, thus their low concentration.

Report Validation meeting in Kebetkache office with staff and community representatives

5.0 Socio-economic assessment

Introduction

Socioeconomic assessment measures the economic activities of a people that shape their social process. It evaluates the influence of social and economic activities on their standard of living, poverty level, household income and access to or deprivation from social cum economic services that enhance their quality of life. The socioeconomic status of any people is often measured as a combination of income, occupation, education, housing, ethnicity and sometimes religion.

Settlement history

Ibaa is one of the autonomous communities in Ikwerre Kingdom. History has it that Ibaa people have a common ancestry with their neighbour (Obelle) who were believed to have migrated from Ojigba their ancestral home in Ekpeye hundreds of years ago. This ancestral connection exist to date as Ibaa and Obelle sent relief materials to Ojigba in 2012 to cushion the impact of flood waters on the people.

Social organization and traditional governance

Ibaahave a homogenous organization and traditional governance structure with other Ikwerre speaking communities in Rivers state. 'Nyeweali'title is a traditional stool belonging to the members of the Royal family. He presided over the traditional and social affairs of the settlement. Next to the 'Nyeweali', are the'Oha', council of chiefs, community development committee (CDC) and age grade.

In power and authority hierarchy, the 'Nyeweali' is the head of the community followed by 'Oha', council of chiefs, CDC, age grades, youth and women group. The office of the 'Nyeweali' is rotated among members of the Royal family.

The criteria for appointing the 'Nyeweali' among other things include literacy, honesty. Charisma and the ability to represent the people, the 'Oha' is the oldest man in the larger family unit. The council of chiefs appointed from the villages to represent them at the community level. The CDC chairman and executives, the age grade, youth and women group are recognized institutions in the social organization and traditional governance of the people.

The CDC chairman and executives are elected to serve for a period of 4 years. He is charged with the day-to-day administration of the community and mediated between the community and the government.The age grades are answerable to the 'Nyeweali', the council of chiefs, 'Oha' and CDC executives.

They supervise and monitor activities in the community in addition to other activities that they may be assigned from time to time. The youth group headed by the youth chairman is charged with the responsibility of providing security, presides over all issues on youth matter, organize communal labour and perform other responsibilities assigned them. The women group headed by the women leader is charged with the responsibility of organizing the women in the community and presides over women affairs.

Rewards and punishment are vital aspects of the culture of Ibaa people. Illustrious sons and daughters are honoured with chieftancy titles for their prowess (in all spheres of life) or by formal public appreciation and acceptance by community leaders.

In the same vein, outlaws (evil doers, murderers, witches and wizards) are punished in accordance with the native laws and customs. These punishments may assume the form of public flogging or outright banishment from the community.

This system of traditional governance which exist side-by-side with modern forms of government still assumes its prime position in the local governance and administration of Ibaa, as indeed all other Ikwerre communities.

Religious Affiliations

The people of Ibaa are predominantly practitioners of age-old traditional religion with a total fellowship of about 98 percent of the natives. The people believe in the presence of a spiritual being called "Chi" which symbolize the existence of a supreme being that guide and protects the people.

However, over the years, the advent of Christianity has gain ground and won large number of converts as evident by the number of churches in the settlement. There was no practitioner of Islam among natives.

Festivals

Ibaa people observe three main festivals, in addition to the normal Easter, Christmas and New Year festivals, the wrestling festival, new yam festivals (Egwu-Ekwensu) and Oba-Uku (initiation into manhood). The first two festivals are celebrated annually between the months of August and September to mark the end of the farming season and the harvest of new yam. During the wrestling festivals, the various villages host wrestling competition first between females then males. In Egwu-Ekwensu festivals sacrifices are made to their gods in appreciation for the harvest. Oba-Uku festival is celebrated every seven years between the months of September to December to mark the initiation of adult males into manhood. It is one of the most celebrated festivals as it confers certain rights and privileges on inductees

Social conflicts and crime

Conflicts arising from chieftaincy and leadership tussles youth restiveness, and land disputes have not been reported in recent times. However, secret cult clashes that resulted in sporadic gunshots, beheading of opposition cult members, and arson that severally sacked the community has been reported in the study area in the recent past. There were reports of isolated cases of violent crime at the time field work was mobilized.

Instruments of social control have failed as lawlessness is gradually the order of the day. Punishments meted to criminals and outlaws in the customs and tradition of the people have been defiled. This has engendered insecurity, loss of life and property.

Security

The community is served by Emohua local vigilante group (EMOVIS) sponsored by the local government council in the absence of federal security agency (Nigerian Police Force). The security agents' population ratio is abysmally low as there are about one security agents per thousand populations. The closest police station to the area is at Rumuji about 1.5km from Ibaa which serves over five other neighbouring communities. The number of police officers in the only police station in the area cannot effectively police the settlement. This explains why the security situation is poor in addition to different secret cult groups.

Socio-demographic characteristics

The 1991 population census figure were used in the analysis of the demographic attributes of the study location owing to the unavailability of the disaggregated 2006 national population figures by settlement. The population of the community was given as 24163 in the 1991 census (NPC, 1996). Using an assumed annual growth rate of 0.03 percent for 2023 will be 63055 persons.

Population structure

Population structure according to Palmer and Gardner (1983) is characterized with reference to two main attributes:

- The age-sex distribution; and
- Two types of demographic ratios: sex and dependency ratios.

The study revealed that the population is quite young as those aged less than 20years accounted for about half of the population as represented by 46.8%. These values compares favourably with the national profile where those below 20 years of age accounted for 55.0% of the 1991 population census figure (NPC, 1996).

The population was less loaded in older age bracket as those aged 65 years and above accounts for only 2.6 percent.

With respect to the sex ratio, the study revealed that the population of males and females in the area were about equal with a sex ratio of 101.2, a figure that is consistent with the state and national profile with sex ratio 108.19 and 1005 respectively. The dependency ratio of 87.6 was found to be very high, especially when compared against the national average of 97.6 for rural areas. However, this figure compares favourably with the state's average rural dependency ratio of 88.0 in 1991 (NBS, 2006).

Number and size of household

Table 5.1 shows the number and size of houses hold size in the area. The data reveals that the spread of questionnaire across the three sections of the community. Twelve households with an average size of 9 persons were sampled in Mgbuosimini section, 10 households in Omuosunu section with an average size of 8 persons and 8 households in Mgbu-Esasection with an average size of 9 were interviewed.

The overall average household size in the area is high compared with national average house hold size of 4.5 persons per household.

Table 5.1: Number and size of households in the study area

Settlement	Number of households surveyed	Average household size
Mgbu-Osimini	9	9
Omu–Osunu	11	8
MgbuEsa	12	9

Source: Researchers' field survey

Employment status

An assessment of the employment status of the study population reveals along gender divide that an estimated 8.7% of males within the working population are employed as civil servants. Of this population are the self - employed engaged in arts and craft, motorcycle transport service (okada), fashion designers, oil palm fruit processing, timber, and trading. Among the female working age population1.5% of the women are self-employed being engaged in salon and hair dressing, patent medicine dealers. Most of the women employed in white collar jobs are in the city. Others are housewife engaged in farming and petty animal rearing.

The overall unemployment rate in the area stands at 53% of which about 49% of youth are unemployed. The unemployment rate is high when compared with National unemployment statistics of 33.3% and youth unemployment rate of 42.5% (NBS, 2020). This situation has led to an increased in the number of youths engaged in illegal crude oil activities.

Generally, access to soft loans and microcredit facilities as a means of stimulating the development and sustenance of small and medium scale businesses is restricted. There is no state policy to promote access to loan and credit facilities that can drive the micro-economy of the area. This has contributed immensely to high unemployment rate as self-employment and cooperative societies are not encouraged.

The high unemployment rate implies that over 60 percent of the working age populations are without paid employment, a situation that increases their dependence on natural resources for survival.

Occupational distribution

Ibaa people are predominantly farmer being gifted with fertile land. Farming is practiced using crude farm implements such as hoes and cutlasses. Crops produced include cassava, yam, plantain, cocoyam, pepper, amongst other crops. Farmers cultivate an average of five plots of land per annum and harvest several sacks of cassava worth between N50,000 and N200,000 depending on the prevailing price and the period of sales. Intensive farm practice and increasing population as well as short fallow period for decreasing soil fertility and low yield. Aside from farming, the people are renowned for subsistence rearing of livestock such as goat and poultry.

Other occupational pursuits undertaken by the people include cassava processing, oil palm processing, salon, builders and masons, mechanics and restaurants. Table 4.14 presents a major occupation of the people.

Table 5.2: Estimated percentage distribution of occupation

Occupation	Estimated percentage
Agriculture	86.0
Motorcyclist	5.0
Mechanics	2.0
Arts and crafts	4.0
Furniture builders	0.5
Petty trading	1.0
Restaurant	0.5
Oil palm fruit processing	0.5
Salon and other	1.0

Source: Researchers' field survey

Income

A distribution of household income categories reveals that the modal monthly income level was less than N15,000 with 45% of the people having this income status. The average monthly income as calculated was approximately N25,000 an amount that translates to about US$54.31 per household.Thus an average house hold of nine (9) persons per household lives on N107.50K per person per day. This implies a perceptible level of poverty as the above per capita household income is below the internationally accepted poverty line of US$2.15 per capital daily expenditure (World Bank, 2022).

Table 5.3: percentage distribution of household monthly income

| Settlement	Less than N20,000	N20,000-N25,000	N25,000-N30,000	N30,000-N35,000	N3,5000-0N40,000	Above N40,000
Ibaa	1	14	20	33	17	15

Source: Researchers' field survey

Poverty

povertyin the study area is not just a case of income or monetary poverty rather it can best be described as multidimensional poverty as the majority of the people especially children are deprived of quality education, sanitation, clean water, healthcare, clean cooking fuel, adequate housing, reliable electricity, food insecurity, and basic modern assets.

Household Expenditure pattern

The allocation of household income on goods and services are influenced by age, sex and income category amongst other factors. The expenditure pattern of the study area in no particular order is on education, health care, food, housing, energy and transportation. The highest percentage of household income is allocated to education followed by health care, transportation, food, energy and housing. An estimated 40% of the house hold income is spent on education to cover the tuition of children/ wards in all levels of education from (nursery) kindergarten to tertiary education. Household income of30% is allocated to health care as majority of the people resort to herbal and traditional medicine as well as patent medicine stores for health care in the absence of functional health centres. As stated earlier the modal means of transport is bicycle and motor cycles. Owners of private motor cycles spend an estimated household income of 15% on maintenance and fuel due to fluctuating fuel prices and high exchange rate. Food receives an estimated 10% of household income because the people are predominately farmers of tuber crops which constitute their staple food with other food items such as rice beans, fish and meat bought from the market. Education and housing receives the lowest allocation of 3% and 2% respectively. The main source of domestic energy is fuel wood (a situation that exacerbates deforestation and biodiversity depletion) and kerosene. Use of bottled gas is not common as there is no gas refilling stations in the area. Electric energy supply is not available due to the activities of vandals' as such private electric generators serves the peoples energy needs and accounts for household expenditure on energy. Residents live in their own houses and as such expenditure on housing is low. The cost of accommodation for rent is between N1000 to N1500 per month for single rooms without kitchen and toilet facilities as is the case in other rural communities in the Niger delta due to lack of competitive demand. The expenditure pattern in most rural settlement with regards to housing has been affected by insecurity.

Household expenditure pattern
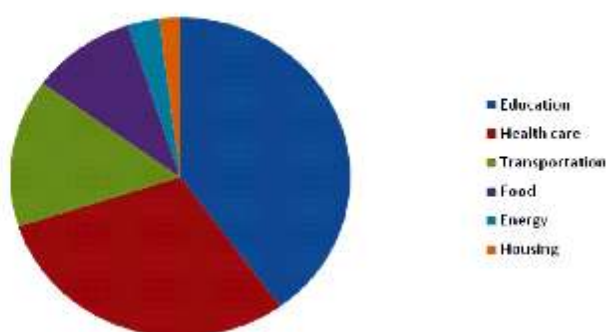
Standard of living

The level of material wealth and income available to community members measured by their life expectancy, literacy rate, access to education, health care and housing conditions as well as their gross domestic product (GDP) and per capita income represents their standard of living.

Given an average household per capita income of N107.50K and their lack of access to clean water and sanitation, adequate shelter, health care, education, high unemployment rates and unhealthy diets; the standard of living is undeniably low. The low standard of living reported in Ibaa is synonymous with that of other rural communities in the Niger delta region.

Educational attainment

Educational attainment is a critical factor in the measurement of any population human development index. This is because of the role of education in poverty reduction, and improved gross domestic product, GDP. A literate population is an enlightened society with better perception of their environment. The inadequate teaching and learning facilities in these institutions compares favourably with those in other rural settlement in Rivers state where the schools are in ruins plagued with poverty, corruption and poor infrastructure.

The inhabitants of the area are served by 6 public primary and 2 public secondary schools. The staff strength and students enrolment figures for the primary and secondary school were not available at the time the report was compiled. However, it is likely that the number of out of school children may be high due to incessant secret cult related crisis that have created some level of insecurity amongst the people in recent time. This situation corroborates UNESCO's report that Nigeria has the highest number of out-of-school children in the world (Okoroafor, 2023).Table 8 presents the percentage distribution of educational attainment of respondent by sex.

The data show that 53% and48% of female respondents and 56% and 62% of male respondents which had primary and secondary education respectively. The modal level of educational attainment for both male and female respondent is secondary school completed. The proportion of male respondents that had attained tertiary education is 45% while that of female stands at 23%.

With regards to literacy rate an estimated 51% of the people are literate. This figure compares poorly with Rivers State literacy rate of 70.8% (Okoroafor, 2023).

Table 5.4: percentage distribution of educational attainment of respondents by sex

Settlement	No formal Education		Attainment primary Education		Attainment secondary Education		Attainment tertiary Education	
Ibaa	-	-	56	53	62	49	57	23

Source: Researchers' field survey

Facilities and infrastructure
Transport facilities
The availability of good road network and an efficient means of transportation are vital in the socioeconomic transformation of any society. Road is essentially the mode of transport within and around the community. Other conventional modes of transportation such as air and rail are non-existent. Bicycle is the modal means of transporting goods and services from one point to another as the farming populace move their harvest from their distant farms to the homes and markets. Other means of transport in the locality include motor cycle and motor vehicles.

An assessment of the road network in the area indicates that settlement have accessible roads all year round though the state of the roads deteriorates during the rainy seasons. The total length of the only road connecting Ibaa to neighbouring community from Rumuji along the East-West road to Obelle is about 11.5km as there are no internal road networks. The cost of transport in the area is relatively cheap. However this largely depends on the fuel situation and festivities.

Telecommunication
The role of telecommunication in the socioeconomic transformation of any society is enormous; from job creation, gross domestic product (GDP) growth to instant messaging, financial inclusion, telemedicine, e-commerce, virtual learning and much more. These translate to reduction of income inequality and poverty. Two decades after the introduction of mobile phone in Nigeria by the President Olusegun Obasanjo's administration about 187.9million SIM connections spread across the four major mobile service providers has been reported in Nigeria as at January 2021(www. Geopoll.com/blog/mobile).

In the study area the population of people using mobile phone has increased greatly. Of the number of respondents interviewed, 98% have mobile phones this has impacted positively in their ease of communication and overall way of life.

It is estimated that about 85% of rural dwellers women inclusive does not have bank accounts because of the absence of financial institutions and have not exploited the benefits of digital technology using mobile phones since majority of them do not have android phones.

Economic institutions and social welfare Facilities
The presence of government, allied and social welfare institution in any area is a criteria for its classification as rural or urban and enhance its socioeconomic activities. The area lacks both allied and social welfare institution such as banks, other financial institution, day-care centres, old peoples home and orphanages. It was not clear whether economic institution such as co-operatives societies, postal agencies, and agricultural/research centres exist in the area.

Neighbourhood quality
Neighbourhood condition of built environment is defined on the basis of access to four key services: water, electricity, sanitation and type or quality of housing necessary for a standard of living adequate for health and wellbeing.

Housing and recreation
The income categories, economic, and social status of the study population is a reflection of their housing and recreational facilities. The family's financial status determines the size and types of house they own. The predominant house types were the single-family bungalow constructed with block cement and mortar; roofed with corrugated roofing materials, others are I- or L-shaped single rooms without kitchen or toilet facilities. An estimated 90% of houses with service facilities fenced with sand Crete block walls are owned by indigenes of higher income categories residing in the cities. This represents an estimated 10% of the total housing stock. Multi-family, duplexes, detached dwelling, low medium, and high-rise apartment are not common. The overall recreational condition is fairly good; largely due to nucleated settlement pattern with out - door open spaces around the houses allowing for recreation and seat out under tree shades and makeshift shade structure on hot days, play grounds and open spaces in public places such as schools and churches.

Housing type in the area

Water supply

Water constitutes about 70% of the earth crust, it is vital for all life forms, even though it provides no caloric or organic nutrient but its availability in the right quantity and quality is nearly elusive especially in the developing countries of the world. This explains the reason for the prevalence of water borne disease in the third world nations.

The major sources of water in Ibaa are unprotected hand dug water wells, untreated private boreholes, sachet/bottled water(water vendors), river and rainwater. Fig. 2 shows an estimated percentage distribution of sources of water supply. The data reveals that estimated 80% of study population depends on hand-dug water wells for their domestic water supply. However, about 65% of these wells are unprotected. Access to safe and clean drinking water is elusive as the water supply from the unprotected water wells and untreated boreholes does not guarantee water quality. It is estimated that more than 95% of the people lack access to clean drinking water.
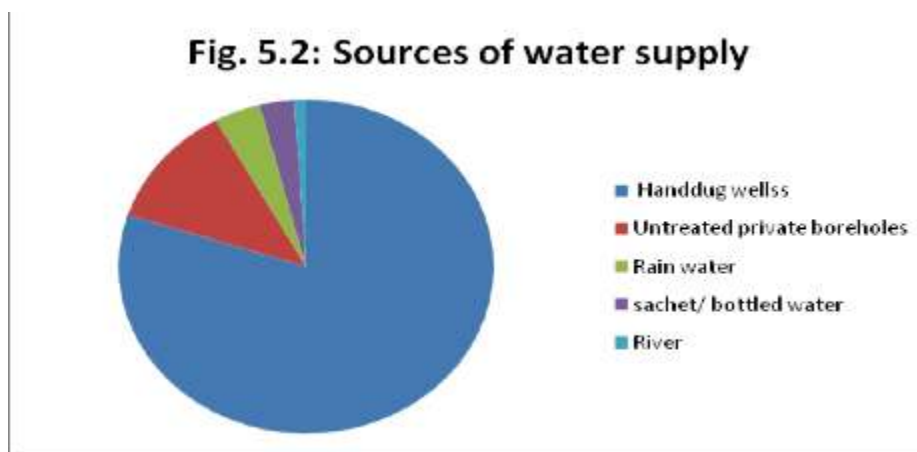
Boreholes accounts for 21.5% of tap water supply to households in Nigeria as of 2010. A study in 2017 revealed that 200bottled and sachet water samples collected for testing showed that 30% of them had bacteria. Sachet water has worst quality than bottled water. It also reported that 90.8% of household drinking water in Nigeria is contaminated by E. Coli bacteria. It is reported that by institute for health metrics and evaluation, IHME (Global Burden of Disease) that unsafe drinking water sources accounts for 7.3% of deaths in Nigeria as of 2017.

This is consistent with the views expressed by National Bureau of Statistics (NBS) and United Nation International Children Emergency Fund (UNICEF) that about 60million Nigerians do not have access to clean drinking water which translates to about 33 percent of the population. It is generally unsafe to drink tap water in Nigeria because is mostly contains bacteria, pollutants and chemical contaminants as most of Nigeria's drinking water is untreated groundwater. Also it is reported that 54% of rural dwellers have no basic water supply.

The river which was once a reliable source of water supply has been largely contaminated in recent times with hydrocarbons from illegal crude oil refining activities which has also affected rainwater quality in the rainy season.There is no pipe borne water supply in the area.

The average daily per capita water consumption as revealed by the study was put at about 70 litres per day for a household size of six persons. This average daily per capita water consumption of 11.7litres compares favourably with national recommended minimum standard of 12 to 16 litres per day (NBS 2022). High water demand, consumption and use are veritable indicator of improved quality of life.

Fig. 5.2: Sources of water supply

- Handdug wellss
- Untreated private boreholes
- Rain water
- sachet/ bottled water
- River

Electricity supply

Electricity supply from national and state grid is epileptic as is the case in other parts of the nation. This situation has been exacerbated by vandals who stole all the electric transmission lines and accessories keeping the community in darkness for over two years. However in all cases few individuals resort to private generators for alternative power supply especially at night. The near absence of electricity has greatly affected the socioeconomic activities, development of small scale industries and the quality of life.

Sanitation and waste management

Solid waste source, generation and composition in the study area are similar to those of other rural settlements in the Niger delta region. Waste generation arise basically from agricultural and household activities and comprise predominantly of food and vegetables from food processing.

Other types of solid waste are recyclable metal scrapes, plastics especially sachets water bays, polythene bags, glass and bottles, and textile the volume of which are very low. The average daily per capita solid waste generation varies according to household size, domestic activities, income, and seasons for agricultural waste.

These wastes are disposed in open dumpsites and sometimes incinerated during the dry seasons as no refuse collection agent service the area. This waste management pattern is applicable in other parts of the state as there is no engineered waste disposal landfill in the state. The community lacks adequate drainage systems and sewers.

With respect to sewage, the modal method of sewage disposal is pit latrine followed by pour-flush method. An estimated 80% of residents use the pit latrine method while about 10% use pour-flush, 7% use water closet with underground septic tank. The remaining 3% of the people engage in open defecation in nearby bush. This practice is common among children and residents living in less populated parts of the community. The estimated sewage disposal method is presented in a fig.3.
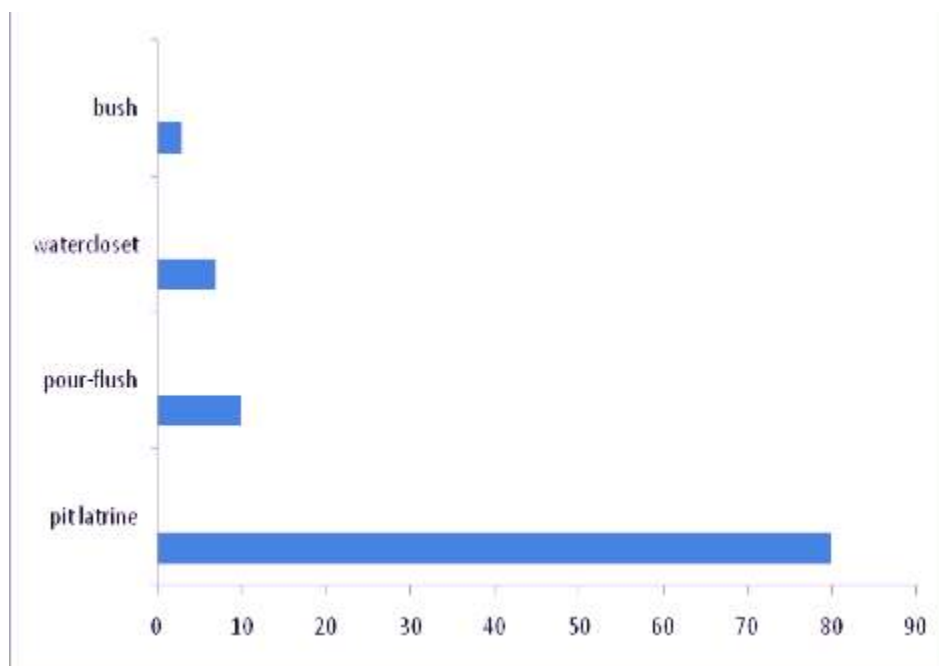
Fig. 5.3: Estimated percentage of sewage disposal methods

Land tenure, agriculture and local economy

The vast expanse of land in the area is communally or privately owned. This system of land tenure alienated women and strangers from right of land ownership. Parcels of land acquired from the community by parents in whatever guise are bequeathed to their children. This confers private rights otherwise the community owns the land. Subsistence and semi-commercial agriculture are the main occupation and major income earner for the people.

This system of farming encourages deforestation as the land is continually cultivated following a short fallow period of between four to five years with the wood harvested as fuel for domestic source of energy.

Except for cassava farms which are mono-crop, the common farm practice is mixed cropping. Common crops cultivated in the area are annual crops except plantains and banana. Cash crops such as oil palm, pea trees, orchards, and coconut and mango trees are also grown in the area.

The local economy is entirely non-basic as represented by primary activities such as farming, cassava processing, oil palm fruit processing, and small scale commercial activities and artesian which constitutes the primary socioeconomic activities.

Price of local goods and services

Local commodities in the area consist mainly of tubers, plantain, banana and vegetables. Tuber constitutes over 90 percent of the people's stable food. At harvest tubers such as cassava and yam are affordable selling for between N400 to N1000 depending on the size. A basin of processed cassava (garri) sells for between N5500 to N6500; a bundle of green vegetables also sells for about N150. In the planting season prices of local commodities increase as the quantity available for sales reduces. Plantain and banana are generally expensive during the planting season because the storms that accompany the early rains pull down the stands causing scarcity. With the regards to service provision, a plate of garri (loiloi) and soup in a local restaurant cost between N350 to N500. Other services such as hotel and accommodation are not common as is the case in other rural communities. However where they exist it is usually cheap because of low patronage.

Movement within the area by motorcycle (okada) cost N100 per drop depending on fuel situation and festivities. The survey of the overall prices of local commodities reveals that the cost of all is comparatively low.

These local price regimes of commodities are consistent with the rural price profile in other localities in the Niger delta where similar commodities are produced. However, according to (NBS, 2023) commodity price index (CPI) and inflation Report January, 2023 reveals an inflation rate of 21.82% as against 21.34% in December, 2022. Inflation rate on year- on year basis the headline inflation rate was 6.22% point higher compared to the rate recorded in January 2022.

Gender issues/ Women development

The term gender is often misconstrued and sometimes loosely used to imply women affairs or concern in resource utilization, and capacity building and overall socio-economic cum-cultural development of a people. However, the term gender refers to socially constructed roles, responsibilities, aspirations and social expectations of an individual along the biological divide of sex as either male or females (NDES, 2006). Gender as a form of social stratification determines a person's life chances and shapes their ability to participate in the overall socio-economic development of their area.

Women in the area and other parts of the world at large play prominent roles in the socioeconomic development of their household, community and nation.

A part from predominating economic activities such as farming (using crude implement of cutlasses and hoes), cultivating and processing of staple food, they engage in marketing, petty trading without assess to microcredit facilities, gathering of fuel wood and exploitation of non-timber forest resources. Rural women are also involved in local capacity utilization, resource development and entrepreneurial pursuits. Other socio-economic activities women in the area engage in are: production of cassava based food items (such as garri, starch, and 'loiloi'), palm kernel oil, soap making.

Women as agent development participate in public life through their membership in women organizations, such as social clubs, cooperative societies, and other close to home groups as a means of improving the socioeconomic status of their family, creating awareness and enlightening other women. Women constitute a large proportion of the population in the settlement as is the case globally; unfortunately their population does not count in decision making process. Non-inclusion of women in decision making has relegated them to the background even in issues that affects them. Even when laws are being enacted by the national assembly recognizing the rights of women to inheritance, such laws are not fully harnessed to

their advantage in redressing perceived cases of alienation to parents and husbands inheritance due to traditional and customary restrictions.

In the political sphere, women are not adequately represented as befits their population. At the state and federal government levels, the percentage of women at the legislative chambers is a far cry. Currently, of the 360 member of the federal house of representative only 18 are women, out of the 108 senate members 8 are women and in the 36 states of the federation no woman is governor. However, at the local government level in most states as it's the case in Rivers state women are appointed to serve as local government chairpersons thereby given them some representation at the third tier of government. This level of representation is poor compared with what obtains in developed countries.

In education and employment, the chances of women have improved in recent time as both men and women have equal access to education and employment. Enrolment of the girl child into school competes favourably with that of their male counterparts in recent times. Though school enrolment have been affected due to incessant secret cult clashes that has decimated the community population as most of the people have migrated to safer communities. The number of girl child affected will be more than their male counterpart. Some employers of labour still discriminate against women taken up certain jobs. However their population in the work force is gradually increasing.

In times of social unrest and environmental crisis women are the most affected as they bear the brunt of catering for their children, cultivating farm lands, trekking miles to fetch water, gather fuel woods in addition to other social services they render.

Perception and Expectation

Key informants, focus groups and respondents express worry that the facility which has not yielded the desired benefits them in terms of employment opportunities scholarships and other social benefits has become a source of threat to life and livelihood. They fear that their lives is threatened by their vulnerability to toxic substances in their groundwater, soil and air as a result of the seepage of crude oil and ongoing artisanal crude oil refining activities with possible impact on their crops.

Other perceived adverse impacts of the seepage include: pollution of the water and land, and disruption of the ecosystem balance.

Expectation of host community

Respondents were asked to indicate mitigative measures to cushion the effect of the seepage. The most important measures raised were:

Clamping of the defective pipeline from which the seepage emanates

Payment of adequate compensation for environmental damage to the impacted families and the entire community

Provision of potable water for the community

Provision of health facility and personnel to serve the community

Regular health checks should be carried out periodically.

Monitoring plans

In order to avoid the recurrence of the seepage, the integrity of the underground pipes should be periodically examined in line with international best practices in the industry

6.0 Public Health Assessment

Background to the study

Oil development and related industrial activities tend to release obnoxious substance into the physical, biophysical and social environments of human populations, impairing essential community resource (e.g.

ambient air, aquatic system, soil, and vegetable, etc) on which human life is sustained (NEST, 1981; Cunningham et al; 2023; Mughalu, 2004; Ezemonye, 2004, WHO, 1989).These substances or hazards usually gain entry into the human body and affect health negatively via normal processes like inhalation, ingestion, and absorption (Olishifski, 1971; Jarvis, 1981; WHO, 1980). Industrial hazard exposures by human populations may be acute or chronic, depending on the level of concentration of the substance and the durations of exposure. Some exposure may lower the human body's resistance to diseases, causing pathological states in distal tissues and organs while others may even hasten or cause death (WHO, 1980; WHO, 1985)

The petroleum Act of 1969 empowered the Minister of Petroleum Resources to promulgate regulations to prevent environmental pollution in the Petroleum in the Petroleum Sector (FEPA; 1991; 1995). This is spelt out in Sector 2.0 of DPR'S Guidelines and standards which demand that operators of industries and facilities operating wastes, product and submit an environmental assessment report of their companies to the Agency (DPR, 1991),especially when there are negative impacts furthermore, the operations and maintenance oil the oil industry in Nigeria have shown the need to protect and enhance prudently, the environmental and human resources in the area of industrial operations for sustainable development (Olishifski, 1971, WHO, 1980).

The shell Petroleum Development Company has been operating in the Ibaa Community in Emohua L.G.A for over 60 years. It is expected that over the past 60 years of operation, the company would have generated sufficient measurable health impacts both positive and negative in the host community. Underground crude oil seepage was discovered in Ibaa community near SPDC manifold "8" in January, 2016. Also, oil was discovered in local water wells of residents between 2017-2018 which became a cause for concern among the residents.

This is the health impact assessment study of SPDC's manifold "8"crudeoil seepage in Ibaa community, a part of post impact assessment (PIA) studies commissioned byKebetkache Women Development and Resource center and Obelle Concern Citizen.The study was conducted by F. & E Global Resources, a Port Harcourt based environmental consultancy firm.

PIA is an environmental process used for evaluating an already polluted project environment to help Government ascertain the present state of the recipient environment, so that strategies for environmental protection and restoration could be designed. A health impact refers to any change in health risk (such as an increase in reasonably attributed to a project or activity (AMEC et al. 2002). The aim of the study was to identify the health impacts of SPDC operations in the host community.

Objectives of the study

- ➢ To identify the host community impacted

- ➢ To establish the baseline health status and needs of the community

- ➢ To evaluate morbidity and mortality occurrence, in the study area, the possible causes and patterns of distributions

> To identify the impacts arising from SPDC's long time operations and activities of the manifold in Ibaa community, and their effects on the health of the people

> To discuss mitigative measures (e.g. compensation issues and possible alternatives, etc.), and

> To propose adequate health monitoring plan or health surveillance programmed for the area.

Scope of the study

This embraced the following:

Acquisition of local health statistics from existing health institutions in the study area for disease trends, health care provisions and services, infrastructure, and facilities, etc.

Community health survey through questionnaires and oral interview

Assessment of health vulnerability and sensitivity linkages (e.g. disease vectors, water potability, waste disposal practices, and commercial sex activity if any, in the area.

Public perceptions of SPDC operations and activities

Identification of hazardous agents in the study environment

Appraisal of impacts of SPDC activities on the health of the host community

Discussions of mitigations.

Study area

The study area is located in Ibaa community in Emohua LGA within the upland terrain of Rivers State, in the Niger Delta Region. It is situated between Latitudes $E4^045'$ and Longitudes $N6^050'$. The area is drained by a tributary of the New Kalabar, River which cuts across Choba, Ibaa, Rumuji, on to Ndele and beyond; providing residents with domestic water supply, fishing opportunity, transport, and agricultural resources. The ethnic groups' resident in the area comprised mainly Ikwerre-Speaking people and sprinkles from other tribes'e.g Ibos, Ibibios/Effiks, Ogonis, Ijaws, Yorubas and Hausas.

Meeting of Field Consultants with Community Representatives at HRH Palace

Methodology
Study design

The study design followed the passive observational type (cook and Campbell, 1979) where the subject is studied in situ, without any form of experimental manipulation. The cross-sectional study approach was employed such that the data and information were gathered at one point in time. That one study design ensured important and comprehensive information about the study such as host community public perceptions, attitude, and expectation of the company.

Target population

In January 2023 a reconnaissance visit was undertaken to the study area to identify the host community in question and to meet with the community representatives.

The host community identified in the study area within 1.5km radius of the study site was Ibaa. Ibaa was reportedly one of the highly populated communities in Ikwerre kingdom, a population between 800,000 to one million according to the community representatives. Recently, the community went through social disturbances associated with youth restiveness, cultism, and kidnapping, etc. which led to the out-migration of thousands if residents from the area to surrounding villages, towns and cities for safer, more secure and peaceful dwellings. According to current populations projections based on results of the 1991 census of population (NPC, 1991), Ibaa population stood at about 63,055 inhabitants; and some of the people were still on the move.

To determine the sampling locations proper and proper random sampling of respondents, Ibaa community was broken down into its component blocks/ sub-blocks of villages. The community was divided into 3 blocks of villages: Mgbuosimini, Omu-Osunu and Mgbu-Esa (Oliofe) for administrative purposes and each block was in turn subdivided into sub-blocks of villages. The target block of interest to the health study was Mgbu-Osimini, which hosted 6 sub-blocks: OmuobizuElewo, Omuobizu Ota, Omu-Okpogba, Omu-Mgbere, Omu-Digini, and Omu-Obile. The first 3 of these 6 sub-blocks were affected by SPDC oil spills; oil contaminants were visibly seen in the local wells in three compounds in (Omuobizu and Omu-Okpogba sub-blocks) in Mgbu- Osimini-Osimini block which had an estimated population of 500 hou0seholds according to our community representatives.

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Table 6. I: Host community identified for health survey, and the component
blocks/sub-blocks, and facilities hosted.

Host Community	Names of Blocks	Facility Hosted
Ibaa	Mgbu-Osimini	SPDC's Manifold '8'
	Omu-Osunu	
	Mgbu-Esa (Oliofe)	

Table 6.2:Population attributes of the study settlement,
target populations and the sampling strategy

Name of Target Pop (Block000.)	Names of Sub-blocks in Mgbu-Osimini	Estimated Pop of Mgbu-Osimini Block	No. of Existing Households	No. of Sampled Households	% of Sampled Households	No. of persons
Mgbu-O0simini	Omuobizu			7		
	Omuobizu(2)			7		
	Omu-Okpogba			7		
	Omu-Mgbere			3		
	Omu-Digini			3		
	Omu-Obile			3		
Total	6	4,000	500	30	6	240

Source: Field survey, January 2023.

Table 6.1 indicates the host community name, its component blocks and the facilities
hosted. Table 6.2 provide a more comprehensive information on the blocks and sub-
blocks (target populations) their population attributes and sampling strategy.

Data sources

The study employed both primary and secondary data sources. The latter comprised past
environmental studies and reports, both public and private records and information
published in journals, text books, etc. The former included preceded questionnaires of
both open- and close-ended types, and information sourced from key information (e.g.
community representative or spokesperson) and focused group discussions (community
based organizations)

Data collection

The household questionnaire and communal interview was the data gathering instrument
used for the study. Data collection comprised 5 procedures:

1.   Discussion/Oral interview

2.   Questionnaire administration

3.   Field observation

4.   Telephone call, and

5.   Photography

Discussions and oral interviews were held face to face with key informants and focused group, including medical personnel phone calls were used to contact and interview leader of group e.g. CDC, Youths and Women. The aim was to tap the opinions of residents, health perceptions and expectation of SPDC Company and the impacts and effects of their operation on the health of the resident population. Health personnel were interviewed via the telephone on health issues, prevalent diseases and death causes, community.

Questionnaire administration

A structural health questionnaire was administered to a sample of 30 heads of household in the target populations; this was to gather information and data on morbidity, mortality, health care provisions and services, environmental hazards, etc. The questionnaires were administered through field assistans follows: Omuobizu, Elewo (7), Omuobizu Ota (7), Omu-Okpogba (7), OmuMgbere (3), OmuDigini (3), Omu-Obile (3). The respondents comprised 30 heads of households, all married, and aged between 24 and 60 years. Their occupations were farming (6), trading (7), civil service work (3), transportation (2), artisans (3), business/contract (3), health personnel (2) and community leaders (4). This was done to ensure that the information and data gathered reflected a wider coverage of subgroups within the study population

Field consultants waiting to move into the Ibaa community

Field research strategy
This comprised the following techniques:

(a). Reconnaissance visit to the study area to identify the host community.

(b). Discussions with community representatives regarding the study and for permission to carry out questionnaire administration and oral interviews with respondents.

©. Determination of sampling locations/random sampling of respondents.

(d). Interview of key informants and focused group (community representatives)

Sampling technique
The random sampling method was used to select a sample of 30 household as sampling frame for questionnaire administration in the target population (Table 6.2). This represented a sampling fraction of 6%. The mean house hold size for the study area was 8, while the sampled population, totaled 240

Data analysis
All the data and information from the respondents were collated and analyzed using simple descriptive methods and uni-variate summary statistics (e.g. means, medians, media, percentages). The report was further illustrated with charts, graphs and tables.

Baseline health assessment

Local health statistics
Local health statistics for the area was not obtainable owing to vandalization of the PHC in the Community by cult boys. Vital statistics for a locality such as the study area usually consists of birth registration, records of deaths, notifiable disease, out-patients cases antenatal outcomes and immunization. These were not available for the study during our data collection phase in the community.

Health care provisions and services

Health Centre Facility
The health care provision in the study area consisted of a defunct primary health center (PHC) built by the state government which provided for Ibaa residents and the surrounding settlements. The facility was headed by a medical doctor and a matron whose supervised the nurses, midwives, community health extension workers (CHEW), laboratory and Pharmacy technicians and other ancillary workers; and ensured that the place operated efficiently until it was vandalized by cult boys in 2017. Presently the only health service taking in the open hall was immunization programme for children; the entire staff of the institution was reportedly threatened and had been too afraid to go back to work there. Since the vandalization, no health care or treatments of patients' exist in the community. Sick cases go outside the community to Rumuji, Ahoada or Port Harcourt for medical treatment or surgery. For obstetrical services, the community hosted 10 traditional birth attendants who attended to pregnant women and conducted baby deliveries for households. Women who were well of enough, go outside the community to seek for obstetrical care.

The range of health care services provided in the PHC before vandalization covered the following:

- ➢ Materials and child welfare services
- ➢ In and out patients
- ➢ Oral rehydration therapy (ORT)
- ➢ Family planning
- ➢ Referral services to specialist clinics
- ➢ Health education and counseling and
- ➢ Immunization

Immunizations were carried out quarterly by health staff from the L.G.A. office, which also provided all the necessary vaccines for immunization.

Patent medical care

The study area hosted about 30 patent medicine stores, where residents resort to for drug supply to treat themselves. The use of patent medicines, self-medication and native treatment (with herbs and roots), instead the conventional medical treatment by trained health personnel, appeared to be the only treatment choice available to residents of Ibaa community.

Public utilities

Public utilities entail water supply, electricity, and telecommunication.
Water supply facilities in the study area consisted of hand-dug local wells (80%), and the private boreholes (20%) whose waters were hardly treated or sanitized for safety. Only a few percentage of population utilized vendor water (bottled water and pure water sachets); potable water was however lacking in the study area. According to our key informants, about a hundred households in Ibaa community had a private borehole. With regards to electricity, although the area was harnessed to the National Grid, there had been no light in Ibaa for several months now according the report of the community representatives. With regards to telecommunication, the area was served with modern telecommunication networks such as MTN, GLO, Airtel, etc.

Sanitary waste disposal facilities

Sanitary waste disposal facilities were absent in the study area, however, monthly sanitation exercise was encouraged in the community by households and the CDC organization. There was need for construction of a good drainage system to check the problem of flash floods and erosion in the community. There were no sanitary waste disposal facilities for proper management of solid and faecal wastes in the study area.

Transportation facility

This consisted of the State- constructed Rumuji-Ibaa Road, which was presently in need of repair; other link roads within the community were in deplorable conditions. There was need to provide link roads in the study area to facilitate development in the study area.

Recreational facilities

These comprised open fields used for playgrounds, and open spaces attached to schools and churches. Ibaa community deserve and a befitting town hall

Community health survey

Morbidity studies

Morbidity causes in the population were investigated via questionnaire administration to a sample of 30 households representing 240 persons 118 male and 122 female). A total of 102 cases of disease were reported from the 30 sampled households for the year 2022.

Table.6.3 presents the annual morbidity rates of prevalent disease in the study area; the figures are prevalence rates percent distribution computed as follows:

$$\text{Prevalence} = \frac{\text{Number of cases of a disease x 100}}{\text{Total number of cases of disease in the population.}}$$

The causes of morbidity in the study area are shown in Table 6.3. The leading causes of morbidity during the period are summarized in figure 5.1. On the whole, malarial infection (17.6%) topped the list, followed by respiratory disease (15.7%), Typhoid fever(11.8%), Diarrhoea/vomiting (9.8%), Skin disease (8.8%), Hypertension/Stroke (6.9%), and Eye problem (5.9%). Communicable disease perse accounted for about percent of all case of disease reported in the study area (fig.6.2) while non-communicable disease represented approximately 56 percent. Chronic disease identified in the population included: cancer of the stomach diabetes, and asthma. Respiratory disease, skin disorders and eye problems were guile evident in the study population and could also be attributed to communicable disease and chemical factors with the study environments.
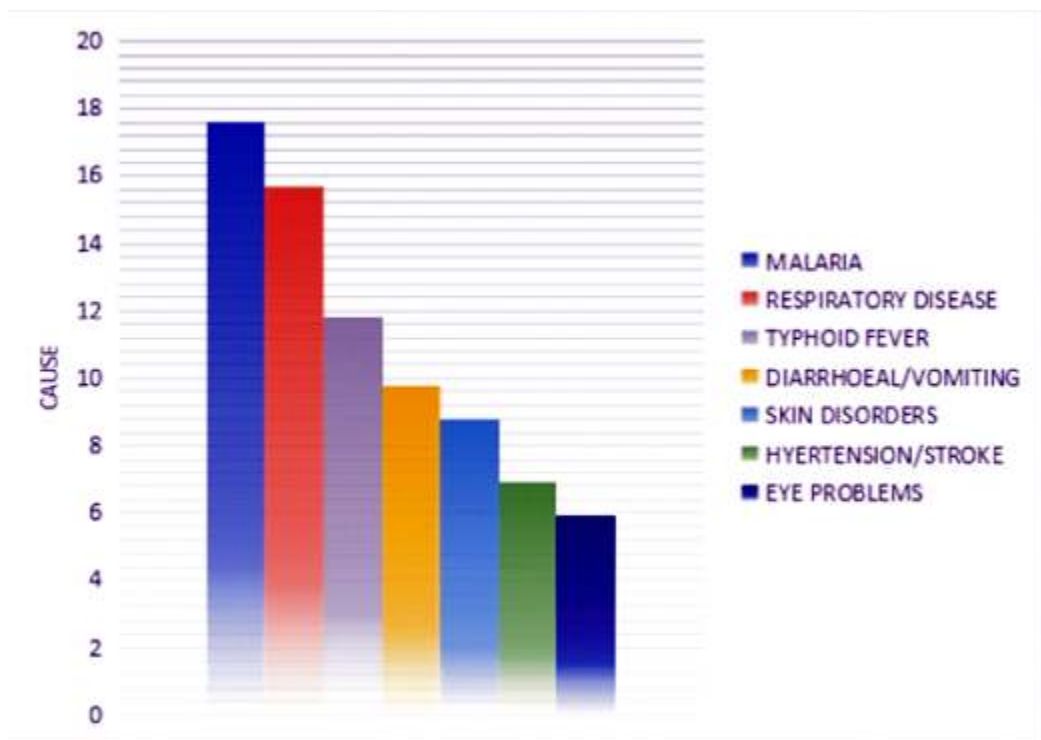
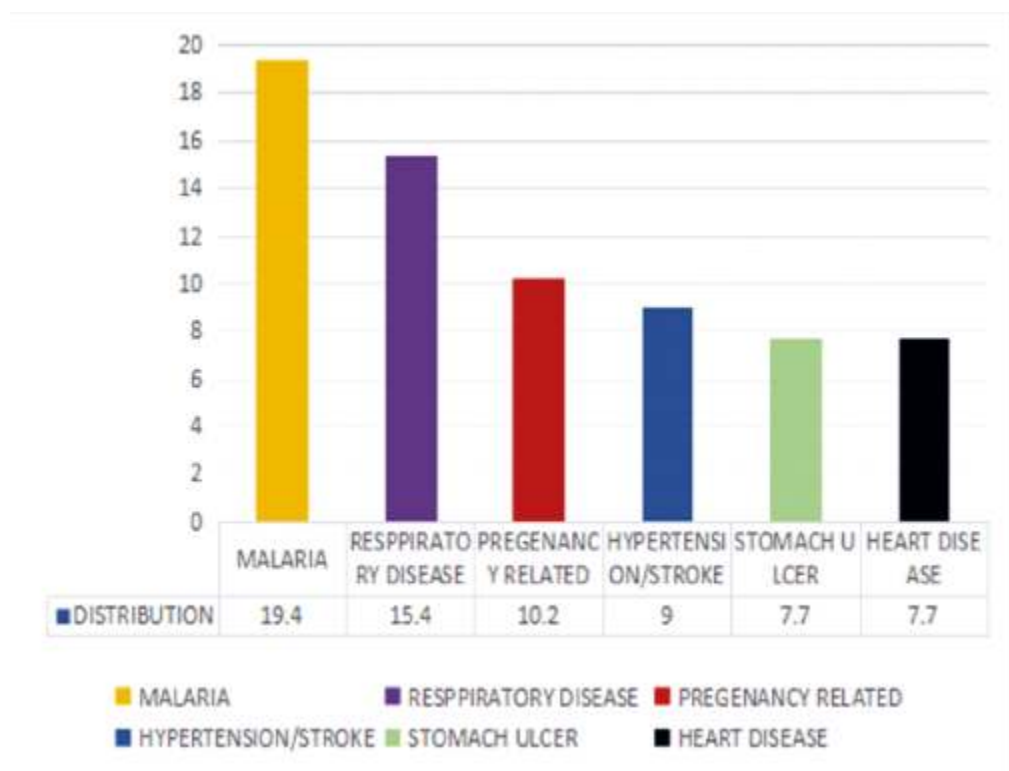*Fig.6.1: Leading Causes of Morbidity in the study Area (2023)*
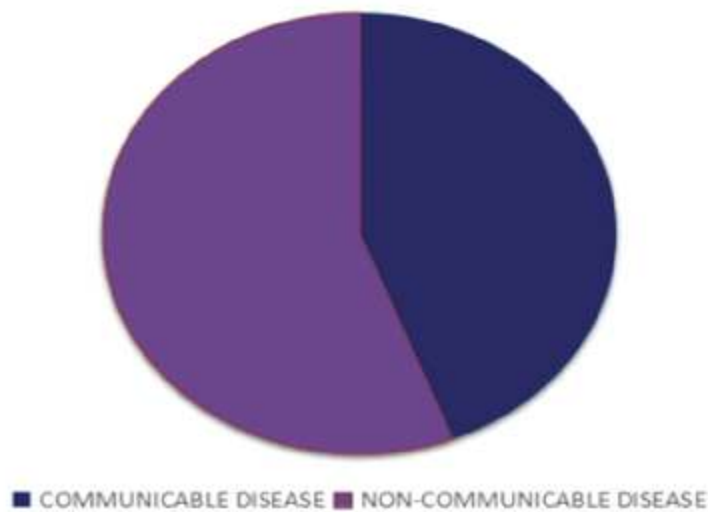
Fig.6. 2: Percentage distribution of communicable and
Non-Communicable diseases (2023)

Table 6. 3: Causes of Morbidity Reported in the Study Area

Cause	No	%
Respiratory	16	15.7
Cancer	2	2.0
Malaria attack	18	17.6
Typhoid fever	12	11.8
Diabetes	4	3.9
Hypertension/strokes	7	6.9
Asthma	4	3.9
Limb deformity	1	1.0
Skin disorder	9	8.8
Eye problem/blindness	6	5.9
Diarrhea/vomiting	10	9.8
Pregnancy-related cases	5	4.9
HIV/AIDS	5	4.9
Nosebleed	3	2.9
Total	**102**	**100**

Source: Field Survey January, 2023.

	MALARIA	RESPPIRATORY DISEASE	PREGENANCY RELATED	HYPERTENSION/STROKE	STOMACH ULCER	HEART DISEASE
■ DISTRIBUTION	19.4	15.4	10.2	9	7.7	7.7

■ MALARIA   ■ RESPPIRATORY DISEASE   ■ PREGENANCY RELATED
■ HYPERTENSION/STROKE   ■ STOMACH ULCER   ■ HEART DISEASE

Fig 6.3: Percentage distribution of Communicable and Non-Communicable Diseases (2022)

Table 6. 4: Probable Causes of Mortality Reported (2022)

Cause	No	%
Malaria	15	19.2
Respiratory disease (cough)	12	15.4
HIV/AIDS	3	3.8
Pregnancy-related cases	8	10.2
Hypertension/stroke	7	9.0
Tuberculosis	2	2.6
Stomach ulcer	6	7.7
Road traffic accident	4	5.1
Asthma	4	5.1
Diabetes	3	3.8
Heart diseases	6	7.7
Stomach cancer	5	6.4
Unknown	5	6.4
Total	**78**	**100**

Source: Field Survey January, 2023.

Mortality investigation

Health records were not available the study owing to vandalization of the Primary Health Centre, the main medical institution in the study area. Thus, health records on mortality like morbidity records were generated through health interview survey of household and medical personnel in the study. A total of 78 cases of mortality were reported from 24 households (see table 6.4)

The leading causes of mortality in the area were: malaria (19.2%) respiratory disease (15.4%), Pregnancy related cause (10.2%), hypertension/stroke (9.0%) stomach ulcer (7.7%), and heart disease (7.7%) The graphical details are presented in fig.6.3 communicable and non-communicable diseases were both implicated as causes of mortality in the study area. Malaria, respiratory disease, pregnancy related cases and stroke were the major causes of death in the study population.

Obstetric services

Obstetric Services in the study area was investigated through interviewing the respondents. The principal mode for baby delivery preferred by households was the conventional type conducted by trained midwives and nurses as indicated by 100% response rate by the interviewees.

There were however, 10 untrained traditional birth attendants (TBAs) in the study area, who carried out native midwifery work.
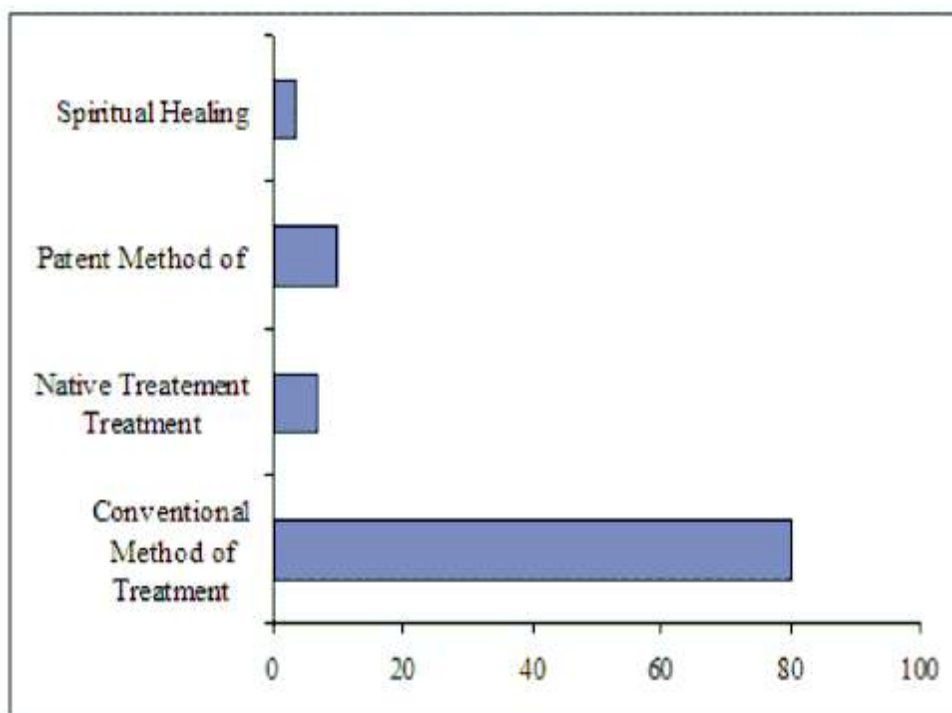
Fig. 6.4: Health treatment preferences of household member in the study area (2023)

Health treatment preferences

With regards to the health treatment preferences of households, Majority (80%) of the people still preferred the use of conventional medical treatment to other forms of treatment e.g. native medicine, self-medication and patient medicine; however, due to the vandalization of the PHC, most residents presently depend largely on patent medical care.

Polluted River in Ibaa community

Socio - Cultural factors and public health

Certain health habits and lifestyles of people tend to enhance or reduce the health status of people of a community. Such factors were evaluated through oral interview and discussion with residents; the responses given are presented below.

(a) Cigarette smoking

This was admitted by 30% of the interviewees. Cigarette smoking has known negative impact on human health. Epidemiological studies have shown that smoking unquestionably contribute to high incidence of respiratory disease and even lung cancer (Jarvis, 1981).

(b) Alcohol consumption

Moderate use of alcohol or spirits was affirmed by 60% of the interviewees. Excessive use of alcohol lead to impairment of physical, mental and psychological health of people; drinking and driving are contributing factors to road traffic accidents.

(c) Communal eating and drinking

About 77% of the interviewees affirmed participation in communal eating and drinking from the same utensils, a practice that promotes communicable disease transmission in the population.

(d) Commercial sex activities

Commercial sex activities (brothels) were not observed in the area however, promiscuity among the youths was on the increase in the area according to field report from the area.

Health vulnerability and sensitivity linkage

Just as cultural habits affect public health, some factors within the population cause people to be vulnerable ill-health. These factors or conditions were appraised and the results presented below.

Disease vectors

Disease vectors identified in the study area were mosquitoes, houseflies, sand flies, rodents and roaches which are endemic in the area. Mosquitoes suck blood causing malaria and anemia; rodents and cockroaches on the other hand convey disease.

germs from open dumps and unhygienic environment into our houses and over our foodstuff, transmitting human diseases such as, gastroenteritis, cholera, dysentery, hepatitis, etc.

Water supply sources available to residents in the study area were: local hand-dug well (80%), private boreholes (16.7%), and vendor's water (3.3%). Details of water sources are shown in table 6.5 and fig 6.5. Potable water is an essential commodity for good health but when it is polluted, it becomes a carrier of disease to humans. The residents in the host community depended mainly on water from local hand-dug well, and the private boreholes for domestic use. Therefore the local water supply sources in the area constitute serious public health hazards; meaning that they expose the residents to ill-health and diseases

Summary of baseline health assessment

In summary, there has been no functional medical service facility in the settlement up till now; all vital statistical records for the area was lost. Weekly immunization of children on Thursdays was about the only health service activity going on in the defunct health centre. The residents of Ibaa community presently leaned mainly on patent medical drugs, self - medication and traditional medicine (herbs and roots). Obstetric services were conducted by 10 untrained TBAs or local midwives; pregnant women whose does not want to subject themselves to local midwives, seek medical attention inotherneghbouring communities (e.g.Rumuji health centre, Ahoada or PH General hospital). There were no private clinic services in the study area where one could get some medical services.
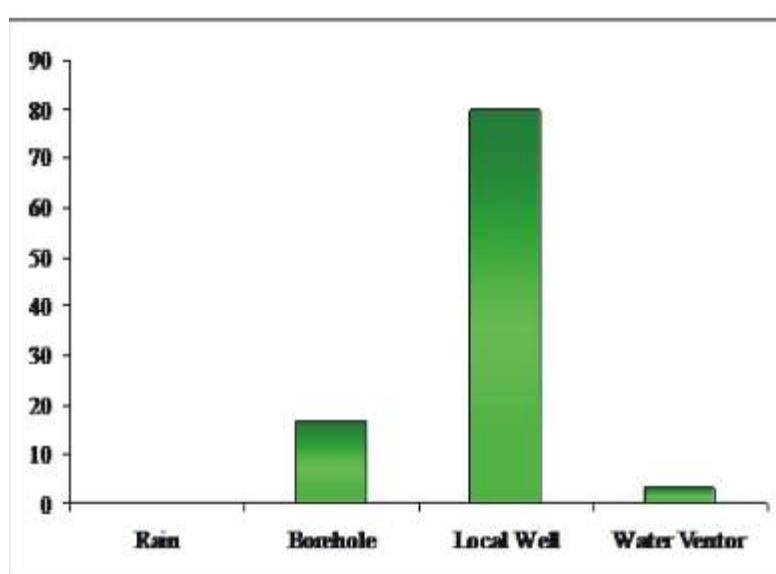
Fig.6.5: Sources of Domestic Water Supply for Household in the Study Area (2023)

**Table 6.5: Sources of Domestic Water Supply for Households in the Study area (2023**

Source	No.	Percent
Rain		
Stream vendor	1	3.3
Local well	24	80
Borehole	5	16.7
Public Tap	–	–
Total	30	100

Source: Field Survey, January, 2023

Table: 6.6: Solid Waste Disposal Methods of Households in the Study area (2023)

Preferences	No	Percent
Bush/swamp	15	50.0
Composting	8	26.7
Burning	3	10.0
Open dump	4	13.3
Total	30	

Source: Field Survey, January, 2023.
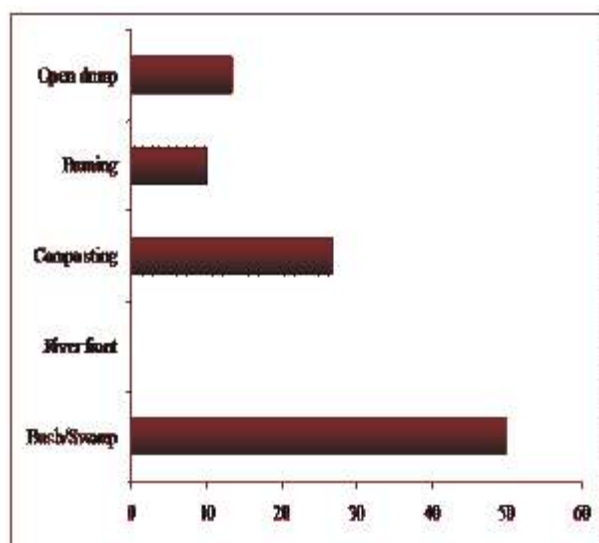
Fig.6.6: Solid Waste Disposal Methods in the Study Area (2023)
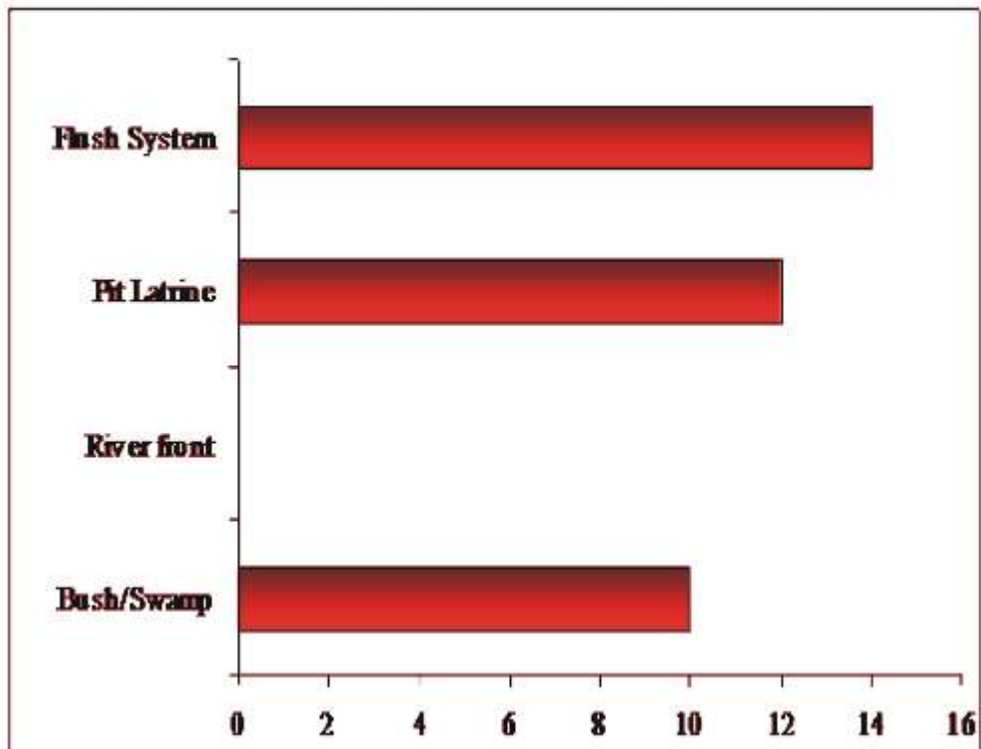
Fig.6.7: Faecal waste disposal method for household in the study area (2023)

6.22: Waste disposal management

Solid wastes disposal methods employed in the area were: Bush/swamp (50%), composting (26.78), Burning (10%), and open dump (13.3%). The modal disposal method was Bush/swamp disposal (Table 6. 6 and fig. 6.6)

With regards to faecal waste disposal (fig. 6.7), the modal method utilized by residents was the'pour flush' or flush system (80%).

Local hand dug well for domestic water supply in the study area.

Borehole water supply source

Environmental hazards

Environmental hazards identified in the study area were oil spills, air, water, and noise pollution; insect vectors and seasonal flooding/erosion. The practice of burning, oil bunkering ("kpofires") contributed immensely to oil spills and ambient air pollution in the study area apart from the main oil leakages/spills from SPDC operations at its manifold and gas flaring in the environment. The study area however, had experienced several oil spills from the manifold activities.

PERCEPTIONS AND EXPECTATIONS

Perceived impacts (Beneficial and Adverse) of SPDC's operations

Respondents were asked to state their perceptions of benefits and adverse impacts of SPDC's Operations in Ibaa community over the years (from the sixties till date). The results of the responses given are itemized below.

The Perceived Benefits of SPDC

According to the community representatives, SPDChad some welfare programme (such as compensation and scholarship opportunity) for Ibaa community in the seventies, but these have since stopped. Despite the several oil spill incidents in the host community, SPDC has had little or no positive impacts on the health care status of Ibaa community, according to the community report.

Adverse Effects of SPDC's Operations in Ibaa Community

- ➢ These include the following
- ➢ Oil spill occurrences
- ➢ Oil leakages from SPDC's corroded and rusty pipelines.
- ➢ Pollution of River, creeks and swamps by oil spills
- ➢ Pollution of underground water resources by hydrocarbons
- ➢ Pollution of ambient air quality through flare emissions
- ➢ Pollution of soil, farmlands and agricultural products
- ➢ Pollution of fishery products
- ➢ Wildlife depletion
- ➢ Environmental degradation

Health challenges such as: respiratory diseases, cancer, skin disease, eye disorders (blindness), asthma, seizures, cleft palate, limb atrophy, nose bleeding, high and low blood pressure

Expectations of residents

From SPDC

- ➢ Infrastructural development
- ➢ Improved health care delivery
- ➢ Provide light in Ibaa community
- ➢ Potable borehole water provision
- ➢ Revamp the PHC
- ➢ Provide security for health centre through fencing
- ➢ Provide free medical services for residents
- ➢ Bring in medical manpower doctors, Nurses, midwifes etc. to man the
- ➢ Provide contract opportunity
- ➢ Give scholarship to post graduate level
- ➢ Provide street lights powered by Solar energy system
- ➢ Construct link road in the area
- ➢ Construct a befitting Town hall for Ibaa.
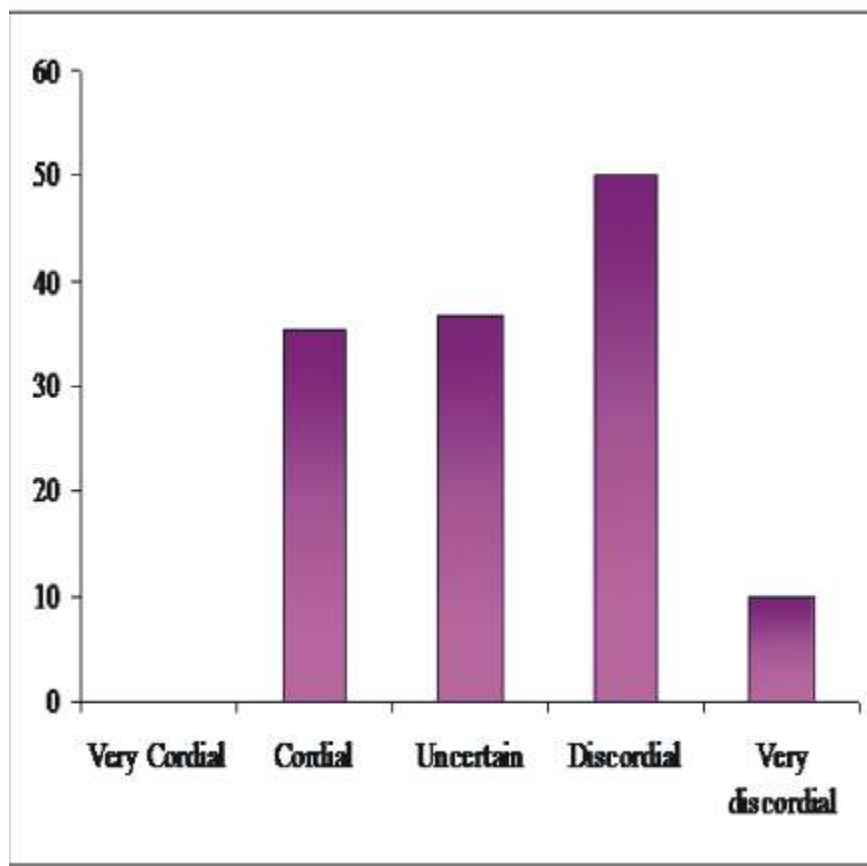
Fig.6.8: Host Community Perceptions of SPDC Operation and Relationship

Host community's perceptions of SPDC's operations

The interviewees in the host communities were asked to state their perceptions regarding SPDC operations in the host community. About 80% of the interviewees indicated they were either displeased/very displeased with their operations. On the issue of cordiality of relationship, approximately 60% response from the interviewees affirmed that the relationship between SPDC and the host community was discordial/very discordial.From the fore-goings, it was obvious that the public image of SPDC in the host community was not pleasant; the host community was not pleased with the way and manner that SPDC was carrying out its operations and activities in the study area. The relationship between the two parties was not cordial at all.

When crude oil spill into the river, creeks and swamps tampered with the economic resources and incomes on which host community households were sustained. When clean-ups and remediation were not aptly effected, during flood seasons in the area, the spill would be spread to other sites, increasing the extent of the pollution

. When oil companies destroy the swamps and the aquatic system of the host community, the people are stripped of their economic potentials and quality of life. When SPDC begins to live up to expectations through the application Standard Practices in oil exploration and exploitation operations, its public image in the host communities will be more positive. There is always room for improvement on the relationship between SPDC and its host community at Ibaa.

Health impact assessment of SPDC's operations
Impacts of SPDC Operations in the Study Area

SPDC has been operating in Ibaa community of Emohua L.G.A for over 60 years. Within this period, there had been recurring oil spills from the manifold operations, contaminating the river, creeks and swamps, and fish ponds. The principal complaints of residents against SPDC oil development activities had always been the problem of not cleaning-up the spills and not remediating the environment following oil spill occurrence. According to the residents, the impacts of oil spills and gas flaring had been devastating to their health and socio-economic resources. The host community by this time has experienced several oil spill incidents, oil leakages from the pipelines and gas flaring activities. The following were the health impacts identified in the study area.

- ➢ Water pollution from oil spills and leakages in the environment
- ➢ Pollution of ambient air quality by flare emissions at Obelle flare stacks
- ➢ Pollution of fishery resources (including fish ponds) by hydrocarbons
- ➢ Pollution of crops and farmlands by hydrocarbons.

Health issues reported by members of household during the field study include:

➢ Respiratory diseases (chronic cough and catarrha) caused by inhalation of hydrocarbons particles from flare emissions in the air and the black dust resulting from bunkering activities in the study area.

- ➢ Skin diseases (dermatitis) from skin exposures to polluted air, and waters from polluted from local wells, creek and the river.
- ➢ Gastro-intestinal disturbances (diarrhoea/vomiting, and abdominal pains, etc.)
- ➢ Eye problems (blindness) due to hydrocarbon pollutants in the air and water.

Other complaints raised by residents during our field studies in the community were, the prevalence of asthma, diabetes, hypertension and stroke and ulcers of the food passage. The residents also queried the increase in strange disease cases like cleft palate, atrophy of limbs, nose bleeding, and seizures not associated with epilepsy. There was need for an in-depth study of diseases prevalence and patterns in the study community to unravel these mysteries.

- and conducted in accordance with international specifications. Health safety and environmental standards should be strictly adhered to.
- Early attempts should be made to clean oil spills and conduct remediation
- The use of underground water sources (local wells and private boreholes) was a health risk. Potable water was lacking in the study area, hence the government and or SPCD should provide a source of power to supply light and a potable water in Ibaa community
- Adequate compensations should be paid to the community or individuals for damages done to lands and properties (e.g. fish ponds, etc.)
- SPDC should support the health and welfare of its host helping to equip the existing PHC facilities in Ibaa; the health center should be fenced.
- SPDC should have an MOU with Ibaa, its host community

Monitoring Plan
The perceptions of the host communities regarding the health impacts of oil facilities, and the welfare implications should be evaluated from time to time, since these serve as indicators for project sustainability and safeguard to both parties.
The following variables should be monitored regularly, every 2 to 3 year interval:
- Oil spill incidents
- Water quality studies
- Air quality studies
- Pipeline corrosion, leakages and replacement
- Potable water availability in the host community
- Health infrastructural status
- Fishery Studies
- Spill cleanup and environmental remediation
- Fishery outputs in the study area
- Quality of life in the study settlement
- Morbidity and mortality investigations in host communities
- Disease prevalence patterns and distributions in oil communities

Conclusion and Recommendation

Conclusion

In order to investigate the impact of crude oil seepage from SPDC manifold "8" trunk line on the surrounding environment in Ibaa community, a one day assessment of water, soil, outdoor air samples as well as public health and socioeconomic studies were conducted. Samples were collected from locations determined by the people rather than probability. However for a more empirical study reference samples were taken from outside the area to cover the length of the community.

The results of the water, soil and air samples analyzed revealed the presence of hydrocarbon in all samples which implies exposure to hydrocarbon contaminants. Although the period of exposure and dosage may be unknown, exposure to hydrocarbon is a public health risk. Other water quality criteria analyzed such as bacteriological and heavy metal indicates the presence of heterotrophic bacteria, total coliform, heterotrophic fungi, and hydrocarbon utilizers in addition of heavy metals.In general, water samples were of low quality; showed no faecal contamination and likely absence of pathogenic bacteria (WHO, 1996).

Three borehole samples showed presence of crude oil contamination while the other water samples showed absence of crude oil contamination.

The outdoor air quality analysis indicates that the concentration of criteria air pollutants carbon (II) oxide (CO) were within the set limit, sulphur (IV) oxide and ozone were not detected while nitrogen (IV) oxide was above permissible limits. The presence of volatile organic compounds (VOCs) and methane suggest oil spillage or illegal refining activities.

Air quality index (AQI) for $PM_{2.5}$was "moderate" at site 1 (reference) and "unhealthy for sensitive groups" at site 2 while PM_{10} was moderate at both sites 1 and 2. The AQI for CO indicates "unhealthy for sensitive group at site 1(reference) and "moderate" at site 2.The meteorological factors measured are indicative of dry season with low mean levels of relative humidity, high temperature, with wind speed above 2.00m/s blowing from the direction of South West.

The Pearson correlation analysis indicated a strong significant positive association between $PM_{2.5}$ with PM_{10} and Relative humidity, between NO_2 and CO, and very strong between CH_4 and VOCs, between wind speed and relative humidity. A strong but negative correlation was observed between Relative humidity with NO_2, VOCs and CH4. Also negative between Wind speed with NO_2, VOCs and CH_4.

Recommendation

Basedon the study findings the following recommendations are suggested on emergency and long term basis:

Emergency measures

(i) A comprehensive health check to ascertain the people's extent of exposure to hydrocarbons and particulates from crude oil seepage and illegal crude oil refining activities;

(ii) Provide alternative source of water supply for the populace since the aquifer is contaminated;

(iii)   Relocate the impacted families to a safe location

Long term measures

(i) Investigate the source of the seepage with a view control it and halt every illegal crude oil refining activities;

(ii) Educate the people on the dangers of hydrocarbon pollution on their health and the environment;

(iii)   Regularly engage with community stakeholder;

(iv)   Adequate compensation should paid to the impacted families and the community for undue exposure to hydrocarbons;

(v) Remediation of the impacted groundwater should be carried with empirical evidence.

References

Abam, T&Nwankoala, H (2020). Hydrology of Eastern Niger Delta: A Review Journal of Water Resources and Protection.

Akinfolarin, O,;Boisa, N and Obunwo, C (2017). Assessment of Particulate Matter-based Air Quality Index in Port Harcourt, Nigeria. Journal of Environmental Analytical Chemistry.

Akinfolarin, O. M. (2020) Introduction to Environemntal Chemistry, Environmental Pollution and Remediation. In Sharma, P (ed) Research Trends in Environmental Sciences (Vol. 4 pp 55 -83) New Delhi, China: AkinikNik Publications. https://doi.org/10.22271/ed.book.770

Akpokodje, E.G. (1996). A Study of Environmental Effects of Deep Sub-surface Injection of Drilling Waste on water resources of the Niger Delta. CORDEC, University of Port Harcourt. Port Harcourt.

Alexander, M. (1977). Introduction to Soil Microbiology. 2nd Edition, John wiley and Sons. New York.

Amajor, L. C. (1989). Geological Appraisal of Groundwater Exploitation in the Eastern Niger Delta: In: Ofoegbu, C ed; Groundwater and Mineral Resources of Nigeria, Braunscweigh/ Weisbaden, FriedrVieweg and Sohn, 85 – 100

Amajor, L. (1991). Acquifiers in the Bennin Formation (Miocene) Recent, Eastern Niger Delta, Nigeria: Lithosstratigraphy, Hydraulics and Water Quality . Environmental Geology and Water Sciences.

Atlas, R. (1981). Microbial Degradation of Petroleum Hydrocarbons: An environmental Perspective. Microbial Review. 45 (1): 180 – 209.

Bentayeb, M., Simoni, M., Norback, D., Baldacci, S., (2013). Indoor Air Pollution and Respiratory Health in the Elderly. Journal of Environ Sci Health A Tox Hazard Subst Environ Eng

Brucker, N., Charao, M., Moro, A., Ferari, P., Bubols, G., (2014). Atherosclerotic Process in Taxi Drivers Occupationally Exposed to Air Pollution and Co-Morbidities. Environ Res

Canova, C., (2010) et al. Carbon Monoxide Pollution Is Associated with Decreased Lung Function in