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**PILEX CENTRE FOR CIVIC EDUCATION INITIATIVE
THE PEOPLES ADVOCATES**

**REPORT ON THE ENVIRONMENTAL AND PUBLIC HEALTH
ASSESSMENT IN RUKPOKWU, RUMUEKPE AND IBAA
COMMUNITIES**

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**Manuscript:
DR. BRIGGS, BIEYE R.R.**

**Editors:
Courage Nsirimovu Esq.
Timizimor E. Victory**

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PILEX CENTRE FOR CIVIC EDUCATION INITIATIVE – THE PEOPLES
ADVOCATES

#40b Wogu Street, D/Line

Port Harcourt, Rivers State.

Tel; + 234 803 292 5998, 0810 282 0496

Email: pilexcentrengo@gmail.com

Website: www.pilexcentre.org

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ABOUT PILEX CENTRE;

PILEX CENTRE; aka The Peoples Advocates (TPA) is an association and assembly of public interest lawyers and citizens of Nigeria who are interested in the rights of peoples globally. We are part of the Public Interest Lawyering Initiative for West Africa, Institute of Human Rights and Humanitarian Law, Rivers State Network of Non-Governmental Organizations, CSO I-Report Platform/CIEPD Election Situation Room, Network of Police Reform in Nigeria, Transition Monitoring Group, Civic Space Watch Cluster, Environmental Rights Africa, African Climate Platform etc.

Pilex Centre was registered in July 2023 and within a twinkling of an eye, we are everywhere, tirelessly working to make life better for humanity.

In the month of September 2023, we broke into Kaduna, Nigeria to profile/verify Human and Environmental Rights Defenders who had suffered reprisal attacks from 2022 to 2023 and we recorded 160 cases of such incidents that led to the death/injury of affected defenders. It may interest you to know that global reporters of such incidents have not been capturing Nigeria and Africa in their yearly reports.

Hence the support from Green Advocates/Mano River Union to undertake the said task. We completed that project on September 28, 2023 and produced a report which we are yet to publish.

Pushing forward into 2024, we secured our international Pilex Secretariat at 40b Wogu Street, D/line, Port Harcourt, Nigeria and hit the ground running with our Legal Trainee program and RIV 3 Project (focused on Environmental Impact Assessment and litigation in oil and gas extractive sector) sponsored by Advocates for Community Alternative (ACA) and Public Interest Lawyering Initiative for West Africa (PILIWA). PILEX has a Board (Sir Everest Nwankwo, Madam Egondur Esinwoke etc) with over 60 years of experience in this sector of Human and Environmental Advocacy.

ESSENCE AND ACKNOWLEDGEMENT

Courage Nsirimovu Esq. who is a member of the Public Interest Lawyering Initiative in West Africa and Founder of Pilex Centre has over the years wondered how communities in Niger Delta can effectively seek justice.

Most public Interest Law advocacies and litigations have failed due to lack of adequate evidence to link the pollution or damage to its impact on the environment and community victims.

As such Pilex Centre acknowledges the invaluable support from Advocates for Community Initiatives and the PILIWA family in funding our Legal Trainee and RIV 3 projects which enabled us to embark on this fact-finding mission.

We also acknowledge ELAW Team of Experts for offering their scientific and legal support in the interpretation of these assessments and how it can be harnessed to seek justice for impacted communities (Rukpokwu, Rumuekpe, Ibaa Communities amongst hundreds of other communities in the Niger Delta Region of Nigeria).

Furthermore, we acknowledge the effort of Dr. Bieye Briggs and his Team for conducting this daunting task. We also thank Hon. Henry Efergbo who helped us navigate the environment in order to have a hitch-free research.

Finally, I thank Pilex Team for working harmoniously and tirelessly with the Coordinator to make this effort a reality, Pilex Board for their kind advice and Late Anyakwee Nsirimovu who taught me how to do this job.

Thanks be to God and Father of our Lord Jesus Christ who has blessed us with understanding, knowledge, wisdom, strength and Courage to stand up in victory for humanity in Jesus name, Amen.

FOR: **PILEX CENTRE**



COURAGE NSIRIMOVU Esq.

FOREWORD

Although it seems obvious that the widespread water, soil, and air pollution caused by the petroleum industry in the Niger Delta is having serious health impacts on affected communities, the studies that connect the dots and prove the chains of causality are few and far between. PILEX Centre for Civic Education Initiative's study helps to fill this gap in scientific knowledge. The study also, however, underlines the injustice of a system that requires impoverished, health-burdened communities and their civil society allies to find proof of the ways in which extractive activities are devastating their health and the environment, when those responsible have the resources and access to the information that could save lives. It is to be hoped that Nigerian authorities and the oil companies will seize on the study's actionable conclusions to support and improve health in local communities and remediate the harm they have caused to the precious environment of the Niger Delta.

Jonathan G. Kaufman

Advocates for Community Alternatives

Executive Director

CHAPTER ONE

Introduction

1.1 Background of the Study

On the western coast of Africa lies Nigeria with a land mass of approximately 923,769 square kilometers (356,669 square miles). Pre-colonial period had distinct nation states (tribes) that functioned independent of each other such as the Hausa/Fulani, Igbo, Yoruba, Ijaw, Efik, Edo, Ibibio, Ogoni, Ikwerre, Igala, Itsekiri etc speaking over one hundred distinct languages. However, in 1914 the British colonialists amalgamated the Southern and Northern protectorates to form what is now known and called Nigeria. In October 1, 1960, Nigeria gained independence from the British and became an independent Nation. Nigeria is blessed with abundance of natural resources such as crude oil, natural gas, coal, lithium, gold, iron ore, cobalt, copper, californium and a vast array of arable land for agriculture.

Nigeria is currently made up of thirty six states and a Federal Capital Territory (FCT), Abuja which is the capital of Nigeria. However, Lagos situated at the South Western part of the country is the commercial and economic nerve centre of the nation. It is a cosmopolitan state, with seaports, an international airport and the most populous State of Nigeria.

Nigeria is bordered to the north by Niger, to the east by Chad and Cameroon, to the south by the Gulf of Guinea in the Atlantic Ocean, and to the west by the Republic of Benin. Nigeria is not only Africa's most populous country but also the most populous black nation on the planet, with an estimated population of 222,486,000 according to the National Population Commission (Kirk-Green et al, 2023).

The Niger Delta, which reaches roughly 150 miles (240 km) from north to south and around 200 miles (320 km) along the coast, has an area of 14,000 square miles (36,000 square kilometers). Within the delta, the river forms an intricate network of channels known as rivers. The Nun River is considered the river's direct continuation, while additional notable channels include (from west to east) the Forcados, Brass, Sombreiro, and Bonny. Sandbars restrict the mouths of the majority of these canals. The Forcados, for example, which replaced the Nun as the most trafficked channel in the early

twentieth century, was eventually eclipsed by the Escravos River in 1964. The delta is progressively being stretched seaward by the river's sediment, and mangrove swamps have spread beyond its outer margin (Mabogunje, 2023). The Niger Delta region is



Coordinator of Pilex Centre bailing crude oil at a spill site

blessed with a rich mangrove swamp which is one of the widest and thickest in the world after India and Indonesia. (Itehm, U; 2019. Wildlife Conservation Society Cross River National park (Oban Division) Annual Report: January –December, 2018. And Ajibola MO, Awordian OO. 2015: Assessing wetland services in the Niger Delta, Nigeria. *International Journal of Humanities and Social Sciences* 5 (1): 268-277).

The Niger Delta is made up of nine states: Rivers, Cross-Rivers, Akwa-Ibom, Delta, Bayelsa, Edo, Ondo, Abia and Imo with a total population of more than 30,000,000. The Niger Delta region remains one of the hydrocarbon most polluted regions of the world. The youths of the region have been agitating of resource control and environmental justice following widespread oil spills, gas flaring, loss of livelihood sources, unemployment and under-development in the region.

Rivers State which is one of the thirty six states of the nation is situated in the Niger Delta region of the country and is the headquarters of oil and gas exploration and exploitation business in Nigeria due to huge crude oil and natural gas deposits in the state. Buried deep within the ground of Rivers State are crude oil pipelines that criss-cross the length and breadth of the State and this is true for all the states of the Niger Delta. Majority of these pipelines and crude oil production facilities were installed over

five to six decades ago and are yet to be replaced, this is one of the major reasons why there are incessant cases of crude oil spills, gas leaks and pipeline explosions recorded almost on a daily basis in Rivers State and other parts of the Niger Delta. Another major problem in Rivers State is gas flaring which emits soot into the atmosphere, this has been further compounded by artisanal crude oil refining in Rivers State. In 2017, the concentration of soot popularly called “**black soot**” by residents, became exponentially high leading to widespread protests by citizens and residents of the State under the #StopTheSoot campaign which trended globally at the time. In response to the protests by concerned citizens, the Federal and State Governments made promises to end the menace of soot in Rivers, nearly eight years later, nothing concrete has been done to curb the menace of soot in the atmosphere.

CHAPTER TWO

Socioeconomic Impact of Hydrocarbon Pollution

Hydrocarbons are one of the major constituents of crude oil. It has very serious deleterious effects on both the environment and human health. The social and economic fabric of society is deeply intertwined with the environment, therefore, whatever affects the environment whether positively or negatively can have direct or indirect impact on the social and economic status of communities and individuals in any given system. It is from the environment and the resources found therein that humans, plants and animals derive their source of livelihood and sustenance. Everything to make life comfortable is gotten from the environment. Almost all human industry has a direct link to the environment, therefore, destruction of the environment by activities of crude oil and natural gas exploration and exploitation activities by multinational oil companies will adversely affect socioeconomic status of individuals and communities. In the Niger Delta, the people are predominantly fisherfolks and farmers, however, the rivers and farmlands have been polluted by incessant crude oil spills and gas leaks which occurs almost on a daily basis. Therefore, farmers and fisherfolks have become poorer and cannot afford the basic necessities of life such as food, healthcare, education, decent shelter etc. Traditional Niger Delta communities are characterized by swimming for recreational activity and as part of the culture of the people, certain traditional spiritual rituals performed as customs are no longer practiced due to pollution of rivers by crude oil. Deep forests which were used as sacred grounds for some traditional deities and performance of certain traditional rituals in Niger Delta communities have been cleared for crude oil exploration activities thus desecrating such places. Everywhere crude oil was discovered is almost always thrown into crisis, these may include but not limited to intra-communal conflicts, inter-communal conflicts, youth restiveness, cult clashes, chieftaincy and kingship tussles, kidnapping etc.

Nigeria is Africa's leading crude oil producer, the world's seventh-largest crude oil exporter, and the tenth largest processed gas reserve (Amnesty International 2006; Donwa et al., 2015). Despite its large oil revenues, Nigeria is one of the world's poorest and most indebted countries (Agbibo, 2013; Investopedia, 2020). More than 70% of

its estimated 200 million people live on less than \$2 USD every day, According to the corruption perception index (CPI) reports (Hope, 2017), this is related to resource and revenue misuse. The diversion of monies from public coffers to specific individuals, as well as the awarding of oil blocks, contracts, licenses, and production rights to individuals, has hampered economic growth and resulted in civil conflict, banditry, and insurgency in Nigeria. The widespread corruption of government officials, particularly in Africa, is a drawback to crude oil extraction and processing in Africa. A vast majority of Africa's host villages for crude oil reserves lack adequate infrastructure. Residents of local towns rely on fertile soils and clean rivers for their economic well-being, which has been badly impacted by crude oil processing, exploration, and transportation (Ehirim et al., 2018). The majority of communities lack access to safe drinking water as a result of oil spills caused by crude oil drilling. The oil spills' impact on water bodies endangers aquatic life, exacerbating hunger and poverty (Pittock et al., 2018). Agricultural farmlands are also damaged by runoff from crude oil deposit regions,



High pressure pipeline near inhabited area

transforming once fertile soils into wastelands. The economic downturn is caused by a decrease in agricultural output and productivity (Sam et al., 2017; Chijioke et al., 2018), which has an impact on sales and, as a result, the GDP from agriculture. Inoni et al (2006) in his study observed a negative impact of oil pollution on farm lands in the Niger Delta. He noted that for every 10% increase in crude oil pollution on farmlands, there is a corresponding decline of 1.3% in crop yield while income from farm produce reduced by 5%. Gas flaring is defined by the discharge of toxic gases and particulate matter, which can endanger both humans and animals (Otitolaju and Dan-Patrick, 2010). Over 250 toxins, including polycyclic aromatic hydrocarbons (PAHs), hydrogen sulfide, toluene, benzene, sulfur dioxide, nitrogen dioxides, xylene, and others, have been found in flared gases, some of which are responsible for acid rain, ozone depletion, global warming, cancer, and other negative effects (PAHs) (Giwa et al., 2019). Thus, the indiscriminate discharge of particulate matter and precursor gases near oil-producing towns may be a cause for concern. Furthermore, several African oil-producing countries rely substantially on crude oil processing output. The system's corruption leaves little possibility for accountability, and as a result, bulk sums are siphoned elsewhere. This impairs the infrastructure development of oil processing because the majority of the money is siphoned elsewhere. Many African countries' socioeconomic structures have been transformed as a result of crude oil exploration activities, resulting in a lack of accountability and decreased citizen participation (Kyomugasho, 2016). Countries that received much less revenue from oil extraction performed better in terms of human development and capacity building. This demonstrates that revenue does not immediately transform weak economies into prosperous ones, unless it is efficiently managed, effectively redistributed, and correctly tapped for diverse local investments. Nigeria continues to experience national under-development despite her enormous exploration and processing of crude oil. This is largely due to neglect experienced by other sectors of the economy as a result of the large revenue incurred from crude oil, thus making the nation a mono-culture economy (Adefolaju, 2014). The failure of most African governments to mitigate corruption and associated risks of oil pollution has reportedly contributed to militant activities in the crude oil-producing regions (Tantua and Kamruzzaman, 2016; Babatunde et al., 2018). In addition, poverty is a major experience of crude oil-host communities in Africa (Sam and Zabbey, 2018). Crude oil is majorly found in rural areas in Africa. The technological expertise required for its exploration and processing is oftentimes

imported due to the low level of education of persons living in such communities. According to Amnesty International (2006), around 70% of residents of Nigeria's Niger Delta live on less than \$1 per day.

In a research conducted in the Niger Delta, Ipigbemi (2009) discovered that the severe loss of livelihood following spill incidents prompted 43 percent of respondents to shift their means of sustenance, while another 25 percent considered abandoning their existing company. In Bodo, a host community notable for suing Shell for oil spills, a comparative study by Ebere et al., (2016) discovered that profits from shellfish collecting in polluted portions of the Creek were only about 40% of those earned in comparable non-polluted localities. The spills in these regions decimated the periwinkle population. Pegg and Zabbeh (2013) conducted a post-spill assessment of the area and discovered no surviving specimens, forcing local women who had previously earned 500 Naira (US \$1.22) per day picking them to seek alternative jobs in a neighboring state. In Bayelsa, research undertaken in recent decades have revealed the destructive effects of oil pollution and gas flaring on livelihoods. A 2009 poll of 150 respondents on the impact of gas flaring in Ogbia LGA revealed that more than 40% of respondents considered that gas flaring jeopardized their socioeconomic well-being. Furthermore, farm people complained that flaring by oil firms in Ogbia decreased their agricultural output and income from farming activities, according to Esu and Dominic (2013). Another study on the impact of oil pollution in the Epebu community, also in Ogbia LGA, by Ibegu and Olusola (2017) concluded that oil spillage had severely harmed the community's people's livelihoods by destroying forests and trees, causing untold damage to economic activities and agricultural production, as well as the destruction of fish stocks in ponds and other bodies of water. Long-term gas flaring, oil spills, and other forms of pollution have devastated the native wild palm trees. Furthermore, the extension services of the Nigerian Institute of Palm Oil Research (NIFOR) in Bayelsa have been impacted by oil firms' environmental deterioration. As a result, the tapping of palm trees has nearly ended, and farmers have also reported bad yields across the state to the extent that they have had wider negative impacts on food production as opined by Omoweh (2009). The repercussions of spills are not limited to fishing. According to Ojimba's (2012) study in Rivers State, polluted crop farms had an average yield that was 22% lower than those that were not polluted. This is consistent with evidence from the Bodo spills, where a 2011 research indicated that average yields

for staples such as yams and cassava plummeted drastically following a pollution episode and stayed low for several years afterward, according to Pegg and Zabbeh (2013). These findings are backed by study into the production rates of 262 farms in neighboring Delta State, to the west of Bayelsa, which found that as spill intensities increased, yields decreased.

Human Health Impact of Hydrocarbon Pollution

The United States Environmental Protection Agency (USEPA) have designated sixteen PAHs as high priority pollutants because of their carcinogenic, mutagenic, teratogenic and immunogenic effects on the human cells. These PAHs include Naphthalene, Acephnaphthylene, Acephnaphthene, Fluorene, Phenanthrine, Anthracene, Fluoranthene, Pyrene, Benz(a)anthracene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)perylene, Benzo(a)pyrene, Chrysene, Dibenz(a,h)anthracene, Indeno(1,2,3-c,d)pyrene.

These PAHs gain access into the human body through 3 main routes namely, inhalation (as in gas flaring/leaks), ingestion (as in consumption of food and water contaminated with hydrocarbons) and dermal contact (as in bathing water contaminated with hydrocarbon or skin deposit by aerosols of gas flaring/artisanal crude oil refining). Irrespective of the route of entry, PAHs ultimately get absorbed into the bloodstream from where it is distributed to every part of the human system, particularly the nuclei of cells where through an interplay of complex biochemical processes lead to exertion of its toxic effects overtime. No system of the human body is immune to the toxic effects of PAHs and no age group is spared as well.

They have been identified as potential causers of neurological illnesses, respiratory, cardiovascular, visual, cutaneous, and gastrointestinal ailments. They have also been connected to potential morbidity and mortality hazards among children under the age of five, which are associated with the widespread use of biomass and other fuel types in SSA (Owili, Pan, & Kuo, 2017). The health concerns associated with PAH exposure vary depending on the route, intensity, and duration of exposure. Other determinants include individual vulnerability, age at exposure, gender, and immune system capabilities (Brandt & Einhenkel, 2016; Bruce, Perez-Padilla & Albalak, 2017; Onanuga & Onanuga, 2014). Because these compounds accumulate in organisms at a rate that surpasses their ability to detoxify and eliminate them, they gradually



Human Health Impact of Hydrocarbon Pollution

bioaccumulate over time. This bioaccumulative propensity leads to the emergence of pathogenic processes that disrupt homeostasis and generate negative health outcomes. According to Sanderson (2006) and Sweeney (2002) PAHs are endocrine disruptors due to the presence of a benzene ring in their structure, which are similar to steroid hormones. Because of the nature of their structure they can cause dysfunction in the female reproductive functions such as distortion in hormone production, infertility, anovulation, premature ovarian failure and menstrual abnormalities.

According to Drwal and Gregoraszczuk (2019), PAHs are known reproductive and developmental toxicants that can pass the placenta and affect the developing fetus. Maternal exposure to PAHs during pregnancy has been linked to negative health outcomes for children. Occupational exposure during pregnancy has been associated to an increased risk of small for gestational age newborns and birth abnormalities (Li & Sundquist, 2010; Lupo et al., 2012; O'Brien et al., 2016). Prenatal exposure to ambient PAHs was linked to fetal growth decrease, poor cognitive development, and juvenile obesity in a multiethnic longitudinal cohort in New York City (Choi et al., 2008; Perera et al., 2006; Perera et al., 2009, Rundle et al., 2012). Similarly, in an identical cohort

study of Polish women residing in Krakow, scientists observed links between prenatal PAH exposure and unfavorable cognitive development and respiratory outcomes, such as wheezing and impaired lung function (Jedrychowski et al., 2005; Jedrychowski et al., 2015, Edward et al., 2010). Notably, exposure to PAHs had a larger effect on child birthweight reduction (Jedrychowski et al., 2017). Sram et al. (2005), Balise et al. (2016) and Harville et al. (2017) observed that when a pregnant mother is exposed to pollutants from hydrocarbons in crude oil, the risk of miscarriage, congenital malformations, intrauterine growth restrictions, intrauterine fetal death, prematurity, stillbirth and neonatal death is increased. In a study conducted in a tertiary hospital in Port Harcourt, Fienimika et al (2018) found that the high concentration of soot (PM_{2.5}) in the environment increased the prevalence of acute respiratory infections among children under the age of five. Similarly, Abbey et al (2017) in a study done at the University of Port Harcourt Teaching Hospital observed that the prevalence of congenital birth defects was 20.73 per 1000 live births in Port Harcourt, compared to South East's 4.15 per 1000 live births, North East's 5.51 per 1000 live births and South West's 15.84 per 1000 live births.

CHAPTER THREE

Materials and Methods

3.1 Study area

3.1.1 Rukpokwu

Rukpokwu Town in Rivers State is located at the northern fringes of Port Harcourt with land boundary of 289km² (area). Rukpokwu town is made up of about 100 streets. According to the 1999 population census Rukpokwu Town has a population of 3,626, using the exponential growth model, with an annual growth rate of (5.8%), the projected population of Rukpokwu to 2014 is about 10,500 (Brown et al., 2015). The custom, culture and traditions have been at the center of affairs in Rukpokwu clan, especially in upholding of dedicated places earmarked as sacred, holy and spiritual e.g, Ru'nwhu-Eli for the Traditionalists, Churches for the Christians, Mosque for the Muslim faithfuls etc.

Rukpokwu, situated within the Obio-Akpor Local Government Area, is predominantly Ikwerre in ethnicity. The Ikwerre language is distinct yet shares a common linguistic heritage with other Igbo dialects, contributing to the rich tapestry of languages in Nigeria.

Rukpokwu is made up of five contiguous communities namely: Elipokwo-Udu, Mgbuchi, Rumuapu, Rumuijuma, Rumuehienwo (Brown et al., 2015). The natives of Rukpokwu community are predominantly farmers. Historically, agriculture has been the backbone of the Rukpokwu economy. Increasingly, the Rukpokwu people are involved in small to medium-sized businesses, ranging from retail shops to service-oriented enterprises. This shift reflects the broader economic trends in the region as it becomes more integrated into the urban economy of Port Harcourt (Okoh, 2003).

Rukpokwu, a community has evolved into a vibrant center for various commercial activities. This evolution reflects its strategic location near Port Harcourt, one of Nigeria's major urban and economic hubs. Local markets are the heartbeat of commercial life in Rukpokwu, besides fresh produce, these markets also offer a range

of food items, household goods, and clothings. The diversity of products attracts people from surrounding areas, making Rukpokwu a notable trading center in the region. Oil was discovered in Rukpokwu/Aluu adjoining land by Shell Petroleum Development Company (SPDC) in 1961. There were 15 oil wells in Rukpokwu, which had been decommissioned. SPDC acquired a total of four (4) hectares of land within the area referred to as Agbada oilfield. The two (2) families that own the land where oil was found in Rukpokwu are: Eli-Kpokwu and Eledo-Kpokwu. These families in Rukpokwu are joint owners of Agbada farmland and landlords to SPDC (Eyinndah, 2020).

Rukpokwu community near the oil city of Port Harcourt is where Shell's facilities were installed in 1963 and intense oil and gas activities have continued to date. On December 3, 2003, a huge explosion occurred at the Rukpokwu-Rumuekpe trunk line, a large pipeline that crisscrosses community settlements, forests, farmlands and wetlands. The pipeline is operated by the SPDC in partnership with the Nigerian National Petroleum Corporation (NNPC). But neither Shell nor the Nigerian government have cleaned up after the spill. Since then there have been three oil spills originating from the same pipeline. Before the oil spill, the fields yielded palm oil for sale and food for the family.

Pipeline vandalism, crude oil theft and artisanal crude oil refining has a storied and contentious history in the Niger Delta region of Nigeria, including communities like Rukpokwu. The practice, often driven by economic necessity and fueled by systemic issues within the oil industry on one hand and sheer greed from locals on the other hand, has significant environmental, economic, and social impacts. The expansion of bunkering in Rukpokwu was also linked to the broader environmental degradation caused by legal oil extraction processes. Frequent oil spills and pipeline leaks reduced the viability of traditional livelihoods such as farming and fishing, pushing some locals toward bunkering as an alternative source of income.

The illicit activities in Rukpokwu are part of a larger network affecting Nigeria's oil industry. Oil theft and illegal bunkering contribute to substantial revenue losses for the government and oil companies. Additionally, the environmental impact is severe, with frequent oil spills leading to land and water pollution, which devastates local ecosystems and communities dependent on agriculture and fishing. The Nigerian government and security agencies like the National Security and Civil Defense Corps

(NSCDC) have been actively combating these illegal activities. Recent efforts include the deployment of special intelligence squads and the destruction of illegal refineries. However, the persistence of these activities suggests a need for more effective measures and community engagement to tackle the underlying socio-economic factors driving individuals into bunkering ([PRNigeria News](#)).

3.1.2 Rumuekpe

Rumuekpe is an Ikwerre community in Emohua LGA of Rivers State, Niger Delta region of Southern Nigeria. It has a geographical coordinates of approximately 4.883° N latitude and 6.767° E longitude. Rumuekpe is relatively close to Port Harcourt, the capital of Rivers State, which is about 50 km to the southeast. According to National Population Census (2006) Rumuekpe's population is a dynamic figure influenced by various socio-economic factors, but current estimates place it at approximately **43,000** residents, making it a significant community within the Emohua LGA of Rivers State.

The Rumuekpe community is governed by a Council of Chiefs and Elders who play pivotal roles in decision-making and maintaining order. These traditional leaders are highly respected and are integral to the community's social structure. Omu-Akwu is a key traditional leadership title among the Ikwerre people. One of the major festivals celebrated in Rumuekpe is the Owu-Okirika, which is marked by various traditional dances, songs, and masquerade displays. This festival is not only a time for celebration but also for honoring ancestors and deities. Like many Igbo-speaking communities, Rumuekpe celebrates the New Yam Festival, which signifies the end of the farming season and the beginning of a new one.

The people of Rumuekpe primarily speak the Ikwerre language, which is a part of the larger Niger-Congo language family. Ikwerre is one of the major languages in Rivers State. Ikwerre is a tonal language with three primary tones: high, mid, and low. This tonality is crucial as it can change the meaning of words. Rumuekpe is made up of eight villages - Rumuegwu, Omoviri, Mgbodo, Ovelle-Odouha, Mgbuhie, Ekwutche, Imogu and Ovelle (SDIC, 2009).

Traditionally, the people of the town, like other Ikwerre are predominantly farmers and fisherfolks. The people basically are involved in trading. Although, abundantly endowed with oil and gas resources, they also grow cash crops such as oil palm and rubber, which are sold in regional markets and contribute to household income.



Hunting is another traditional occupation, providing meat from animals such as antelope, grass-cutter, and wild boar. This practice is both for subsistence and for commercial purposes.

The Rumuekpe people maintain a deep connection with their indigenous religious practices. Central to their traditional beliefs is the reverence for ancestors, who are believed to continue 16

influencing the living from the spiritual realm. These ancestral spirits are honored and appeased through rituals and offerings. These deities are often considered guardians of the land, rivers, and forests, playing critical roles in agriculture, health, and protection. Sacred groves, rivers, and shrines are integral to their spiritual practices. These places serve as venues for important rituals, ceremonies, and community gatherings (Kalu, 2005). Christianity has significantly influenced the Rumuekpe community since its introduction by missionaries in the 19th and 20th centuries. Denominations such as the Roman Catholic Church, Anglican Church, and Methodist Church have established a strong presence in Rumuekpe, often providing not just spiritual guidance but also education and social services.

Rumuekpe is part of the oil-rich Niger Delta region, and its economic activities are diverse, with a strong emphasis on both traditional and modern sectors. The oil and gas sector is the most significant economic activity in Rumuekpe, reflecting the broader economic landscape of the Niger Delta. Rumuekpe hosts numerous oil facilities operated by major oil companies such as Shell Petroleum Development Company (SPDC). The community has been a critical site for crude oil extraction, contributing significantly to Nigeria's oil exports. The area is crisscrossed with pipelines transporting crude oil and gas. This infrastructure supports both local and international energy demands (Niger Delta Today, 2023). Despite the dominance of the oil sector, agriculture remains an essential part of the Rumuekpe economy, providing livelihood for many of its residents. Trading activities form a backbone of the local economy, providing goods and services to the community and surrounding areas. Rumuekpe has bustling local markets where agricultural produce, fish, and household goods are traded.

Rumuekpe occupies a prominent place in Nigerian oil industry, not necessarily due to her being the second place where oil was found in commercial quantity in Nigeria and next to Otuagbagi (Oloibiri), but due to the fact that all the oil majors have their facilities and operate in Rumuekpe. Shell Petroleum Development Company Nigeria Limited has the following facilities in Rumuekpe: Three (3) functioning oil wells, eight (8) Manifolds (the largest manifold in the world is located in Rumuekpe), one (1) Gas gathering plant (the largest in Africa), two (2) flow stations, One (1) major crude trunk line, one (1) Helipad, one (1) Microwave station, One (1) Booster station, One (1) Flare site, One (1) Oil pipeline and flow lines (Enyindah, 2020). Oil activities in Rumuekpe began in the 1960s with the Shell Petroleum Development Company (SPDC). Since then, the community has experienced numerous oil spills and environmental degradation due to frequent pipeline leaks and sabotage. Mgbuodo is a small rural community in Rumuekpe clan. Shell Petroleum Development Company (SPDC) began activities in the Community in 1963 with four production locations. The inhabitants are poor and their community is highly undeveloped. Due to the high unemployment rates and the easy availability of crude oil, some community members engage in pipeline vandalism, crude oil theft and illegal refining activities. These activities, though controversial and environmentally damaging, provides income for many locals. The oil

industry's operations necessitate a range of support services and logistics. Many community members find employment with companies that provide services to the oil sector, such as transportation, security, and maintenance.

The regrettable Rumuekpe fire incident, happening at an illegal crude oil tapping point from a pipeline operated by the Shell Petroleum Development Company of Nigeria Limited, came just about 18 months after a similar fire explosion rocked an illegal refining site in the area in 2021, killing at least 22 persons. The defiant behaviour of those engaging in illegal oil bunkering activities in the community should be denounced by all. In the past, fire incidents were traceable to power surges, the use of candles and carelessness, among others. However, Rivers State residents have been grappling with a new wave of fire outbreaks caused by artisanal oil refining activities, popularly called “Kpofire”. This is simply the process of heating or cooking the crude to extract petroleum products. Its name originated from the explosive sound that follows whenever adulterated petroleum products are in flames.

3.1.3 Ibaa

The community called Ibaa is popularly known as Uvuawhu is a town found in the heart of Ikwerre in general but located at the extreme east of Emohua Local Government Area of Rivers State. The community is located at the North East of the Calabar River (popularly called Osimini Choba) which runs through from Akpabo of Elele-Alimini being the source, to Choba from where it empties into the Atlantic Creek. Ibaa community is cut out of from the major routes running from Port Harcourt to Owerri via Isiokpo and the East/West road, via, Rumuji. Its immediate neighbouring towns are



Isiokpo, Elele-Alimini, Elele Okaniali, Ndele, Rumuji and Emohua communities (Emeodu & Elem, 2020).

Ibaa community is grouped or divided into three main groups namely, Mgbuosimini, Omusunu, and Mgbuisinu. They generally consist of 20 villages that make up the Ibaa community. The Mgbuosimini group starts from the coast line of the New Calabar River, this group is made up of four villages namely, Omuobizu-Elenwo, Omuobizu-Otaa, Omkpoba and Mgbere. The Omusunu group located at the centre and it includes: Omuchiolu Mgberekea, Omuadie, Ikpokwa, Omuikea, Omuikwu Omuoda, Omuisioha, Mgbogizi and Ogbelegba. On the other, the Mgbuisinu group which start from the old maternity health center now used as police station/Arm check point consist of six villages, namely: Ohionu-Ugwuenji, Ohionu-Ogunda, Omueze, Omuagala, Omuogbo and Ohanyim (IPO, 1997).

The Ibaa community follows a traditional social hierarchy, which includes a Council of Elders, Local Chiefs, and other community leaders. The Council of Elders is responsible for making important decisions and settling disputes. They play a significant role in maintaining law and order within the community. Festivals are an integral part of Ibaa culture and serve as occasions for communal gathering, celebration, and reaffirmation of cultural values, New Yam Festival (Iriji Ohu), Traditional music and dance are vital to Ibaa culture, Traditional rites of passage are important in Ibaa culture. These include ceremonies related to birth, coming of age, marriage, and death, Ibaa people, like many other Igbo communities, are known for their craftsmanship. Traditional crafts include beadwork, pottery, and weaving. Also, the Ibaa community speaks the Ikwerre language, which is rich in proverbs, folklore, and oral traditions. Storytelling, proverbs, and oral history are vital for passing down cultural knowledge and values from one generation to the next.

Ibaa have local markets where residents buy and sell a variety of goods, including agricultural produce, household items, and other essentials. These markets are crucial for the community's economic activities and for the exchange of goods. Trade extends beyond Ibaa to neighboring communities and towns. This includes the exchange of agricultural products, crafts, and other goods, which helps to boost the local economy. The Ibaa community in Rivers State, has experienced significant changes due to the presence of oil wells and facilities in the region. The development of oil infrastructure

has had a profound impact on the local economy and environment. Oil exploration and extraction activities have led to job creation and economic opportunities for the residents, providing them with a source of income and contributing to the overall development of the community (Obi, 2021). However, this economic boost comes with challenges. The environmental consequences of oil extraction, such as oil spills and gas flaring have caused substantial damage to the local ecosystem. This environmental degradation has adversely affected agriculture and fishing, which are vital to the community's traditional livelihood (Ibe, 2022). The presence of oil facilities has also brought about socio-political changes in Ibaa. The local population has had to navigate the complexities of negotiations with oil companies and government agencies regarding compensation and environmental protection (Eze, 2020). There have been instances of conflict and unrest due to perceived inequities in the distribution of oil revenues and inadequate response to environmental damage (Nwachukwu, 2023). Consequently, while the oil industry has contributed to some development in Ibaa, it has also highlighted the need for more effective management practices and equitable



The Royal Highness of Ibaa Community
and Ibaa Chiefs, The Coordinator Pilex Centre etc

solutions to address the community's concerns and ensure sustainable development. In the Ibaa community, oil spills and illegal bunkering activities have profoundly impacted both the environment and the local population. Oil spills, a frequent consequence of both operational failures in oil extraction and illegal activities such as bunkering and artisanal crude oil refining, have severely affected the community's environment. These spills lead to contamination of soil and water resources, resulting in the destruction of local agricultural lands and fisheries, which are critical for the livelihoods of Ibaa's residents (Adewale & Ojo, 2022). The persistent pollution has caused long-term ecological damage, reducing biodiversity and impacting food security (Oluwale, 2021). Bunkering, the illegal siphoning of oil from pipelines, exacerbates these issues by increasing the frequency and scale of spills. The practice not only results in environmental degradation but also contributes to socio-economic challenges, including health problems from exposure to toxic substances and increased conflict within the community due to disputes over stolen oil (Igbinosa, 2023). Furthermore, the illegal nature of bunkering undermines the formal oil industry's regulatory frameworks and often leads to inadequate responses to environmental damage (Olawale, 2022).

3.2 Scope of the study

The scope of the study is to conduct a health impact assessment of hydrocarbon extraction among adult residents in Ibaa, Rumuekpe and Rukpokwu communities in Emohua and Obio-Akpor Local Government Areas of Rivers State.

3.3 Study population

The study is limited to men and women who are above 18 years and resident in Ibaa, Rumuekpe and Rukpokwu communities.

3.4 Study design

The study design is a descriptive cross-sectional.

3.5 Inclusion criteria

All men and women above 18 years who are residents of Ibaa, Rumuekpe and Rukpokwu communities were included in the study.

3.5 Exclusion criteria

Boys and girls less than 18 years and adult members of these communities who do not reside in the communities were excluded from the study.

3.6 Sampling size

The sampling size used was 100

3.7 Sampling method

A multi-stage sampling method was used to recruit research participants. Firstly, a simple random sampling method was used where a number was picked (2) via balloting. Secondly, a systematic sampling method was employed by picking every other potential participant until the sampling size was completed.

3.8 Study instruments

Equipments and Apparatus Used: Interviewer-administered, structured, close ended questionnaires, HP 5890 Series II Gas Chromatography (GC), Injection Temperature = 650 C, Detector temperature = 2750C, Column: capillary (HPS) – 30m length, 0.32mm internal diameter, 0.25µm film diameter, Flame Ionization Detector (FID), Retort stand, Separation funnel, Beaker, Measuring cylinder, Chromatographic column, Sample vials (glass), Spatula, Hand held electronic pH meter (Hannah DI-4337), Hand held electronic conductivity meter (Model H1-4103), Hand held total dissolved solid meter D4 -7103, Hand held electronic dissolved oxygen meter, Atomic Absorption Spectrometer (AAS), Harch 3900 DR Spectrometer, Ethylenediaminetetraacetic acid (EDTA) sample bottles, 5ml syringes, Tourniquet, Cotton wool, Methylated spirit, Hand gloves, Facemasks, Ice packs, Cooler , 2litres sterile containers, Shovel, Cutlass. Aeroqual monitor series 500, Nitrogen dioxide (NO₂) sensor 0205222-031, Sulphur dioxide (SO₂) sensor 1706223-009, Carbon monoxide (CO) sensor 2306221-003, PM 2.5/10 sensor 5004-94ED-001, Ammonia (NH₄) sensor 1307822-063, Methane (CH₄) sensor 8604221-098, Hydrogen sulphide (H₂S) sensor 3408222-011

Reagents: PAH standard for GC Calibration: Restek SV Calibration Mix #5 2,000µg/ml each in Methylene Chloride, 110 Benner Circle- Bellefonte, PA 16823, Dichloromethane, Silica gel, Anhydrous Sodium Sulphate, Methylene Chloride (another name for Dichloromethane)

3.10 Data collection

Administration of questionnaires

Research assistants were trained on how to administer the questionnaires and to assist with sample collection. Some members of the communities were also recruited as interpreters, especially, for research participants who either cannot understand English language or speak fluently.

Eligible men and women who were above 18 years of age were selected and a simple random sampling method was adopted to get the required sample size. There were 8 research assistants who administered the questionnaires to selected participants. Interpreters were handy to assist with elderly men and women who could not understand and speak English language. All questionnaires administered were retrieved immediately after the interview.

Collection of blood samples

Trained and certified laboratory scientists and technicians were recruited to collect blood samples from research participants. The process of blood collection was explained in details to the research participants and consent obtained before blood samples were collected. The laboratory scientists and technicians ensured aseptic procedure while collecting blood samples. They put on their surgical facemasks, sterile hand gloves and laboratory coats while taking samples. Tourniquet was applied about 4cm above the cubital fossa, cotton wool soaked with methylated spirit was used to clean the skin over the cubital fossa to decontaminate the area and 5ml syringe was inserted to withdraw 4mls of blood. Withdrawn blood is put into the sterile EDTA bottle and placed in the rack inside the cooler with ice packs. For every participant a new set of sterile hand gloves were used to ensure and maintain aseptic condition. All blood samples collected were assigned a number before being sent to the laboratory for analysis within 4 hours.

Collection of drinking water samples

The sources of drinking water of the communities were mainly wells, boreholes and stream. Sterile containers of 2 litres were used to collect the sample. Research assistants trained to collect samples put on facemasks, sterile hand gloves before collecting the water into sterile glass bottles. For the wells and boreholes, the water was first used to rinse the containers 3 times before the water sample was collected and tightly sealed and stored in ice packs inside a big cooler. For collection of water samples from the streams, after rinsing the container 3 times, a sterile rope attached to a bucket was thrown to the middle of the stream to collect water samples. The samples were taken against the flow of the tide. These samples were put into the containers and tightly sealed and put inside the coolers containing ice packs and sent to the laboratory within 4 hours. All the water samples taken were properly labelled according to the source it was taken from for ease of identification and reference.



Collection of soil samples

Top soils of the 3 communities (at different locations within each community) were collected. At each of the soil sample collection point, the shovel was used to dig up a v-shaped hole to 4-6cm into the soil and multiple soil samples were collected into a container in which it was thoroughly mixed to form a uniform soil before put into a paper bag. Each soil sample was properly labelled according to where the samples were collected for ease of identification and reference. The coordinates of each soil sample site were obtained and recorded.

Air Quality Assessment

The aeroquality sensors machines were placed at different strategic locations to assess the air quality over a 24hour period. Thereafter, the readings were collated and analyzed by an air quality assessment expert.

3.12 Data analysis

Data retrieved from questionnaires were entered into excel spreadsheet and analyzed using the Statistical Package For Social Sciences (SPSS) version 20.0.

Analysis of PAH in Water

Transfer 250mls of water into a sample separation funnel, rinse the measuring cylinder used for transferring the solution into separation funnel with 25ml of Dichloromethane. Shake to mix sample(s) and organic solvent, so as to have all available organic material extracted into the organic solvent, rinse with further 25mls of Dichloromethane so as to ensure that no trace organic materials are left un-extracted.

Clean-up/Separation I:

The organic extract or crude oil is collected into a receiving container (sample vial), passing the organic extract through an extraction column packed with glass-wool, silica gel and anhydrous sodium sulphate.

The silica gel aids the clean-up of the extract by disallowing the passage of debris and impurities of other compounds that are not PAHs.

Anhydrous sodium sulphate acts as a dehydrating agent to rid the organic extract of every form of moisture/water contained in the sample(s).

Clean-up/ Separation II:

1cm of moderately packed glass wool was placed at the bottom of a 10mm internal diameter x 250mm long chromatographic column.

Slurry of 2g activated silica in 10ml methylene chloride was prepared and placed into

the chromatographic column. To the top of the column was added 0.5cm of sodium sulphate. The column was rinsed with additional 10ml of methylene chloride. The column was pre-diluted with 20ml of dichloromethane, this was allowed to flow through the column at a rate of about 2minutes until the liquid in the column was just above the sodium sulphate layer.

Immediately, 1ml of the extracted sample was transferred into the column. The extraction bottle (sample vial) was rinsed with 1ml of Dichloromethane and added to the receiving end of the column as well.

The stop-cork of the column was opened and the eluent was collected into a 10ml graduated cylinder.

Just prior to exposure of the sodium sulphate layer of air, dichloromethane was added to the column in 1-2ml increments.

Accurately measured volume of 8-10ml of the eluent was collected and labelled "PAH Sample" up to sample number as applicable.

Gas Chromatographic (GC) Analysis (HP5890 Series II)

The concentrated aromatic extract/fraction were transferred into the labelled glass vials with Teflon or rubber crimp caps for GC analysis.

1 μ L of the concentrated sample was injected by means of a hypodermic syringe through a rubber septum into the column. Separation occurs as vapour constituent partition between the gas and liquid phases.

The constituent aromatic compounds are automatically detected as it emerges from the column (at a constant flow rate) by the Flame Ionization Detector (FID) whose response is dependent upon the composition of the vapour.

Equipments Used:

HP 5890 Series II GC, Injection Temperature = 650 C, Detector temperature = 2750C,
Column: capillary (HPS) – 30m length, 0.32mm internal diameter, 0.25 μ m film diameter
Detector : Flame Ionization Detector (FID)

Reagents:

PAH standard for GC Calibration: Restek SV Calibration Mix #5 2,000 μ g/ml each in Methylene Chloride, 110 Benner Circle- Bellefonte, PA 16823, Dichloromethane,



Drinking water samples collected

Silica gel, Anhydrous Sodium Sulphate, Methylene Chloride (another name for Dichloromethane)

Apparatus:

Retort stand, Separation funnel, Beaker, Measuring cylinder, Chromatographic column, Sample vials (glass), Spatula

Soil Sample Analysis For PAH

Extraction :

2g of soil sample was weighed into a clean extraction container. 20ml of extraction solvent (hexane) was added into the sample, mixed thoroughly and allowed to settle. The mixture was carefully filtered into the solvent-rinsed extraction bottles using filter paper fitted into Buchner funnels. The extracts were concentrated to 2ml and then transferred for clean-up/separation.

Clean-up/separation :

1cm of moderately packed glass wool was placed at the bottom of 10mm internal diameter x long chromatographic column. Slurry of 2g activated silica in 10ml

dichloromethane was prepared and placed into the chromatographic column. To the top of the column was added 0.5cm of sodium 28

sulphate. The column was rinsed with additional 10ml dichloromethane. The column was pre-eluted with 20ml of hexane. This was allowed to flow through the column at a rate of about 2minutes until the liquid in the column was just above the sodium sulphate layer. Immediately, 1ml of the extracted sample was transferred into the column. The extraction bottle was rinsed with 1ml of hexane and the dissolved extract was added to the column as well. The stop cork of the column was opened and the eluent was collected in a 10ml graduated measuring cylinder. Just prior to exposure of the sodium sulphate layer to air, hexane was added to the column in 1-2ml increments. Accurately measured volume of 8-10ml of the eluent was collected and was labelled accordingly.

GC Analysis :

The concentrated PAH fractions were transferred into the labelled glass vials with Teflon or rubber crimp caps for GC analysis. 1 μ L of the concentrated sample was injected by means of a hypodermic syringe through a rubber septum into the column. Separation occurs as the vapour constituent partitions between the gas and liquid phases. The sample was automatically detected as it emerged from the column by flame ionization detection (FID) detector whose response is dependent upon the composition of the vapour. The constituent PAHs are thus detected and the concentration recorded.



Soil Samples collected

Extraction and Analysis of PAH in Blood

This involves six steps:

1. Reagent preparation
2. Sample preparation
3. Saponification
4. Extraction
5. Filtration and Drying
6. Dilution and injection

Equipments/Apparatus

Weighing balance (2) Water bath (3) Reflux condenser (4) Saponification flask (5) Separating funnel (6) Oven (7) Measuring cylinder (8) Beakers (9) Funnels (10) Syringes (11) Filter (12) Hexane (13) Methanol (14) Ethanol (15) Deionized water (16) Sodium sulphate anhydrous NaSO_4 (17) Potassium hydroxide (KOH) pellet

1. Reagent Preparation

Prepare 50% KOH

Dissolve 50g KOH pellet into 100ml deionized water. Dilute the solution well to mix the content properly. Prepare the solution ready before use and store in a dark and cool place.

2. Sample preparation

Note: this must be done in low light or dark condition in order to yield accurate result.

Measure 1mls of blood specimen. Note the sample weight and transfer into a clean saponification flask.

Take 1g L-ascorbic acid and transfer into the flask containing the sample. Measure 50ml Ethanol and pour into the flask.

Measure 50ml of 50% KOH transfer into the sample flask. Shake to mix content.

3. Saponification

Attach a reflux condenser and heat sample flask in a water bath at 74°C periodic shaking of the flask should be carried out. After 90 minutes, detach condenser and close the sample immediately. Saponification is done. Cool the flask by keeping it in ice cold water.

4. Extraction Using Hexane

5. Pour the saponification sample into a separating funnel, wash flask with 50ml Ethanol and pour into the separation funnel. Wash the flask again with 100ml of deionized water and transfer into the funnel, close the funnel with the cap and shake

vigorously to mix content (2minute). Heat it at room temperature. Add 50ml n-hexane and shake to mix again.

5. Filtration and drying

Let the funnel stand until a clear layer is formed. Discard again the lower residues. Add 50ml N-hexane again and shake the funnel vigorously. Let the funnel stand until a clear hexane layer is formed. This time, discard all of the lower layers leaving only the hexane layer. Add 100ml of deionized water and shake the funnel vigorously.

Note: washing with water is done to remove KOH and other extracts.

Allow the funnel to stand for like (5minutes) discard the lower water layer, wash again with 100ml of water and shake, allow to stand and discard the lower layer again. Repeat the 100ml deionized water for the third (3rd) time. Shake, allow to stand and collect the water layer.

Add phenolphthalein indicator to confirm that all the KOH is removed. This tells us that no more washing is needed.

Prepare a filtration system adding about 10grams of NaSO₄ to the filter paper. Allow the hexane in the funnel to pass through the NaSO₄ drop by the drop until all is filtered. Take the beaker into the oven and allow the hexane to dry at 37oC until the hexane is dried completely.

6. Dilution and injection

Take the dry beaker containing the PAHs. Add 10ml of methanol into the beaker. Shake and ensure all PAHS are dissolved in the methanol completely. Take the 1ml into the Amber vial. Place the vial for the injection of PAHs into the Gas Chromatography (GC) or High Performance Liquid Chromatographic (HPLC) machine.

Soil Sample Analysis For Hydrocarbon Utilizing Bacteria (HUB) and Hydrocarbon Utilizing Fungi (HUF)

In the analysis of soil samples for hydrocarbon utilizing bacteria and fungi estimation, the vapour phase transfer method was used. Modified mineral salt medium was inoculated with a suspension of the brewery solid waste sample. The medium contained in grams/liter, NaCl, 20.0g, MgSO₄, 7H₂O 42g, KCl, 1g, H₂PO₄, 0.35g, NaNO₃ 0.42g, K₂HPO₄ 1.27g, Agar 20g, Distilled water 1litre, pH 7.2, sterile filter paper (Watman No. 1) was saturated with soil sample and placed on the side cover of

each petri dish and kept in an inverted position. Those filter paper saturated with soil sample, supplies hydrocarbon by vapour phase transfer to the inoculation. However, for hydrocarbon utilizing fungal counts, the mineral salt medium was acidified to suppress the growth of bacteria with lactic acid. The pH of the medium was adjusted to 5.4 after incubation at room temperature ($30 \pm 20^\circ\text{C}$) for 7 days. The plates were counted and the percentage of hydrocarbon utilization with the heterotrophic populations were estimated and recorded. The number of hydrocarbon utilizing bacteria in the samples were determined using the method described by Zajic and Supplission (1972), Okpokwasili and Okorie (1988). Serial dilutions of the samples were carried out. The modified mineral salt media as stated by Zajic and Supplission (1972), Okpokwasili and Okorie (1988) was used for the enumeration for both aerobic and anaerobic bacteria. Spread plate method was used. The cultures for anaerobic enumeration were inoculated in the anaerobic jar containing gas pack. The incubation temperature was set at 30°C for 5 days.

The Standard Most Probable Number (MPN) was used to analyze and estimate fecal coliform in water samples. In this method a single Mac Conkey Broth medium was prepared according to the manufacturers directives. Mac Conkey Broth powder 20g was dissolved in 500ml of diluted water in conical flask. This mixture was thoroughly stirred before it was slightly heated on the hot plate to hasten its dissolution. 9ml of this solution was dispensed into some test tubes that have inverted Durham tubes. In order to ensure that no gas bubbles were developed and trapped, the test tubes were shaken to fill the Durham tubes with broth. Then the test tubes in the dark were covered with sterilized cotton wool and also with an aluminium foil. They were left in the autoclave for 15 minutes at a temperature of 120°C , after which they were allowed to cool before aseptically inoculating them at different factors of 1:10 and 1:100 dilutions of the stock samples. The one of these dilution mixtures was inoculated in replicate of five tubes for the entire sampling population in number. These tubes were later inoculated at 37°C for 24 hours. This step was followed by the identification of the number of positive results. With reference to Mc Crady's probability table, the Most Probable Number (MPN) of the coliform in 100ml of the sample computed. The positive test shows the production of acid and gas that were collected due to the presence of air bubbles in the Durham tubes and it was detected by a change in colour from reddish purple to yellow.

Analysis of Water Samples for Physiochemical Properties.

To check for the pH of water, a hand held electronic meter (Hannah DI-4337) was dipped into the water sample for 2-3 minutes and the reading recorded.

To check for electrical conductivity of water, a hand held electronic meter (Model H1-4103) was dipped into the water sample for 2-3 minutes and the reading recorded.

To check for total dissolved solids, a hand held electronic meter (D4-7103) was dipped into the water sample for 2-3 minutes and the reading recorded.

To check for the concentration of dissolved oxygen, a hand held electronic meter was dipped into the water sample for 2-3 minutes and the reading recorded.

To check for the total suspended solids, the gravimetric method was used. This process involves heating the water sample until all the water evaporates and the residue is measured to determine the concentration of the suspended solids in water.

To check for the presence and concentration of various metals in the water sample, the flame atomic absorption spectrometry method was used. Here, the water sample is passed through a flame which acts as a sample holder as the light passes through the atoms and the flame concurrently and the light absorption is measured and recorded for each of the metals present in the sample.

To check for the presence and concentration of anions present in the water sample, Hach DR 3900 Spectrophotometry was used. This machine measures how much light is absorbed as water sample passes through it. Chemical reagents were added to the water samples and these reagents react with analytes to form colour complexes which are then measured and recorded.

To check for the chloride content and concentration, argentometric method of titration was used. A solution of silver nitrate (AgNO_3) of known concentration was titrated against the water sample.

To check for the turbidity of the water sample, the nephelometric turbidity unit (NTU) was used. This measures the amount of light from the incident beam (nephelometer) that is scattered by the suspended and colloidal matter in the water at an angle of 90° . Air quality assessment data were taken from the different sensor machines and analyzed. Results were compared to WHO reference values for the various parameters assessed.

3.13 Data presentation

Results from data analysis were presented in tables, frequencies, percentages and pie charts.

3.14 Ethical consideration

Consent and approval from the leadership of the communities was sought and received from the Kings and Council of Chiefs, Community Development Committees (CDC), Women and Youth Groups. We had meetings with them and explained in details the research and how it will be of benefit to the community. Thereafter, a town hall meeting was called where we met with members of the community to intimate them of the research and when we have scheduled to commence the research. They were told their blood samples, drinking water source samples, soil and air samples will be taken for the research.

Prior, informed and voluntary consent were obtained from all research participants before enrolling them into the study.

Research participants were educated on the consequences of hydrocarbon pollution on their farmlands, rivers, ground water, air and its overwhelming impact on their health. Therefore, the need to go for regular health checks in the hospital for early detection of diseases was emphasized.

3.15 Study limitation

Mobilization of research participants: Most of the research participants were farmers. They go to farm from morning till evening. Getting them assembled for interviews and blood sample collection was a huge challenge. The CDC had to do a massive sensitization and mobilization by going house to house before they had to come out. Some of the research participants wanted some form of financial gratification for taking part in the research while others expressed fears of giving out their blood samples

Paucity of funds: The scope of the research would have been expanded to accommodate more research participants and also to include children, however, due to the paucity of funds the research was limited to adults above 18years only with a sample size of 100.

Security concerns: There is almost, always threat to security of lives and property in the Niger Delta region due to its volatility. Members of the research team were anxious and scared as we traversed the communities especially as we entered the thick forests particularly in Ibaa and Rumuekpe communities. The communities provided some form of security and allayed our fears and anxiety.

CHAPTER FOUR

Presentation of Results

This chapter deals with the presentation of analyzed data based on the research questions. The data and result of each research questions are presented in tables, discussed and summarized in accordance with research questions raised for the study.

4.1 Demographic Characteristics of the Respondents

Table 4.1: Distribution of the demographic Variable

Demographics	Category	Frequency	Percent (%)
Age	18-24	0	0.0
	25-49	40	40.0
	50 and above	60	60.0
Sex	Male	76	76.0
	Female	24	24.0
Marital Status	Single	4	3.8
	Married	72	67.9
	Separated	0	0.0
	Divorced	0	0.0
	Widow	24	24.0
	Widower	0	0.0
Educational Status	Non-formal education	24	22.6
	Primary	17	16.0
	Secondary	36	34.0
	Tertiary	8	7.5
	Vocational skill	15	14.2
Occupation	Farmer	52	49.1
	Fisher folk	4	3.8
	Trader	4	3.8
	Teacher	0	0.0
	Civil Servant	4	3.8
	Hunter	0	0.0
	Others	36	34.0
	Christianity	84	79.2
Religion	Islam	0	0.0
	Traditional Worshipper	4	3.8
	Others	12	11.3

Table 4.1 presents the distribution of demographic variables among respondents, revealing diverse characteristics. The age distribution shows that 60% are aged 50 and above, with no respondents

in the 18-24 range. Males constitute a significant majority at 76%, while females make up 24%. Most respondents are married (67.9%), with a notable proportion of widows (24%). Educational status varies, with the highest percentage having secondary education (34%), and a small number achieving tertiary education (7.5%). Occupationally, nearly half are farmers (49.1%), with 'others' accounting for 34%. Religiously, Christianity predominates (79.2%), while traditional worshippers and other religions are minimally represented.

4.2 Data visualization

Figure 4.1 illustrates the age distribution of respondents, showing a higher concentration in the 50 and above bracket. The 25-49 age group is also represented, while there are no respondents in the 18-24 category.

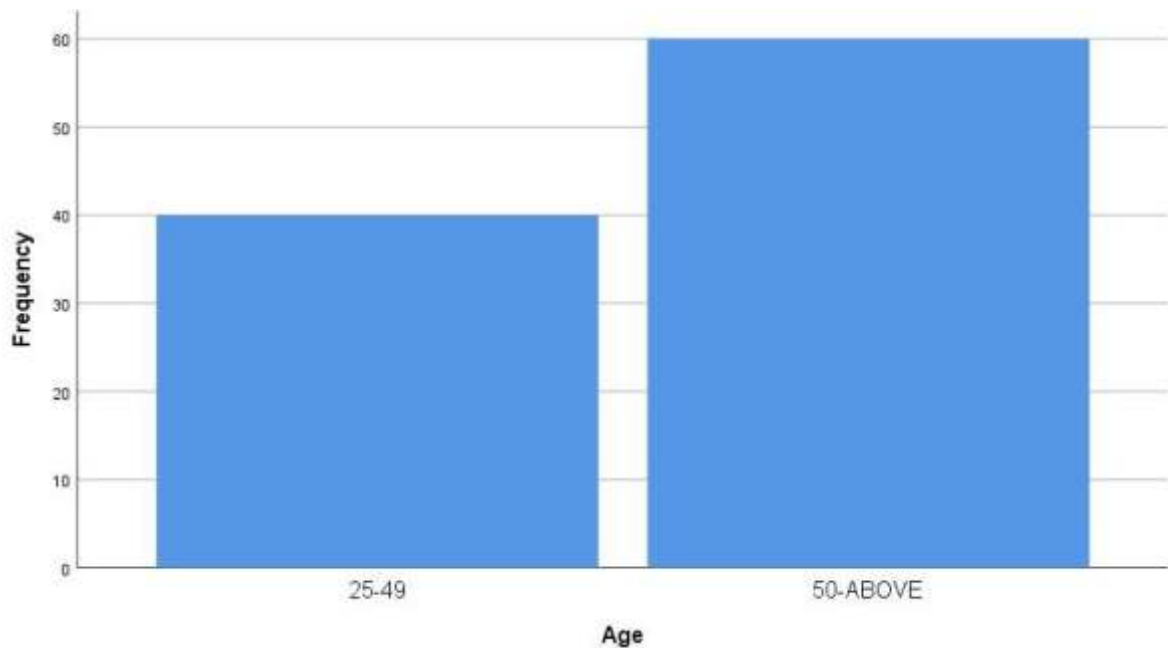


Figure 4.1: Bar chart of respondents based on age bracket

Figure 4.2 displays the gender distribution of respondents, highlighting a significant male majority at 76%. Female respondents are notably fewer, comprising only 24% of the total.

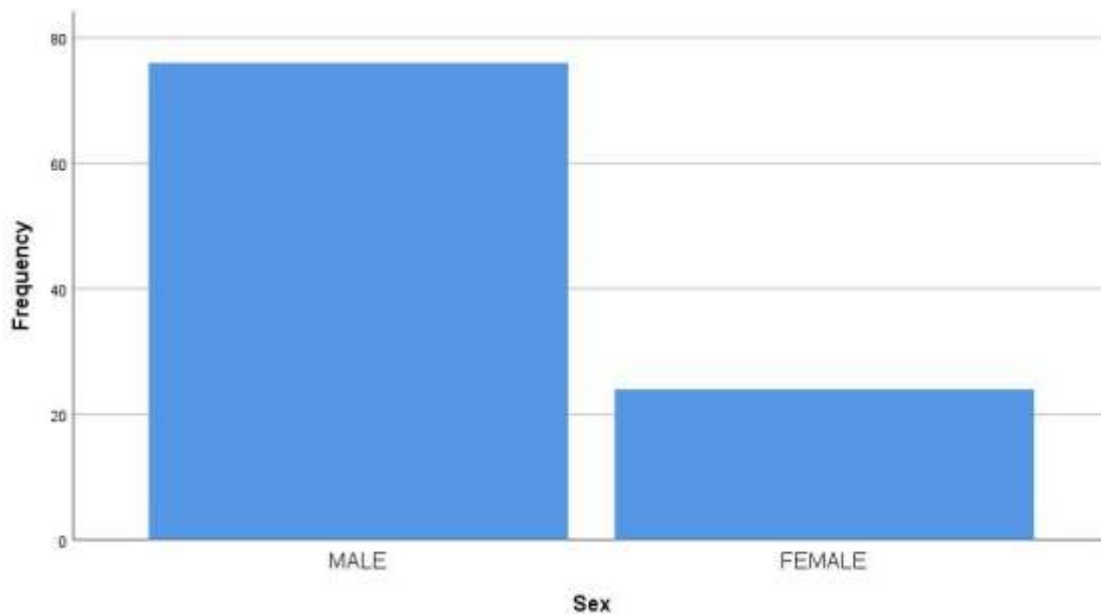


Figure 4.2: Bar chart of respondents based on sex

Figure 4.3 depicts the marital status of respondents, with the majority being married (67.9%). A substantial portion of respondents are widows (24%), while single, separated, divorced, and widower categories have minimal or no representation.

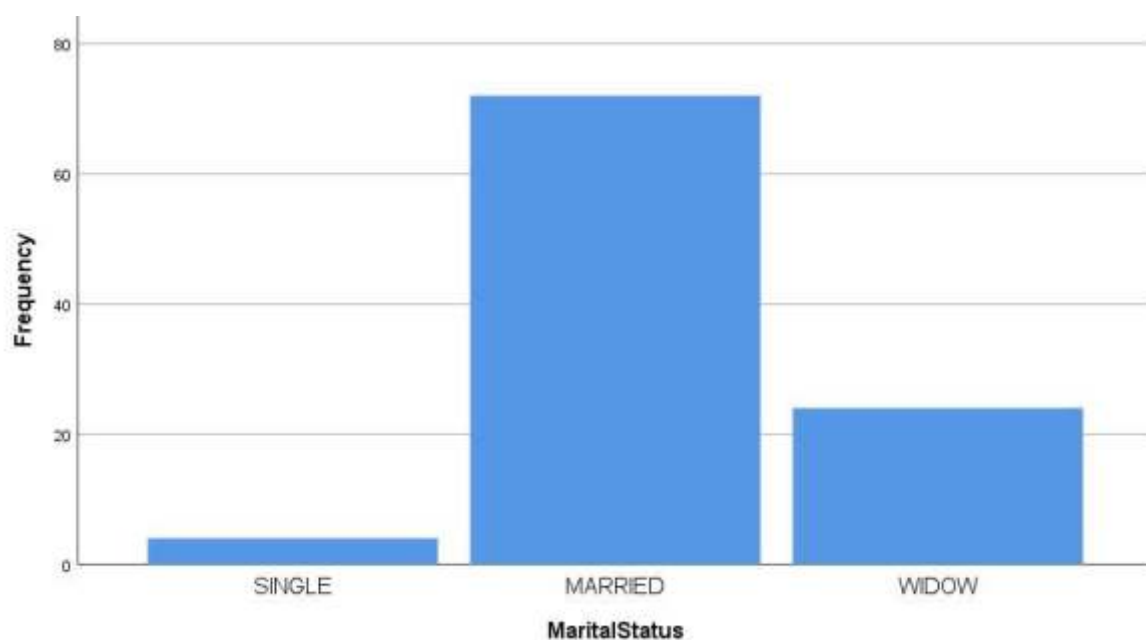


Figure 4.3: Bar chart of respondents based on marital status

Figure 4.4 illustrates the educational status of respondents, showing that the largest group has secondary education (34%). Other notable categories include non-formal education (22.6%), primary education (16%), and vocational skills (14.2%), with tertiary education being the least represented (7.5%).

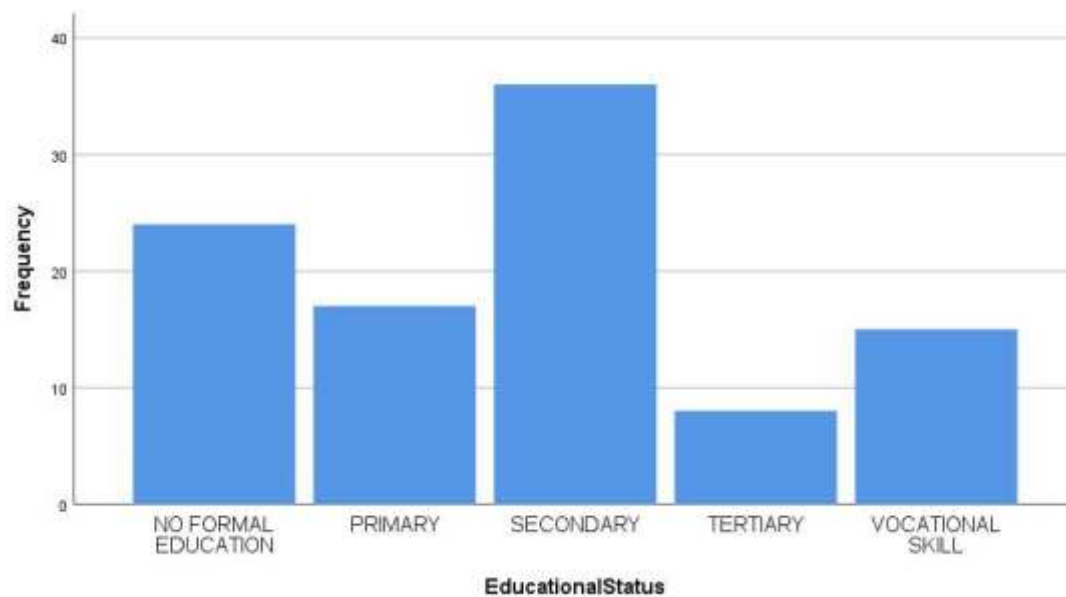


Figure 4.4: Bar chart of respondents based on educational status

Figure 4.5 represents the occupational distribution of respondents, with farmers making up the largest group at 49.1%. Other occupations include 'others' at 34%, while fisher folk, traders, and civil servants each constitute 3.8%, and there are no respondents listed as teachers or hunters.

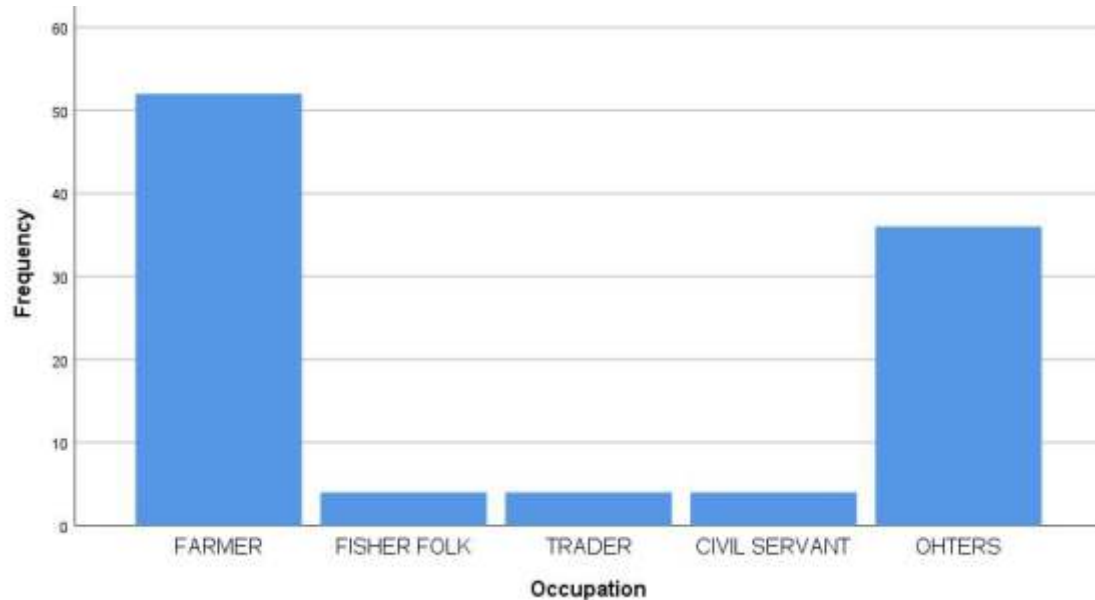


Figure 4.5: Bar chart of respondents based on occupation

Figure 4.6 shows the religious affiliation of respondents, with the majority identifying as Christians (79.2%). Traditional worshippers account for 3.8%, other religions for 11.3%, and there are no respondents identifying as Muslim.

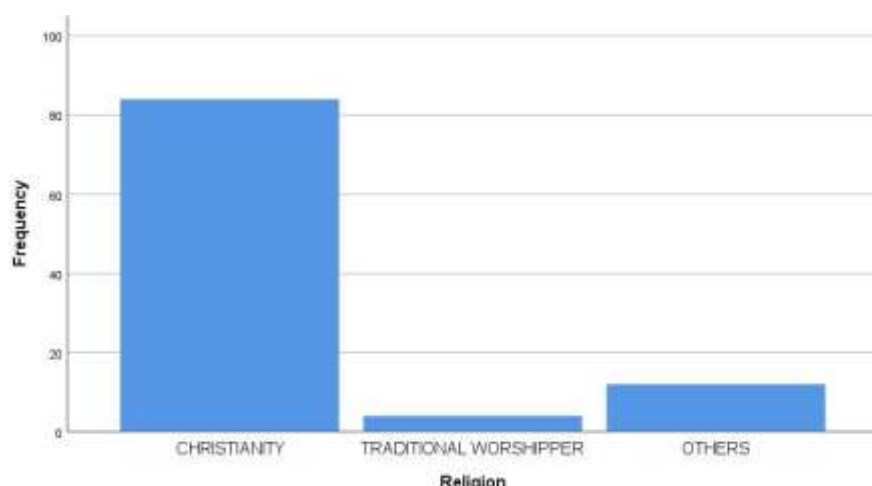


Figure 4.6: Bar chart of respondents based on religion

4.2 Answer to Research Questions

Research question 1: What is the socio-economic status of the communities before oil exploration?

Table 4.2: Summary of descriptive statistics on the socio-economic status of the community before oil exploration

S/N	Items	SA	A	D	SD	IDK	Mean	St.D	Decision
1	There was abundance of varieties of fishes, shrimps, periwinkle, oysters, crabs, and crayfish in the rivers of the community before oil exploration.	33	36	8	23	0	3.79	1.14	*
2	There was abundance of farm produce such as yams, cassava, plantain, cocoyam, palm fruits, vegetables etc. before oil exploration.	47	30	5	18	0	4.06	1.12	*
3	We made enough money from the sale of fishes and farm produce from your rivers and farmlands.	56	20	8	16	0	4.16	1.13	*
4	There was electricity in the community before oil exploration.	13	20	38	29	0	3.17	0.99	*
5	There was portable drinking water in the community before oil exploration.	31	15	29	25	0	3.52	1.18	*
6	There was hospital in the community before oil exploration.	25	3	35	37	0	3.16	1.18	*
7	There were schools in the community before oil exploration.	21	48	19	12	0	3.78	0.92	*
8	There were tarred roads in the community before oil exploration.	20	35	36	9	0	3.66	0.90	*
9	There was relative peace in the community before oil exploration.	42	44	2	12	0	4.16	0.95	*
Grand mean							3.72	1.06	*

Footnote: * = Agreed; # = Disagreed; IDK = I don't know

Table 4.2 provides descriptive statistics summarizing the socio-economic status of the community before oil exploration. The mean scores indicate that respondents generally agreed (mean > 3) that there was an abundance of fish, farm produce, and income from these resources (items 1-3). However, there were mixed opinions about the availability of electricity, portable drinking water, hospitals, schools, and tarred roads (items 4-8), with mean scores hovering around 3. Despite some disagreements, the overall perception suggests relative peace in the community before oil exploration (item 9). The grand mean of 3.72 supports the consensus that the community's socio-economic status was relatively favorable before oil exploration began.

Research question 2: What is the socio-economic status of the communities since oil exploration began?

Table 4.3: Summary of descriptive statistics on the socio-economic status of the community since oil exploration began

S/N	Items	SA	A	D	SD	IDK	Mean	St.D	Decision
1	There is abundance of varieties of fishes, shrimps, periwinkle, oysters, crabs, and crayfish in the rivers since oil exploration commenced.	5	20	16	59	0	2.71	0.96	#
2	There is abundance of farm produce such as yams, cassava, plantain, cocoyam, palm fruits, vegetables etc. since oil exploration commenced.	9	41	13	37	0	3.22	1.05	*
3	There is enough money from the sale of fishes and farm produce from the community since oil exploration began.	24	26	18	32	0	3.42	1.17	*
4	Electricity has been installed since oil exploration began.	16	17	17	50	0	2.99	1.15	#
5	There is portable drinking water in the community since oil exploration began.	5	18	25	52	0	2.76	0.92	#
6	Hospital has been built in the community since oil exploration began.	5	18	20	57	0	2.71	0.94	#
7	Schools have been built in the community since oil exploration began.	6	35	32	27	0	3.20	0.91	*
8	There are tarred roads in the community since oil exploration began.	12	15	59	14	0	3.25	0.85	*
9	There has been peace in the community since oil exploration began.	22	49	7	22	0	3.71	1.05	*
10	Your lives have been better since the commencement of oil exploration.	17	20	24	39	0	3.15	1.12	*
	Grand mean						3.11	1.01	*

Footnote: * = Agreed; # = Disagreed; IDK = I don't know

Table 4.3 evaluates the socio-economic status of the community since oil exploration began, with mean scores indicating mixed responses. Respondents generally disagreed that there has been an abundance of aquatic resources (item 1) and improvements in electricity and portable water (items 4-5), with mean scores below 3. In contrast, there were modest agreements regarding farm produce abundance, income from sales, new schools, tarred roads, and peace in the community (items 2-3, 7-9), reflected in mean scores above 3. The overall perception of improved life since oil exploration (item 10) is slightly positive but not overwhelming. The grand mean of 3.11 suggests a slightly favorable but divided view on the socio-economic impact of oil exploration.

Research question 3: What are the perceived health impacts of oil exploration?

Table 4.4: Summary of descriptive statistics on the perceived health impacts of oil exploration

S/N	Items	Yes	No	NS	NA	Mean	St.D	Decision
1	Oil exploration has negatively impacted our health.	53	12	7	28	2.90	1.31	*
2	Oil companies and /or government have built hospitals for easy access to healthcare with facilities and equipments.	10	62	7	21	2.61	0.93	*
3	Have you had cough in the past?	44	28	9	19	2.97	1.14	*
4	Have you had nasal discharge (Catarrh) in the past?	42	20	10	28	2.76	1.26	*
5	Have you had difficulty in breathing in the past?	18	34	18	30	2.40	1.10	#
6	Have you had noisy breathing in the past?	15	40	10	35	2.35	1.11	#
7	Have you ever visited the hospital due to problem of breathing?	16	51	19	14	2.69	0.91	*
8	Have you ever been diagnosed of high blood pressure (BP)?	24	21	44	11	2.58	0.98	*
9	Do you find it difficult to sleep at night?	28	49	8	15	2.90	0.98	*
10	Do you have frequent headaches that does not reduced when you take paracetamol?	34	25	13	28	2.65	1.22	*
11	Do you have shortness of breath?	23	39	8	30	2.55	1.15	*
12	Do you fell easily tired when you walk short distances or climb the stairs?	39	42	6	13	3.07	0.99	*
13	Have you ever been diagnosed of high blood sugar?	38	47	5	10	3.13	0.91	*
14	Do you have itchy skin?	50	32	9	9	3.23	0.95	*
15	Do you have any rashes on your skin?	34	53	1	12	3.09	0.91	*
16	Does your eye itch you?	31	53	9	7	3.08	0.82	*
17	Do you see well?	48	33	12	7	3.22	0.92	*
18	Do you use eye glasses?	24	54	16	6	2.96	0.80	*
19	Do you have waist pain?	33	45	9	13	2.98	0.97	*
20	Do you have pains in both knees?	45	38	9	8	3.20	0.91	*
	Grand mean					2.87	1.01	*

Footnote: * = Agreed; # = Disagreed; NS = Not sure; NA = Not applicable

Table 4.3 evaluates the socio-economic status of the community since oil exploration began, with mean scores indicating mixed responses. Respondents generally disagreed that there has been an abundance of aquatic resources (item 1) and improvements in electricity and portable water (items 4-5), with mean scores below 3. In contrast, there were modest agreements regarding farm produce abundance, income from sales, new schools, tarred roads, and peace in the community (items 2-3, 7-9), reflected in mean scores above 3. The overall perception of improved life since oil exploration (item 10) is slightly positive but not overwhelming. The grand mean of 3.11 suggests a slightly favorable but divided view on the socio-economic impact of oil exploration.

Research question 3: What are the perceived health impacts of oil exploration?

Table 4.4: Summary of descriptive statistics on the perceived health impacts of oil exploration

S/N	Items	Yes	No	NS	NA	Mean	St.D	Decision
1	Oil exploration has negatively impacted our health.	53	12	7	28	2.90	1.31	*
2	Oil companies and /or government have built hospitals for easy access to healthcare with facilities and equipments.	10	62	7	21	2.61	0.93	*
3	Have you had cough in the past?	44	28	9	19	2.97	1.14	*
4	Have you had nasal discharge (Catarrh) in the past?	42	20	10	28	2.76	1.26	*
5	Have you had difficulty in breathing in the past?	18	34	18	30	2.40	1.10	#
6	Have you had noisy breathing in the past?	15	40	10	35	2.35	1.11	#
7	Have you ever visited the hospital due to problem of breathing?	16	51	19	14	2.69	0.91	*
8	Have you ever been diagnosed of high blood pressure (BP)?	24	21	44	11	2.58	0.98	*
9	Do you find it difficult to sleep at night?	28	49	8	15	2.90	0.98	*
10	Do you have frequent headaches that does not reduced when you take paracetamol?	34	25	13	28	2.65	1.22	*
11	Do you have shortness of breath?	23	39	8	30	2.55	1.15	*
12	Do you fell easily tired when you walk short distances or climb the stairs?	39	42	6	13	3.07	0.99	*
13	Have you ever been diagnosed of high blood sugar?	38	47	5	10	3.13	0.91	*
14	Do you have itchy skin?	50	32	9	9	3.23	0.95	*
15	Do you have any rashes on your skin?	34	53	1	12	3.09	0.91	*
16	Does your eye itch you?	31	53	9	7	3.08	0.82	*
17	Do you see well?	48	33	12	7	3.22	0.92	*
18	Do you use eye glasses?	24	54	16	6	2.96	0.80	*
19	Do you have waist pain?	33	45	9	13	2.98	0.97	*
20	Do you have pains in both knees?	45	38	9	8	3.20	0.91	*
	Grand mean					2.87	1.01	*

Footnote: * = Agreed; # = Disagreed; NS = Not sure; NA = Not applicable

Table 4.4 summarizes respondents' perceptions of health impacts due to oil exploration, with varied responses across different health conditions. The majority agreed that oil exploration negatively impacted health (item 1, mean = 2.90) and reported experiencing specific health issues such as cough, nasal discharge, difficulty sleeping, frequent headaches, fatigue, high blood sugar, itchy skin, and knee pain (items 3-4, 9-10, 12-15, 20, mean > 2.5). There was general agreement on the inadequacy of healthcare facilities provided by oil companies or the government (item 2, mean = 2.61). However, there was some disagreement or uncertainty regarding difficulties in breathing and noisy breathing (items 5-6, mean < 2.5). The grand mean of 2.87 suggests an overall perception of moderate negative health impacts attributed to oil exploration.

Table 4.5: Results of Physio-chemical analysis of water samples of Ibaa community

S/N	Parameters	Method	Ibaa 001	Mgbere 002	Omkpoba 003	Anele Cmpd 004	Princewill compd 005A	Princewill compd 005B	Ibaa/Rumuji River 006
1	pH	APHA1998	6.52	6.21	6.54	5.63	6.45	5.76	6.61
2	Temp. (°C)	APHA1998	28.7	28.3	28.9	28.1	28.1	28.8	28.9
3	Turbidity (NTU)	APHA1998	33.5	2.73	18.9	21.3	30.0	0.69	1.15
4	Conductivity (µS/cm)	APHA1998	106	865	206	208	162	330	18
5	Salinity (%)	APHA1998	0.06	0.49	0.12	0.12	0.09	0.19	0.01
6	TDS (mg/l)	APHA1998	74.2	605.5	14 4.2	145.6	113.4	231.0	12.6
7	Total Hardness (mg/l as CaCO ₃)	APHA1998	38.3	143.6	55.2	60.3	50.2	62.3	15.7
8	Total Alkalinity (mg/l as CaCO ₃)	APHA1998	16	14	18	10	12	6	6
9	Chloride (mg/l)	APHA1998	13.8	47.4	15.3	29.6	21.7	35.6	8.9
10	Sulphate SO ₄ ²⁻ (mg/l)	APHA1998	1.20	7.90	3.35	<1.00	<1.00	<1.00	<1.00
11	Nitrate NO ₃ ⁻ (mg/l)	APHA1998	7.93	0.43	3.30	3.36	2.13	12.76	1.08
12	Phosphate PO ₄ ⁻³ (mg/l)	APHA1998	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
13	Manganese Mn (mg/l)	APHA1998	0.031	0.806	0.057	0.390	0.214	0.080	<0.002
14	Calcium Ca ²⁺ (mg/l)	APHA1998	13.8	39.9	20.7	21.5	16.8	23.0	6.1
15	Magnesium Mg ²⁺ (mg/l)	APHA1998	0.094	10.7	0.878	1.633	2.083	1.199	0.124
16	Iron Fe (mg/l)	APHA1998	<0.005	8.095	0.474	1.723	1.199	<0.005	<0.005
17	Faecal Coliform Bacteria MPN/100ml	APHA1998	0.1x10	Nil	Nil	Nil	Nil	Nil	Nil
18	Total Coliform Bacteria MPN/100ml	APHA1998	Nil	Nil	Nil	0.5x10	Nil	Nil	Nil
19	Total Heterotrophic Bacteria MPN 100/ml	APHA1998	2.9x10 ²	2.4x10 ²	6.3x10 ²	6.9x10 ²	3.5x10 ²	4.1x10 ²	2.5x10 ²

Key: < = less than detection limit ; **MPN** = Most Probable Number **Temp.**= Temperature
TDS = Total Dissolved Solids; **Cmpd** = Compound.

Table 4.6: Results of Physico-chemical Properties and PAH analysis of Water Samples in Rumuekpe community

S/N	Parameter(s)	Analytical methods	Sombreiro River 001	Ederi-Rumuekpe Spill Site 002	Dimkpa's Cmpd 003	Rumunkirikpa Rumuekpe 004	Ovelle Nvaka Obia R. 005
1	Temperature (°c)	APHA 2250	28.6	28.5	28.7	28.7	28.5
2	pH	APHA 460	5.9	5.7	5.0	5.1	5.6
3	Elect. Cond (us/cm)	APHA 2510B	20	21	15	20	9
4	Turbidity (NTU)	APHA2510B	0	34	0	0	0
5	Total Hardness (mg/l)	APHA122B	5	5	3	5	3
6	Total Alkalinity (mg/l)	APHA2320B	3	3	1	2	1
7	DO(mg/l)	APHA422B	6.3	5.2	5.8	6.8	6.7
8	COD(mg/l)	APHA508	1.81	2.56	2.13	2.06	1.75
9	BOS(mg/l)	APHA507	1.21	1.71	1.42	1.38	1.17
10	Sulphate, SO ₄ ²⁻ (mg/l)	APHA427C	0	0	0	0	0
11	Nitrate, NO ₃ ⁻ (mg/l)	APHA419C	0.5	0.5	0.4	0.6	0.1
12	Phosphate, PO ₄ ³⁻ (mg/l)	APHA425C	0.13	0.12	0.10	0.15	0.08
13	TSS(mg/l)	APHA208D	1	13	0	0	0
14	Chloride CF(mg/l)	APHA480C	6	6	4	6	3
15	TDS (mg/l)	APHA208D	11	12	8	11	5
16	Nitrite, NO ₂ ⁻ (mg/l)	APHA419C	<0.001	<0.001	<0.001	<0.001	<0.001
17	PAH (mg/l)	APHA6440B	0.0040	0.0041	0.016	0.0038	0.0014
18	Calcium, Ca ²⁺ (mg/l)	APHA301A	0.204	0.202	0.083	0.246	0.120
19	Magnesium, Mg ²⁺ (mg/l)	APHA301A	0.234	0.558	0.750	2.069	0.473
20	Potassium, K ⁺ (mg/l)	APHA301A	0.987	1.268	0.350	0.014	0.800
21	Sodium, Na ⁺ (mg/l)	APHA301A	0.337	0.410	0.490	0.653	0.699
22	Copper, Cu(mg/l)	APHA301A	0.025	<0.001	<0.001	0.970	<0.001
23	Lead, Pb(mg/l)	APHA301A	<0.001	<0.001	<0.001	<0.001	<0.001
24	Iron, Fe(mg/l)	APHA301A	<0.001	2.918	<0.001	<0.001	<0.001
25	Nickel, Ni (mg/l)	APHA301A	0.061	<0.001	<0.001	<0.001	<0.001
26	Cadmium, Cd(mg/l)	APHA301A	0.042	<0.001	<0.001	<0.001	<0.001
27	Chromium, Cr (mg/l)	APHA301A	<0.001	<0.001	0.046	<0.001	<0.001
28	Zinc, Zn(mg/l)	APHA301A	0.470	0.324	<0.001	0.054	0.045
29	HUB (CFU/ml) x 10 ²	APHA9215 C	NIL	NIL	0.3	NIL	0.3
30	HUF(CFU/ml) x 10 ²	APHA9215 C	NIL	NIL	NIL	NIL	NIL
31	THB(CFU/ml) x 10 ²	APHA9215 C	2.1	2.1	2.3	3.0	2.5
32	THF(CFU/ml) x 10 ²	APHA9215 C	1.2	1.1	1.2	2.0	1.2
33	Faecal Coliform (MPN/100ml)	APHA922E	43	≥2400	9	0	4
34	Total Coliform (MPN/100)	APHA922E	43	≥2400	15	0	240

Key: Elect cond= Electrical conductivity; NTU=Nephelometric Turbidity Unit; DO= Dissolved Oxygen; COD= Chemical Oxygen Demand; TDS= Total Dissolved Solids; PAH=Polycyclic Aromatic Hydrocarbon; HUB= Hydrocarbon Utilizing Bacteria; HUF= Hydrocarbon Utilizing Fungi; THB= Total Hydrocarbon Bacteria; THF= Total Hydrocarbon Fungi; MPN= Most Probable Number; CFU= Colony Forming Unit

Table 4.7: Results of Physio-chemical Properties and PAH analysis of Water Samples in Rukpokwu

S/N	Parameter(s)	Analytical methods	Mini-Anatha R.001	Rumuado Town Hall R. 002	Vita Eterna Filling Station. 003	Worlu Wamadi Family E. R. 004	Hydropet Filling Station E. R. 005
1	Temperature (°c)	APHA 2250	28.5	28.6	28.5	28.8	28.7
2	pH	APHA 460	5.7	4.0	4.2	4.7	5.2
3	Elect. Cond (us/cm)	APHA2510B	15	434	166	93	12
4	Turbidity (NTU)	APHA2130B	0	0	0	0	0
5	Total Hardness (mg/l)	APHA122B	4	80	35	15	4
6	Total Alkalinity (mg/l)	APHA2320B	2	10	8	5	2
7	DO(mg/l)	APHA422B	6.8	6.9	5.6	6.9	7.0
8	COD(mg/l)	APHA508	1.94	1.94	1.88	1.81	1.56
9	BOS(mg/l)	APHA507	1.23	1.23	1.25	1.21	1.04
10	Sulphate, SO ₄ ²⁻ (mg/l)	APHA427C	0	8	3	2	0
11	Nitrate, NO ₃ ⁻ (mg/l)	APHA419C	0.3	1.3	1.2	1.0	0.3
12	Phosphate, PO ₄ ³⁻ (mg/l)	APHA425C	0.10	0.48	0.53	0.62	0.10
13	TSS(mg/l)	APHA208D	0	0	1	1	0
14	Chloride CF(mg/l)	APHA480C	5	132	50	28	4
15	TDS (mg/l)	APHA208D	8	239	91	51	7
16	Nitrite, NO ₂ ⁻ (mg/l)	APHA419C	<0.001	<0.001	<0.001	<0.001	<0.001
17	PAH (mg/l)	APHA6440B	0.0025	0.0009	0.0025	0.0015	0.0027
18	Calcium, Ca ²⁺ (mg/l)	APHA301A	0.062	1.387	0.263	0.174	0.271
19	Magnesium, Mg ²⁺ (mg/l)	APHA301A	0.106	38.660	7.540	8.873	0.729
20	Potassium, K ⁺ (mg/l)	APHA301A	0.133	6.075	0.576	0.347	<0.001
21	Sodium, Na ⁺ (mg/l)	APHA301A	0.278	18.450	7.824	4.693	0.679
22	Copper, Cu(mg/l)	APHA301A	0.115	<0.001	<0.001	<0.001	<0.001
23	Lead, Pb(mg/l)	APHA301A	<0.001	<0.001	<0.001	<0.001	<0.001
24	Iron, Fe(mg/l)	APHA301A	<0.001	<0.001	0.452	<0.001	0.025
25	Nickel, Ni (mg/l)	APHA301A	0.015	<0.001	<0.001	0.034	0.045
26	Cadmium, Cd(mg/l)	APHA301A	<0.001	<0.001	<0.001	<0.001	0.033
27	Chromium, Cr (mg/l)	APHA301A	<0.001	0.020	<0.001	<0.001	<0.001
28	Zinc, Zn(mg/l)	APHA301A	0.357	0.055	0.015	0.116	<0.001
29	HUB (CFU/ml) x 10 ²	APHA9215 C	0.1	0.1	0.3	0.1	0.2
30	HUF(CFU/ml) x 10 ²	APHA9215 C	NIL	NIL	0.1	0.1	0.1
31	THB(CFU/ml) x 10 ²	APHA9215 C	2.3	2.0	3.3	1.8	2.6
32	THF(CFU/ml) x 10 ²	APHA9215 C	1.0	1.7	1.7	0.6	1.5
33	Faecal Coliform (MPN/100ml)	APHA922E	1100	21	0	0	240
34	Total coliform (MPN/100ml)	APHA922E	1100	93	0	0	4

Key: Elect cond= Electrical conductivity; NTU=Nephelometric Turbidity Unit; DO= Dissolved Oxygen; COD= Chemical Oxygen Demand; TDS = Total Dissolved Solids; PAH=Polycyclic Aromatic Hydrocarbon; HUB= Hydrocarbon Utilizing Bacteria; HUF= Hydrocarbon Utilizing

Fungi; THB= Total Hydrocarbon Bacteria; THF= Total Hydrocarbon Fungi; MPN= Most Probable Number; CFU= Colony Forming Unit

Table 4.8: Results showing the Benzo (a) pyrene concentration in Water Samples and the number of times Benzo (a) pyrene exceed ATSDR and WHO guideline values in Ibaa Community

S/N	Sample ID	Water Source	Method	Benzo (a) pyrene conc. (mg/L)	ATSDR guideline value = 0.0002mg/L	WHO guideline value = 0.0007mg/L
1	Ibaa 001	Well (Drinking)	APHA6440B	0.0000	-	-
2	Mkpoba Umueche 002	Well (Drinking)	APHA6440B	2.3664	11,832 times	3,380.5 times
3	Princewill Chukwure 003	Bore hole (Drinking)	APHA6440B	0.0000	-	-
4	Mgbere 004	Well (Drinking)	APHA6440B	0.0000	-	-
5	Princewill 005	Bore hole (Drinking)	APHA6440B	2.3302	11,651times	3,328.8times
6	Rumuji/Ibaa River 006	River (Not for drinking)	APHA6440B	0.0253	-	-

ATSDR= Agency for Toxic Substances and Disease Register

Table 4.9: Results showing Soil Sample Analysis for Benzo (a) pyrene and Microbiological Agents (HUB & HUF) in Rukpokwu and Rumuekpe Communities.

S/N	Sample ID	Method	Benzo (a) pyrene concentration (mg/kg)	HUB (CFU/g) $\times 10^3$	HUF (CFU/g) $\times 10^3$
1	Mini-antha Rukpokwu 001	EPA 8271A	0.00027	0.8	0.3
2	Mini-Ihie Rukpokwu 002	EPA 8271A	0.0480	0.6	0.3
3	Sombreiro River Bank Omoviri Rumuekpe 001	EPA 8271A	0.2789	0.8	0.6
4	Ederi Rumuekpe 002	EPA 8271A	1.4789	1.4	0.5
5	Rumunkrikpa Rumuekpe 003	EPA 8271A	0.0091	0.8	0.2
6	Ovelle Nvako Ohia Rumuekpe 004	EPA 8271A	0.0151	0.4	0.3
7	Ovelle Nvako Ohia Rumuekpe 005	EPA 8271A	0.0742	1.0	0.4

CFU = Colony Forming Unit

Table 4.10 showing Non-metabolized Benzo (a) pyrene Concentrations in Blood Samples of Residents of Ibaa Community in Emohua LGA

S/N	Sample Identification	Benzo (a) pyrene concentration (mg/L)
1	Ibaa 01	0.00069
2	Ibaa 02	0.00139
3	Ibaa 03	0.00009
4	Ibaa 04	0.00095
5	Ibaa 05	0.00033
6	Ibaa 06	0.00084
7	Ibaa 07	0.00041
8	Ibaa 08	0.00019
9	Ibaa 09	0.00037
10	Ibaa 10	0.00000
11	Ibaa 11	0.00042
12	Ibaa 12	0.00014
13	Ibaa 13	0.00009
14	Ibaa 14	0.00006
15	Ibaa 15	0.00063
16	Ibaa 16	0.00094
17	Ibaa 17	0.00018
18	Ibaa 18	0.00007
19	Ibaa 19	0.00004
20	Ibaa 20	0.00274
21	Ibaa 21	0.00019
22	Ibaa 22	0.00034
23	Ibaa 23	0.00301
24	Ibaa 24	0.00000
25	Ibaa 25	0.00000
26	Ibaa 26	0.000003
27	Ibaa 27	0.00100
28	Ibaa 28	0.00079
29	Ibaa 29	0.00000
30	Ibaa 30	0.00034
31	Ibaa 31	0.00013
32	Ibaa 32	0.00079
33	Ibaa 33	0.00040
34	Ibaa 34	0.00039
35	Ibaa 35	0.00016
36	Ibaa 36	0.00033
37	Ibaa 37	0.00025
38	Ibaa 38	0.00003
39	Ibaa 39	0.00012
40	Ibaa 40	0.00041

Table 4.11 showing Unmetabolized Benzo (a) pyrene Concentrations in Blood Samples of Residents of Rumuekpe Community in Emohua LGA

S/N	Sample Identification	Benzo (a) pyrene concentration (mg/L)
1	Rumuekpe 01	0.00006
2	Rumuekpe 02	0.00004
3	Rumuekpe 03	0.00000
4	Rumuekpe 04	0.00051
5	Rumuekpe 05	0.00028
6	Rumuekpe 06	0.00024
7	Rumuekpe 07	0.00001
8	Rumuekpe 08	0.00001
9	Rumuekpe 09	0.00038
10	Rumuekpe 10	0.00026
11	Rumuekpe 11	0.00021
12	Rumuekpe 12	0.00023
13	Rumuekpe 13	0.00000
14	Rumuekpe 14	0.00000
15	Rumuekpe 15	0.00028
16	Rumuekpe 16	0.00059
17	Rumuekpe 17	0.00115
18	Rumuekpe 18	0.00004
19	Rumuekpe 19	0.00094
20	Rumuekpe 20	0.00065
21	Rumuekpe 21	0.00015
22	Rumuekpe 22	0.00038
23	Rumuekpe 23	0.00017
24	Rumuekpe 24	0.00195
25	Rumuekpe 25	0.00014
26	Rumuekpe 26	0.00047
27	Rumuekpe 27	0.00011
28	Rumuekpe 28	0.00054
29	Rumuekpe 29	0.00176
30	Rumuekpe 30	0.00019

Table 4.12 showing Non-metabolized Benzo (a) pyrene Concentrations in Blood Samples of Residents of Rukpokwu Community in Obio-Akpor LGA

S/N	Sample Identification	Benzo (a) pyrene concentration (mg/L)
1	Rukpokwu 01	0.00009
2	Rukpokwu 02	0.00048
3	Rukpokwu 03	0.00038
4	Rukpokwu 04	0.00012
5	Rukpokwu 05	0.00018
6	Rukpokwu 06	0.00004
7	Rukpokwu 07	0.00066
8	Rukpokwu 08	0.00027
9	Rukpokwu 09	0.00066
10	Rukpokwu 10	0.00063
11	Rukpokwu 11	0.00138
12	Rukpokwu 12	0.00053
13	Rukpokwu 13	0.00055
14	Rukpokwu 14	0.00107
15	Rukpokwu 15	0.00030
16	Rukpokwu 16	0.00021
17	Rukpokwu 17	0.00010
18	Rukpokwu 18	0.00017
19	Rukpokwu 19	0.00060
20	Rukpokwu 20	0.00004
21	Rukpokwu 21	0.00032
22	Rukpokwu 22	0.00015
23	Rukpokwu 23	0.00016
24	Rukpokwu 24	0.00072
25	Rukpokwu 25	0.00030
26	Rukpokwu 26	0.00031
27	Rukpokwu 27	0.00022
28	Rukpokwu 28	0.00052
29	Rukpokwu 29	0.00030
30	Rukpokwu 30	0.00023

Table 4.13: Results of Ambient Air Quality Data At Rukpokwu Community

PARAMETERS	POINT1: MANIFOLD ROAD SHELL PIPELINE RUKPO KWU	POINT 2: 120 BODO / IGUR RUTA LINK ROAD (APU ROAD)	POINT 3: A2UMINI PIPELINE BEHIND WINNER'S CHURCH	POINT 4: RUMUAPU - ENEKA ROAD	POINT 5 MGBUCHI RUKPO KWU TOWN HALL	CONTROL POINT AIRPORT ROAD BY RUMUAG HOLU	FME _{nv} ¹	NMDPR	NESREA	WHO
NO ₂ PPM	0.04	0.01	0.03	0.00	0.01	0.00	75-113	50*	120	40 ug/m ³
SO ₂ PPM	0.33	0.30	0.41	0.10	0.08	0.01	26	125	120	20 ug/m ³
CO PPM	20.0	11.6	61.0	0.58	0.36	0.11	22.8	10**	5**	100 ug/m ³
VOC PPM	4.40	0.25	0.22	0.29	0.08	0.00	-	-	-	
CH ₄ PPM	0.4	1.4	0.0	0.0	0.0	0.0	-	-	-	
NH ₃ PPM	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	
H ₂ S PPM	0.0	0.0	0.0	0.1	0.0	0.0	-	-	-	
PM ₁₀ UG/M ³	31	38	49	36	24	16	-	-	-	50 ug/m ³
PM _{2.5} UG/M ³	20	26	31	25	15	10	-	-	-	25 ug/m ³
NOISE dB(A)	46.9	55.9	44.8	54.5	59.4	43.0	90	90	80	
Temp°C	30.9	31.2	32.5	32.0	31.9	33.0	-	-	-	
RH%	78.8	76.9	75.0	73.9	74.2	70.4	-	-	-	
Wind Sp (m/s)	1.4	2.3	1.8	2.3	1.0	1.1	-	-	-	
WD	NE	SW	SW	SE	SW	NE				

Key: PPM= Parts per million; NO₂ = Nitrogen dioxide; SO₂ = Sulphur dioxide; CO = Carbon monoxide; VOC = Volatile organic compounds; CH₄ = Methane; NH₃ = Ammonia; H₂S = Hydrogen sulphide; PM₁₀ = Particulate matter of 10micrograms per cubic meter; PM_{2.5} = Particulate matter of 2.5micrograms per cubic meter; dB = Decibel; Temp = Temperature (°C: degrees celcius); RH = Relative humidity; Wind sp = Wind speed (meters per second); WD = Wind direction; NE= Northeast; SE = Southeast; SW = Southwest; Ug/m³ = Micrograms per cubic meter. FME_{nv}¹ = Federal Ministry of Environment; DPR² = Department of Petroleum Resources; NESREA = National Environmental Standards and Regulations Enforcement Agency; WHO = World Health Organization

Table 4.14: Results of Ambient Air Quality Data in Remuekpe Community

Parameter s	Point1: Ovelle Primary School Area	Point2: Emoagu Town Hall play Ground	Point3: State Primary School, Mgbuoda	Point4: Oduoha Ovelle	Point5: Omovirol Oduoha. Christ Army Church	POINT6: Control	FME Env ¹	DPR ²	NES REA	WHO
NO ₂ Ppm	0.01	0.03	0.01	0.01	0.00	0.01	75-113	50*	120	40 uglm ³
SO ₂ PPM	0.01	0.01	0.00	0.01	0.00	0.00	26	125	120	20 uglm ³
CO ppm	0.05	0.06	0.02	0.01	0.00	0.00	22.8	10* *	5**	100 uglm ³
VOC Ppm	0.00	0.08	0.03	0.01	0.00	0.00	-	-	-	
CH ₄ Ppm	0.0	0.1	0.1	0.0	0.0	0.0	-	-	-	
NH ₃ Ppm	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	
H ₂ S Ppm	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	
PM ₁₀ ug/m ³	17	25	37	53	28	14	-	-	-	50 uglm ³
PM _{2.5} ug/m ³	11	16	21	39	18	10	-	-	-	25 uglm ³
Noise dB(A)	42.5	54.3	59.9	52.9	56.6	41.6	90	90	80	
Temp °C	33.8	33.7	33.0	32.6	33.5	33.7	-	-	-	
RH%	81.1	81.1	82.4	81.0	81.0	80.7	-	-	-	
W SP (M/S)	0.6	0.9	11.0	0.8	1.6	1.1	-	-	-	
WD	NE	NE	NE	SE	NW	NW				

Key: PPM= Parts per million; NO₂ = Nitrogen dioxide; SO₂ = Sulphur dioxide; CO = Carbon monoxide; VOC = Volatile organic compounds; CH₄ = Methane; NH₃ = Ammonia; H₂S = Hydrogen sulphide; PM₁₀ = Particulate matter of 10micrograms per cubic meter; PM_{2.5} = Particulate matter of 2.5micrograms per cubic meter; dB = Decibel; Temp = Temperature (°C: degrees celcius); RH = Relative humidity; Wind sp = Wind speed (meters per second); WD = Wind direction; NE= Northeast; SE = Southeast; NW = Northwest; Ug/m³ = Micrograms per cubic meter; FME¹ = Federal Ministry of Environment; DPR² = Department of Petroleum Resources; NESREA = National Environmental Standards and Regulations Enforcement Agency; WHO = World Health Organization

CHAPTER FIVE

Discussion of Findings

Based on the findings from this study, several significant insights into the socio-economic and perceptions of health impacts of oil exploration in the communities have emerged. Firstly, regarding the socio-economic status before oil exploration (Research Question 1), the data revealed a generally positive outlook among respondents. They recalled abundant aquatic and agricultural resources, contributing to a robust local economy. However, infrastructure indicators such as electricity, water, healthcare, and education showed mixed perceptions, indicating some deficiencies that were present even before the onset of oil exploration. This suggests that while natural resources were plentiful, essential services were not uniformly accessible, laying a foundation for evaluating changes post-oil exploration.

Secondly, the socio-economic status since oil exploration began (Research Question 2) showed a more nuanced picture. While there were perceived improvements in some areas like the construction of schools and tarred roads, other critical aspects such as aquatic resources and essential services like electricity and drinking water did not show substantial improvements. This finding aligns with existing literature highlighting the uneven distribution of benefits from resource extraction projects, where infrastructural gains may not always translate into comprehensive community development. The study contributes by providing empirical evidence of these dynamics, underscoring the need for equitable resource management and community development strategies in oil-rich regions.

Thirdly, regarding the perceived health impacts of oil exploration (Research Question 3), the study uncovered significant concerns among respondents. Many reported negative health impacts, including respiratory issues, fatigue, skin problems, and joint pains, which they attributed to oil exploration activities. This finding is consistent with literature documenting the health risks associated with oil extraction, such as air and water pollution, noise, and stress-related ailments. The study's contribution lies in substantiating these concerns with local data, highlighting the need for rigorous health monitoring and mitigation measures in communities affected by extractive industries.

The results of the physio-chemical analysis of water samples in the communities showed that the water samples have varying degrees of acidity. These water when consumed by residents of these communities can cause metabolic acidosis which ultimately alters electrolyte balance resulting in impairment in cardiac, kidney and gastrointestinal functions.

The results further showed that some of the water samples were highly turbid (turbidity is a measure of the degree of cloudiness or opaqueness of water), meaning the water samples were filled with suspended particular matter thus making it unhealthy for consumption. Sadly, some community members continue to consume and use these water for bathing and cooking.

Although most of water samples were found to contain benzo (a) pyrene, they were within the ATSDR guideline value of 0.0002milligram/litre and WHO guideline value of 0.0007milligram/litre for drinking water. However, the benzo (a) pyrene concentration of drinking water samples 002 (Mkpoba Umueche) and 005 (Princewill), were exponentially high exceeding the WHO drinking water guideline value by 3,380.5 and 3,328 times respectively. It is important to emphasize that instead of water to come out of the borehole in Princewill's Compound (Ibaa water sample 005), it was purely crude oil. The pollution with Benzo (a) pyrene was further confirmed by the presence of hydrocarbon utilizing bacteria and fungi, total hydrocarbon bacteria and fungi (which are usually present in places where hydrocarbon is found, this is because these microorganisms breakdown hydrocarbon for their metabolic activities). The presence of these hydrocarbons poses a great risk to the health of residents of these communities because the human system has the capacity to bio-accumulate toxic substances especially hydrocarbons and heavy metals. Bio-accumulation simply means storing these harmful substances gradually until they reach concentrations at which they can exert deleterious effects on the health of humans. This unique characteristic of the human cell is the reason why it takes several years before the carcinogenic, immunogenic and mutagenic effects of PAHs manifest even in the midst of exposure to pollution. Therefore, it is expected that all those who have been consuming water from the sources from where these samples were collected will in the years to come begin to manifest the negative effects of PAHs on their health if they are not experiencing it already.

In addition to the hydrocarbon utilizing micro-organisms mentioned above, the water

samples analyzed were also found to contain faecal coliform, total coliform and total heterotrophic bacteria which can affect the gastrointestinal system, impairing absorption of fluid and nutrients from the small intestine, causing diarrheal disease, electrolyte imbalance, dehydration and impairment of kidney function which is usually worse in children under the age of 5 years. These microorganisms are not due to hydrocarbon pollution but rather poor sanitary condition of the communities,

According to WHO, water is said to be potable for drinking and cooking if it is tasteless, odourless, colourless, free from micro-organisms and chemicals. Any water that falls short of any or all of these criteria is not potable for human consumption, therefore, all the water samples analyzed are not potable and hence not safe for drinking.

Although, there were visible evidences of crude oil pollution in Ibaa and Rukpokwu communities, results of soil analysis showed that benzo (a) pyrene concentrations were within permissible limits. However, results of soil samples 001 (Sombrieiro River bank) and 002 (Ederi) in Rumuekpe community revealed an increase in benzo (a) pyrene levels beyond the pollution value of (200-600 nanogram/gram) 0.2 milligrams/kilogram as given by Wu et al. (2019), ranging from 1.4 times to 7.4 times.

Hydrocarbon utilizing bacteria and hydrocarbon utilizing fungi were found in the soil samples of the communities, this simply implies that these communities have been polluted by crude oil. These micro-organisms are found only at sites where crude oil (hydrocarbon) spills have occurred. They primarily act by metabolizing, that is, breaking down hydrocarbon to perform their intra-cellular functions. It is for this reason that these micro-organisms are used for bio-remediation of polluted sites.

The results of blood sample analysis for non-metabolized benzo (a) pyrene revealed that 93% of the 100 samples analyzed had benzo (a) pyrene present in them. All the blood samples (100%) had more than one PAH present in them (although, we focused on benzo (a) pyrene only). All the 16 PAHs injurious to the health of humans were present in the samples. However, benzo (a) pyrene, the most toxic PAH and marker for hydrocarbon exposure risk assessment, was used as a representative of other less toxic PAHs in the blood samples analyzed. The results showed that more than 93% of the blood samples had benzo (a) pyrene, thus, confirming that members of the

communities have been exposed to hydrocarbon pollution. There seem not to be a globally acceptable limit of benzo (a) pyrene in blood but juxtaposing the results of blood analysis for benzo (a) pyrene and the WHO guideline value for benzo (a) pyrene in drinking water, one can infer that most of the benzo (a) pyrene blood value are high. This is not a surprise finding because as stated above, the water that the some of the residents of these communities drink and bath and soils where they grow their food were found to be contaminated by crude oil. As was explained above, the human cells have the capacity to bio-accumulate harmful chemicals until their concentrations are high enough to cause damage to the human cells and organs, in most cases irreversibly.

The results of air quality index assessment for both Rumuekpe and Rukpokwu communities were within normal ranges. Ibaa community refused the air quality expert from conducting the air quality assessment test due to threats from some misguided youths of the community.

Recommendations

Based on the findings of this research the following recommendations are made;

1. Health audit should be carried out immediately by the Federal Ministry of Health in collaboration with the Rivers State Ministry of Health to ascertain the extent of impact of hydrocarbon pollution in these communities with a view to providing the needed healthcare interventions.
2. There should be immediate remediation of all polluted sites in the affected communities by the Hydrocarbon Pollution and Remediation Project (HYPREP).
3. Potable drinking water should be provided by Shell Petroleum Development Company (SPDC) for the affected communities with all the urgency that it deserves.
4. SPDC and the Federal Government of Nigeria should provide 24hour security for all oil facility and installation to forestall further third party interference of its facilities immediately.
5. The Federal Government and its joint venture partners should increase the stake of oil-bearing communities in the business of oil and gas exploration as a sustainable means of ensuring peace, development and security of its facilities in the communities.
6. SPDC and the Federal Government of Nigeria should ensure prompt payment of adequate and commensurate compensation to communities that have been impacted by oil spills due to equipment failure.
7. SPDC and the Federal Government of Nigeria should carryout vocational training for youths of the affected communities with a view to giving them alternative livelihood opportunities as soon as possible.

Conclusion

This study provided a comprehensive assessment of the socio-economic and perceived health impacts of oil exploration in the studied communities. It underscores the complex interplay between natural resource extraction, socio-economic development and public health outcomes. The study has brought to the fore the socio-economic status of communities before oil exploration and the negative impacts oil exploration has had in the last six decades on the socio-economic indices of not just the environment but also on the indigenes of the communities. One of the key findings of this study is the fact that even the community members now perceive that the activities of oil and gas exploration within their communities have negatively impacted their health. But by far the most intriguing of all the findings was the presence of benzo (a) pyrene in the blood samples of community members at concentrations far beyond what one would have anticipated. We believe without a shadow of doubt that if autopsies are conducted in the affected communities of all deaths, it may be discovered that most of the causes of death may be directly or indirectly related to hydrocarbon pollution.

It is important to state that in countries with strong institutions, oil and gas resources are exploited according to international best practices with particular reference to environmental sustainability, and the proceeds from oil and gas exploration are used to better the lives of their citizens, however, in Niger Delta in particular and Nigeria in general the opposite appears to be the case. Multinational oil companies in Nigeria conduct their business with reckless abandon without recourse to environmental laws and proceeds from oil and gas find their way to the pockets of few powerful individuals and the majority are left to suffer in abject poverty and consequences of environmental pollution occasioned by oil spill and ever-blazing gas flares.

The findings call for holistic approaches to resource management that prioritizes community well-being alongside economic gains, ensuring sustainable development in oil-rich regions. Future research could build upon these findings by exploring long-term impacts and integrating community perspectives into policy and decision-making processes.