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Assessment of Hazards Associated with Siting a Smelting Industry in a Community and the Effects of Emitting Pollutant on the Host and Neighboring Communities; Jimba Oja. (ARMTI), and (NCAM), Ilorin Nigeria

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Abstract: The emission of gaseous pollutants from smelting industries poses momentous environmental and health hazards to host and neighboring communities. Smelting factories are essential for metal production. This study investigates the negative paraphernalia of pollutant discharge from a smelting factory on the environment, human health, and socioeconomic well-being of residents in the surrounding communities. Previous studies revealed that exposure to pollutants from smelting factories lead to respiratory problems, cardiovascular & non-cardiovascular diseases, and increased cancer risk, soil contamination, water pollution, and loss of biodiversity. We want to fill the gap by building on existing research through examining the specific effects of pollutant discharge on host and neighboring communities. The research employed a mixed-methods approach, combining field observations, laboratory analysis of environmental samples of pollutants in air, water, and soil samples and evaluated the health and socioeconomic impacts. Statistical analysis revealed significant correlations between pollutant levels and adverse health effects (the adverse health effect >0 for household on perpetual contact) (staff of KAM Steel's adverse health effect >1) (Jimba Oja & ARMTI community >1(land and water contamination >0.1), including respiratory problems and skin conditions. The socioeconomic well-being of residents was negatively impacted, with decreased agricultural productivity and increased healthcare costs. NCAM staffs were not impacted either positively or negatively due to distance from source and wind direction, it also reveals that the year 2020 accounted for the highest proportion of hazard occurrences, representing 45.5% of the total recorded cases. The next was 2021 with 24.2%, downward trend continued in subsequent years, with 2022 contributing 12.1%, 2023 accounting for 6.1%, and 2024 representing 9.1% of total occurrences. The year 2025 recorded the least share of hazard risk at 3.0%, confirming a substantial reduction in hazard incidents toward the end of the study period. Overall, the result clearly illustrates a consistent decline in hazard frequency over time, suggesting improvements in safety measures or risk management within the study area. The results of the laboratory test reveal elevated concentrations of sulfur dioxide (SO_2), nitrogen oxides (NO_x), particulate matter ($PM_{2.5}$, PM_{10}), and heavy metals (lead, cadmium, arsenic) exceeding WHO and national permissible limits. Conclusively the year 2025 recorded the least share of hazard risk at 3.0%, confirming a substantial reduction in hazard incidents, but laboratory test reveal negative severe environmental and health consequences for the host and neighboring communities. It highlights the need for stricter regulations and enforcement to mitigate the negative effects of pollutant discharge. Underscore the prominence of implementing effective environmental management strategies, recommends that policymakers and stakeholders to prioritize environmental sustainability and community well-being by adopting cleaner production technologies and enforcing stringent environmental regulations.

Keywords: *Gaseous,=Smoky; Pollutants,=Contaminants; Momentous,=Significant; Paraphernalia,=Effects; Devastating, =Disturbing; Mixed-Methods Approach,=Both Qualitative and Quantitative Approach, Prominence,=Importance, Underscore,= Emphasizes, Cardiovascular,=Blood Circulation.*

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I. INTRODUCTION

The siting of a smelting industry in a community could have significant economic benefit, but also possess environmental, health, and socio-economic impacts. Smelting activities release toxic pollutants, including heavy metals, particulate matter, and gases, which can contaminate soil, water, and air. Although the activities of smelting industries have numerous socio-economic merit, this report will discuss the hazards associated with siting a smelting industry in a community and the effects of pollutant discharge on the Host and neighboring communities. Jimba Oja, Agricultural And Management Training Institute. (ARMTI), and National Center for Agricultural Mechanization (NCAM), Ilorin Nigeria.

➢ *Background to the Study*

The siting of smelting industries in communities has raised concerns about the potential hazards and risks associated with the emission of toxic effluents and pollutant discharge. Smelting industries involve the extraction of metals from ores, which can release hazardous substances into the environment, posing risks to human health and the ecosystem.

➢ *Rationale for the Study*

The Disposal of Polluted Effluents from Metallurgical, Mining and Metal Finishing Industries: In this study, published by The Southern African Institute of Mining and Metallurgy, explores the adverse effects of acidic mine drainage on water quality and discusses remedial measures.(Meta AI 2022)

The contamination legacy of a decommissioned iron smelter: A study conducted by University Degli Study di Palermo investigates the environmental impact of a decommissioned iron smelter in the Italian Alps, highlighting the dispersion of potentially toxic elements into the environment. (Meta AI 2022)

Pollution Characteristics, Risk Assessment, and Source Analysis of Heavy Metals in Soil*: Research published in PubMed examines the pollution status and ecological risks of heavy metals in soil from an abandoned antimony smelting factory in China. (Meta AI 2022)

Pollution Prediction and Control Strategies for Heavy Metals: A study available on SSRN explores pollution prediction and control strategies for heavy metals in soil-groundwater systems at smelting sites, emphasizing numerical simulation and groundwater pollution control. Meta AI 2022)

Comprehensive Health Risk Assessment of Polish Smelters: Research published in the International Journal of Environmental Research and Public Health conducts a comprehensive health risk assessment of Polish smelters with Eco toxicological studies. (Meta AI 2022)

Driving Factors for Distribution and Transformation of Heavy Metals Speciation: A study by Central South University investigates the driving factors for distribution and transformation of heavy metals speciation in a zinc smelting site. (Meta AI 2022)

Pollution Analysis and Control of Non-Ferrous Metal Smelting Production: (link unavailable) features a study on pollution analysis and control and non-ferrous metal smelting production, highlighting the environmental pollution caused by the industry (Meta AI 2022)

The study aims to assess the hazards associated with siting a smelting industry in a community and the effects of emitting toxic effluents/pollutant discharge on the host and neighboring communities. The study seeks to identify the potential risks and impacts on human health, environment, and socio-economic aspects of the affected communities.

➢ *Statement of Research Problem*

The activities & location of smelting industries in communities is economically vibrant, but could also lead to the emission of toxic pollutants, including heavy metals, particulate matter, and other hazardous substances, which can contaminate air, water, and soil which can have devastating effects on the health and well-being of people living in the host and neighboring communities.

Hazards associated with working near or inside smelting industries vary depending on the distance and exact type of work executed inside or around the Smelting industries, it include, but not limited to exposure to:

- Moving parts (e.g., loading and off-loading; risk of injuries from entanglement, friction, abrasion, cutting, severing, shearing, stabbing, puncturing, impact, crushing, drawing-in or trapping, etc.)
- Energy (e.g., electrical, electromagnetic, magnetic, etc.)
- Heat or cold (during smelting process)
- Noise of the machines (roaring and flaming)
- Vibration(during sizing, grinding, cutting and smelting)
- Radiation
- Gaseous discharge and inhaling toxic effluent or liquid under pressure (e.g., injuries from injection or ejection by hydraulic systems, pneumatic systems, compressed air, paint sprayers, etc.)
- Psychosocial hazards (e.g., stress, job content, work organization, cognitive factors trauma, burn out, etc.) (Occupational Safety and Health Administration 2023) (OSHA Standards: A Guide to Health and Safety Compliance Published 23 Oct 2023) and (Usman M.D et al 2023)

➢ *Research Questions*

- What are the potential hazards associated with siting a smelting industry in a community?
- What are the effects of emitting toxic effluents/pollutant discharge on the host and neighboring communities?
- What are the current environmental and health impacts of the smelting industry on the community?

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- What measures can be taken to mitigate the adverse effects of the smelting industry on the community?
- What is the level of resilience of the communities to hazard risk and the vulnerability to disaster?

➢ *Objectives of the Study*

The aim of the study is to conduct a baseline survey of the Hazard, Vulnerability and Capacity of the community (Jimba Oja, ARMTI, and NCAM) and to assess the community perception to the nature of hazard risk as well as their capacity to respond to such hazard. The study seeks to fulfill the following specific objectives;

- Evaluate Community understanding of the causes and effects of toxic effluent hazards risk in the community.
- To assess the potential hazards associated with siting a smelting industry in a community
- To identify the current environmental and health impacts of the smelting industry on the community
- To evaluate the effects of emitting toxic effluents/pollutant discharge on the host and neighboring communities
- To recommend and create measures of building capacities, mitigate the consequential disaster ahead and create resilience

➢ *Significance of the Study*

- To identify the current environmental and health impacts of smelting industry on the communities
- To assess the potential hazards associated with siting a smelting industry in a community
- To evaluate the effects of emitting toxic effluents/pollutant discharge on the host and neighboring –communities
- To enlighten the Factory's staff, the communities, the institutions and the neighboring settlement about their vulnerability to the negative consequences of toxic effluent discharged into the air & disaster associated with the effluent.
- To foster recommendation on the disaster risk reduction on how to mitigate the adverse effects of the smelting industry management principles and strategies to be adopted

➢ *Justification of the Study*

The study will provide valuable insights into the potential hazards and risks associated with siting a smelting industry in a community and the effects of emitting toxic effluents/pollutant discharge on the host and neighboring communities. The study will inform policymakers, industry stakeholders, and communities about the need for sustainable and responsible industrial practices.

➢ *Scope of the Study*

Duration; the (Scope) is five (5years) In terms of content, this study focuses on Hazards associated with living and or working near or inside a smelting industries which vary depending on the distance and exact type of work executed inside or around the Smelting industries it examine the level of Hazard, vulnerability and risk management in (KAM Steel) Smelting Factory, Jimba Oja being the host community, Agricultural & Rural Management Training Institute, (ARMTI) National Centre For Agricultural Mechanization (NCAM) With peculiar reference to NCAM, ARMTI, Jimba Oja Ifelodun local Government Area Kwara State Nigeria as the spatial and geographical scope of this study, the temporal scope is between December 2020 to December 2025 (5 years).

➢ *Limitation*

- The most worrisome challenges amongst all others are the obstruction to free flow of information (data collection) from the smelting factory's staff.
- Nonchalant attitude among community members; most members do not give attention to the survey and do not envisage hazard which they are vulnerable
- Literacy level of the staff and settlers in relation to the vulnerability is another worrisome matter

II. LITERATURE REVIEW

A. Conceptual Framework

The Hazard Risk & Disaster Management (HRDM) framework for smelting industries integrates risk management and disaster resilience to minimize harm to people, environment, and assets. It involves:

- Risk Identification 🔍: Identify hazards (chemical, physical, environmental) in smelting processes.
- Risk Analysis 📊: Assess likelihood and impact of hazards.
- Risk Evaluation ⚖️: Prioritize risks, focusing on high-impact scenarios.
- Risk Treatment 🛠️: Implement controls (engineering, administrative, PPE).
- Monitoring & Review 🔄: Continuously update risk assessments and mitigation strategies.

➢ *Disaster Management Cycle:*

- Prevention/Mitigation ⏪: Reduce risks through design, training, and safety protocols.
- Preparedness 📋: Develop emergency plans, train staff, and conduct drills.
- Response 🚨: Activate plans, contain incidents, protect people and environment.
- Recovery 🔄: Restore operations, address environmental impacts.

- *Key Concepts:*

✓ Hazard: Potential source of harm (e.g., toxic gases, molten metal).
✓ Risk: Likelihood × Impact of a hazard.
✓ Disaster: Event causing significant harm to people, environment, or assets.

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- ✓ Disaster = Risk X Hazard (Meta AI 2025, Usman MD et al 2023)

➢ *Theoretical Underpinnings*

According to Jessica Jensen (2009) theory orient individuals to the preview of a given discipline, inspires research questions, guides methodologies, provides framework for data analysis, inform policy development and aids professionalization of fields served by the discipline. Although there are some theoretical models that could be applied to emergency management discipline and theory building, many of them however have not been recognized, used or developed to the extent necessary (Jessica. 2009) (Usman MD et al 2023) Nevertheless, one theory that is widely recognised and used in emergency management is the Disaster Phase Model.

Lowell Carr (1932) first introduce the concept of disaster phases, suggesting that there was an inherent "sequence pattern" to disaster. The Disaster phase Model as currently envisioned conceptualizes disaster as "the defining event" within four- phases that is mitigation, preparedness, response and recovery. However (Jessica 2009) observed that the Disaster Phase Model is not testable but consists of several implied propositions, which have varying extent been tested by empirical research as follows;

- There are period before, during and after a disaster when human beings can engage in various type of activity after disaster events
- Certain types of activities are suited to specific phases
- Action taken on one phase have an impact on the outcome of the other phases.
- Meeting the needs generated by disasters requires activity in all the phases.
- Use of the phase approach will improve the ability of humans to adapt to disasters.

The Disaster Phase Model has provide a framework form which a researchers have generated and tasted countless research questions and its implied preposition used to partially explain and predict why disaster occur the way they do as well as when and where they do occur (Jessica Jensen 2005) (Usman MD 2023 et al). With today's advancement in science and technology, including the innovative approaches and strategies for enhancing local capacities, the impact of natural disaster somehow could be predicted and mitigated, its detrimental effects on populations reduced, and the communities adequately protected.

Carr (1932) further concluded that disasters are the collapse (i.e. failure or inadequacy) of cultural protection, a result of human activities and not of natural or supernatural forces; therefore, they are essentially human- made. The assertion assumes that human societies have the capacity to recognize the risks and factors that could lead or cause disasters and the appropriate interventions to control or manage them. It therefore conveys that, disaster can be prevented or their impact on people and communities mitigated, and that human action or inaction to high risk and vulnerability to natural hazards could spell the difference. Signicantly this view enable society to recognize the importance of community action, such as capacity and capacity building, including planning for the response for potential emergencies, managing and mitigating their effects as well as possibly preventing their occurrences or recurrence. This Notion of disaster as principally human made and not attributably to fate presents a challenge to practitioners to reconsider the common use of "natural" and "human-made" in typifying disaster (Usman MD et al 2023)

Russell Dynes (1993) states: "The fact that 'natural' disasters are social, rather than natural phenomena, it has a number of implications as follows:

- Prevention and mitigation must stress social rather than physical solutions.
- Disaster planning is not primarily the search for the implementation of technological solutions.
- Emphasis on the social allows for proactive, rather than reactive strategies. Thus, it is possible to take actions prior to the appearance of the physical agent.
- Emphasis in planning can be on internal, rather than external, factors. The potential threat is not out there' but resides in the 'internal' flaws within the social system.
- The view of disasters as social phenomena allows such happenings to be incorporated as a part of the nation's development process."

The concept of "phases" has been used since the 1930s to help describe, examine, and understand disasters and to help organize the practice of emergency management. In an article titled 'Reconsidering Phases of Disaster', David Neal (1997) cites different examples of different researchers using five, seven, and up to eight phases long before four phases became the standard for Emergency management (Neal 1997) (Usman MD et al 2023).

➢ *The Concept of Disaster Management*

Disaster is a sudden, calamitous event bringing great damage, loss, destruction and devastation to life and WHO defines Disaster as "any occurrence that causes damage, ecological disruption, loss of life, deterioration of health and health services, on a scale sufficient to warrant an extraordinary response from outside the affected community or area" the damage caused by disasters is immeasurable varies with the geographical location, climate and the type of the earth surface/degree of Vulnerability.

This influences the mental, socio-economic, political and cultural state of the affected area. Generally, disaster has the following effects in the concerned areas:

- It completely disrupts the normal day to day life.
- It negatively influences the disaster systems.
- Normal needs and processes like food, shelter, health, etc. are affected and deteriorate depending on the intensity and severity of the disaster.

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It may also be termed as "a serious disruption of the functioning of society, causing widespread human, material or environmental losses which exceed the ability of the affected society to cope using its own resources.

Disaster management is the organization and management of resources and responsibilities for dealing with all humanitarian aspects of emergencies in particular preparedness, response and recovery in order to lessen impacts of disasters (International Federation of Red Cross and Red Crescent Societies of Disaster management). According to Holloway (2003), disaster management is the organization, management of and the responsibilities for dealing with the aspects of emergency particularly it's key of prevention, mitigation, preparedness, response and recovery. He recognized disaster management as a formalized body of knowledge originated in the late 1980s and included in the UN Disaster Management Training Programme for many developing countries in the early-mid 1990s.

Although the "four phases" are part of the common language and theoretical underpinning of disaster management, a number of adaptations can be found in many literatures. Some sources have changed the descriptive terms for one or more of the phases to now reflect five phases rather than four. Some of the changes are subtle and involve only additional words, perhaps to be more descriptive. For instance "mitigation" is changed to "mitigation and prevention" and in other variations; planning/preparedness" is used rather than just "preparedness". The related change that seems to have the most momentum is to add "prevention" as a separate, fifth phase or component of emergency management (Malcolm E. Baird, 2010) (Usman MD et al 2023). Mitigation phase refers to activities that are designed to reduce eliminate risks to persons or property, or lessen the actual or potential effects or consequences of an incident (FEMA, 2006). The four phases namely mitigation, preparation, response, and recovery help to describe "comprehensive emergency management". These terms have been widely used by policy practitioners, trainers, educators and researchers and are often described as part of a continuous as illustrated in Figure 1.

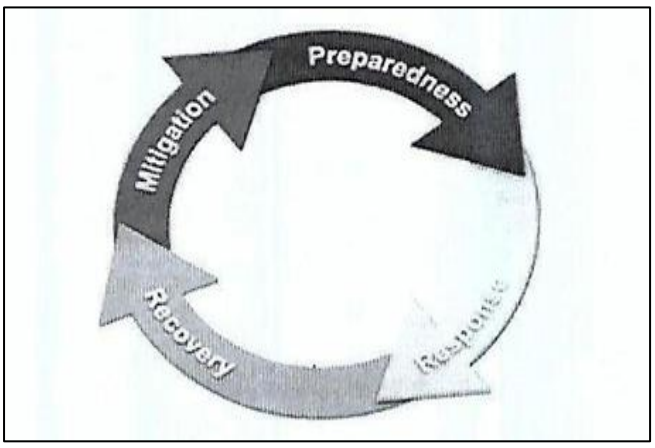

Fig 1 Four Phases of Disaster Management
(Source: NEHRP.2009)

B. Theoretical Framework

C. Review of Related Literature

- *Hazards Risk Associated with Siting a Smelting Industries*

The hazard associated with siting smelting industries include, but not limited to the followings Environmental Degradation: Smelting activities can lead to soil contamination, loss of organic matter, and essential nutrients, making the soil unsuitable for agricultural purposes. The release of toxic pollutants can also contaminate nearby water sources, affecting aquatic life and human consumption. Meta AI 2024.

On the other hand, OHSA 2023 explained on the Health Impacts of the pollutants: Exposure to pollutants from smelting activities can cause a range of health problems, including respiratory diseases, cardiovascular diseases, and cancer. Human Brain mal functioning and Severe Deposits of Toxic Substances Furthermore the body metabolism becomes relentlessly affected, falsifying the normalcy of a defined system, leading to distress, trauma, burnout and fading/ loss of interest, consequently leading to Neurological damage: exposure to toxic substances have perpetually cause neurological damage, including cognitive impairment and neurodegenerative diseases. Meta AI 2023 and Medecine.net 2024.

Medecine.net 2024 view toxic accumulation from smelting with its consequential impairments: prolonged exposure to toxic substances can lead to accumulation in the body, causing long-term health problems, increased risk of neurodegenerative diseases: exposure to toxic substances has been linked to an increased risk of neurodegenerative diseases, such as Alzheimer's and Parkinson's. (Medecine.net 2024).

The devastating consequences of smoke and toxic oxidation from smelting factories can be far-reaching and have long-term effects on human health, the environment, and the economy. It's essential to implement measures to reduce emissions, protect the environment, and ensure the health and safety of people and animals. OHSA 2024.

In a related development Health Risks on human beings and other lives are greatly affected; EHSO 2024 and Meta AI 2024 provide thus; Exposure to heavy metal's smoke and particulate matter from smelting activities can cause respiratory problems, skin diseases, and cancer. Children and adults living near smelting sites are at higher risk of non-carcinogenic and carcinogenic health effects. Carcinogenic health effects refer to the potential of a substance or agent to cause cancer. Carcinogens are substances or agents that can lead to the development of cancer, either by damaging DNA or disrupting cellular processes, examples of Carcinogenic Health Effects include: Cancer: Carcinogens can cause various types of cancer, including lung, skin, breast, and colon cancer. In a related development Tumor Formation; Carcinogens can lead to the formation of tumors, which can be benign or malignant.

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Genetic Mutations is another problem: Carcinogens can cause genetic mutations, which can increase the risk of cancer development. Medecine.net 2024 some common examples of Carcinogens are: Chemicals: Benzene, formaldehyde, and asbestos are known carcinogens. Radiation: Ionizing radiation, such as X-rays and gamma rays, can cause cancer. Viruses: Certain viruses, such as human papillomavirus (HPV), can cause cancer Medecine.net 2024.

Non-carcinogenic health effects refer to adverse health effects that are not related to cancer. These effects can occur due to exposure to various substances or agents and can affect different organs and systems in the body .examples of Non-Carcinogenic Health Effects: include Respiratory Problems: Exposure to certain substances can cause respiratory problems, such as asthma or Chronic Obstructive Pulmonary Disease (COPD). Added to this above, is Neurological Effects: Since exposure to certain substances have caused neurological effects, such as headaches, dizziness, or tremors. Relatively is the Reproductive Effects: Exposure to certain poisonous substances affect reproductive health, including fertility and fetal development. Medecine.net & Meta AI 2024.

In a seemingly consequential analysis Cardiovascular Effects due to exposure to certain emitted pollutant discharged substances increase the risk of cardiovascular disease. Some common examples of Non-Carcinogenic Substances: include Particulate Matter whose exposure causes respiratory problems and cardiovascular disease. Volatile Organic Compounds (VOCs): whose exposure causes respiratory problems, headaches, and other health defects? Heavy Metals exposure such as lead and mercury causes neurological and developmental effects. (OHSA 2024 et al)

The Air Pollution from Smelting industries released particulate matter, sulfur dioxide, nitrogen dioxide, and carbon monoxide, contributing to air pollution and negatively impacting human health and the environment. The toxic substances inhaled gradually accumulate in the respiratory system causing blockage and difficulties in breathing resulting to Asphyxiation, Respiratory failure, Hypoxia e.g. reduction of oxygen supply to the body tissues leading to organ damage and failure a condition where the body, or a part of the body, is deprived of oxygen. Which occur due to various reasons, such as:

- Blockage of the airway: Obstruction of the trachea or bronchi, preventing air from reaching the lungs.
- Inhalation of toxic gases: Breathing in gases that displace oxygen or interfere with oxygen utilization
- Suffocation: Lack of oxygen due to compression of the chest or obstruction of the nose and mouth.
- Drowning: Aspiration of water, leading to asphyxiation. This has the Symptoms to include

✓ Shortness of breath
✓ Difficulty breathing
✓ Confusion
✓ Loss of consciousness
✓ Cyanosis (blue discoloration of the skin) Victims of asphyxiation, it's crucial to: 1. Call for emergency help

Remove the cause of asphyxiation (if possible) 3. Provide rescue breathing or CPR (if trained for (Cardiovascular Protection & Restoration) Prompt medical attention is essential to prevent long-term damage or even death. (OHSA 2024 et al) (Medecine.net & Meta AI 2024).

Cardiovascular diseases (CVDs) refer to conditions that affect the heart and blood vessels, including cardiovascular problems e.g. straining the heart and blood vessel resulting in heart failure, Stroke, Hypertension (High Blood Pressure) elevated blood pressure that may lead to stroke, heart diseases and kidney damage & failure. (Meta AI 2025) (Medicine.net 2025)

Highlights on these diseases include 1. Coronary Artery Disease (CAD): Narrowing or blockage of coronary arteries, reducing blood flow to the heart.2. Heart Failure: The heart's inability to pump enough blood to meet the body's needs.3. Stroke: Interruption of blood flow to the brain, causing damage to brain tissue & body organ 4. Hypertension (High Blood Pressure): Elevated blood pressure that can lead to heart disease, stroke, and kidney damage.5. Peripheral Artery Disease (PAD): Narrowing or blockage of blood vessels in the legs, arms, or other areas. (Meta AI 2025) (Medicine.net 2025)

CVDs are often caused by a combination of factors, including 1. High Blood Pressure 2.High Cholesterol 3.Smoking 4.Diabetes 5.Obesity 6.Physical Inactivity 7.Family History (Meta AI 2025) (Medecine.net 2025)

Symptoms may include: 1. Chest pain or discomfort 2.Shortness of breath 3.Fatigue 4.Swelling in legs or ankles 5.Dizziness or light headedness .Prevention and management strategies include ensuring the application and administration of OSHA in work places and also; 1. Healthy Diet 2.Regular Exercise 3.Stress Management 4, Monitoring and Managing Blood Pressure and Cholesterol 5. Quitting Smoking and smoke areas early detection and treatment can help manage CVDs and reduce complications. Chronic Respiratory Diseases e.g. Chronic Obstructive Pulmonary Disease (COPD) Hypertension (High Blood Pressure) elevated blood pressure can lead to stroke, heart diseases and kidney damage & failure. (Meta AI 2025) (Medecine.net 2025)

➢ *Specific Health Consequence on Concurrent Interaction with Gaseous Toxic from Smelting Plants on;*

Specific Health Consequence on Concurrent Interaction with Gaseous Toxic from Smelting Plants on (1) Staff (2) School Children and (3) Adults in the communities are:- *Respiratory problems*: inhalation of toxic fumes and particles causes respiratory issues, such as asthma and lung damage.

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- *Occupational Health Risks*: prolonged exposure to toxic substances can lead to long-term health problems, including cancer and neurological damage. *Increased risk of accidents*: impaired cognitive function and fatigue due to toxic exposure can increase the risk of workplace accidents.
- *Long-Term Health Consequences*: childhood exposure to toxic substances can lead to long-term health problems, including increased risk of chronic diseases. *Reduced quality of life*: air pollution can reduce quality of life, causing discomfort, stress, and anxiety. (Meta AI 2025) (Medecine.net 2025) (OHSA 2024 et al) (Medecine.net & Meta AI 2024)

Another imperative consequences worth appending in discussion like this, is the Socio-Economic Impacts of a Smelting industries, socio-economic impacts on local communities, including displacement, loss of livelihoods, and cultural heritage, their storages damaged and the stored goods: toxic substances can damage stored goods, such as food and other products. Contamination risk toxic substances can contaminate stored goods, posing a risk to human health. (OHSA 2024 et al) (Medecine.net & Meta AI 2024).

- *In a related development Economic losses* due to air pollution from smelting factories can damage infrastructure, reduce property values, and impact local businesses, can also r*educe productivity* and increased absenteeism among workers which eventually lead to *Loss of business opportunities*: air pollution can deter investment and tourism, leading to lost business opportunities.
- *Added to these, Food Contamination*, a form of toxic substances can contaminate food and water in the host community, posing a risk to human health and *Loss of business*, air pollution can deter customers and damage the reputation of eateries also could *increase costs:* eateries may incur additional costs to mitigate the effects of air pollution, such as installing air filtration systems. (OHSA 2024 et al) (Meta AI 2024)
- *Reduced Crop Yields*: air pollution can damage crops, reducing yields and impacting food security.
- *Soil contamination*: toxic substances can contaminate soil, affecting soil quality and fertility.
- *Increased Costs*: farmers may incur additional costs to mitigate the effects of air pollution, such as using protective equipment. (Meta AI 2025) (Medecine.net 2025)

III. STUDY AREA AND METHODOLOGY

A. Study Area

➢ *The Study Area (Ilorin Kwara State,) Jimba-Oja, Armti, Ncam)*

Ilorin, the capital city of Kwara State, is among the geographically located city within the area known as North Central Geographical Zone. The primary ethnic group is Yoruba, with significant Nupe, Baruba, and Fulani minorities. Geographically South West Central with Time Zone UTC +1 (WAT) It occupies a land area of about 950 hectares on longitude 8.3896*N, and latitude 4.6905*E It lies within the region of tropical climate, and its "North is characterized by double rainfall maxima, and has tropical wet and dry climate (Olanrewaju, 2009). Relative humidity at Ilorin in the wet season is between 75 to 80% while in dry Season it is about 65%. National Centre for Agricultural Mechanization (NCAM) is situated at kilometer 20, along Lokoja-Ilorin, Highway in the ancient and historic city of Ilorin, the capital city of Kwara State, Nigeria.

➢ *Climate*

The climate condition of Ilorin is characterized with oppressive wet season and overcast, the dry season is humid and partly cloudy, and it is hot year round. Over the course of the year, the temperature typically varies from 64F and 95F and is rarely below 57F and above 100F. This make life and liveliness obviously hectic, but fans and big blowers are often provided to reduce the intensity. Before this provision there are cases of less concentration, severe heat and concurrent hazards couple vulnerable operators that led to disaster. The workshop temperature rise tremendously.

➢ *Vegetation*

The vegetative distribution of Ilorin (Kwara state capital) comprise mainly of forest and savannah vegetation, constituting 47.78% and 35.04% of the state landmass respectively, while the built up area and water mass of the state constitute 16.73% and 0.44% of the Kwara state (Google www.geyseco.es)

➢ *Population*

The population of Ilorin the state capital of Kwara, western Nigeria as at 2006 Census it had the population of 777,667.00 making the 7th largest city, by pop in Nigeria. Wikipedia.

Commercial activities, they are mainly traders, with Ilorin the Capital city taken advantage of its close proximity to Lagos. There is a well define transportation network within and outside Ilorin (Inter and intra-Urban transportation system)

➢ *Location*

- *Jimba- Oja.:*

Jimba Oja Village is associated with the Agricultural and Rural Management Training Institute (ARMTI), which is located at Km 18 Ilorin-Lokoja Highway, Ilorin, Kwara State, Nigeria. Approximate coordinates for ARMTI are Latitude: 4.69972.E, Longitude: 8.38401 N.

National Center for Agricultural Mechanization (NCAM), Km 20 Ilorin-Lokoja Highway, Idofian Ifelodun LGA Kwara State, Nigeria Latitude: 4.69022 E Longitudes: 8.38936 N.

- *Economic Activities*

The economic activities in and around Jimba Oja Village are centered around agriculture and agribusiness,

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given the presence of NCAM, with its Agricultural Mechanization and ARMTI and its focus on agricultural training and development. Some common economic activities in the region include: Crop farming and livestock production which are significant contributors to the local economy. Agribusiness: ARMTI's activities suggest a strong presence of agribusiness-related activities, including training and capacity building for farmers and agricultural professionals. Trading: Local markets and trading activities play a crucial role in the village economy.

➢ *Agricultural & Rural Management Trainning Institute (ARMTI) Ilorin*

The Agricultural and Rural Management Training Institute (ARMTI) is located in Ilorin, Kwara State, Nigeria, specifically along same route Ilorin-Lokoja Highway at Km 18 Jimba-Oja. Unfortunately, it is the host community of KAM STEEL (The Smelting Factory) with a population less than a million, also the host of ARMTI. Agricultural and Rural Management Training Institute (ARMTI): Located at 18km same route Ilorin-Lokoja Highway, Ifelodun, LGA. Latitude: 4.69972 E Longitudes: 8.38401 N.

➢ *National Center for Agricultural Mechanisation (NCAM- Ilorin)*

The National Centre for Agricultural Mechanization (NCAM) is situated at kilometer 20, along llorin -Lokoja Highway in the ancient and historic city of Ilorin, the capital city of Kwara State, Nigeria. It occupies a land area of about 950 hectares, on longitude 8.3896*N, and latitude 4.6905*E.

➢ *NCAM Ilorin Establishment*

The Centre was established by the Act of the National Assembly No.35 of 1990 for the development and promotion of agricultural mechanization technologies for the transformation of Nigerian agriculture.

The National Centre for Agricultural Mechanization (NCAM), saddled with the overall objective of accelerating the pace of agricultural mechanization in Nigeria in order to increase the quantity and quality of agricultural products, it has not relented on its efforts to achieve her set objective. The Centre, through innovative and adaptive research over the years, has developed various agricultural tools and machines to alleviate the problems associated with crop production and processing in order to guarantee food security in the country.

The major planks of the Centre’s mandate are the following functions:

- Encourage and engage in adaptive and innovative research towards the development of indigenous machines for farming and processing techniques;
- Design and develop simple and low-cost equipment which can be manufactured with local materials skills and facilities;
- Standardize and certify, in collaboration with the Standards Organization of Nigeria (SON), agricultural machines, equipment and engineering practices in use in Nigeria;
- Bring into focus mechanical technologies and equipment developed by various institutions, agencies or bodies and evaluates their suitability for adoption;
- Assist in the commercialization of proven machines, equipment, tools and techniques;
- Disseminate information on methods and programme for achieving speedy agricultural mechanization;
- Provide training facilities by organizing courses and seminars specially designed to ensure sufficiently trained manpower for appropriate mechanization; and
- Promote cooperation in agricultural mechanization with similar institutions in and outside Nigeria and with International bodies connected with agricultural mechanization.

✓ *Geology*

▪ Kwara State: Underlain by Precambrian Basement Complex rocks, with soils varying from sandy loam to clay loam. The state's geology and soil type support diverse agricultural activities.

✓ *Climate*

▪ Kwara State, where ARMTI is situated, experiences a tropical climate with two main seasons: wet and dry. The region's climate supports agricultural activities, making it suitable for farming and other related endeavors.

✓ *Soil*

▪ Kwara State: Underlain by Precambrian Basement Complex rocks, with soils varying from sandy loam to clay loam. The state's geology and soil type support diverse agricultural activities.

✓ *Vegetation*

The vegetation in Kwara State is characterized by savannah grasslands with scattered trees. This type of vegetation cover supports a range of agricultural activities, including crop farming and livestock production.

Kwara State is characterized by savannah grasslands with scattered trees. This type of vegetation cover supports a range of agricultural activities, including crop farming and livestock production.

B. Methodology

The methodology adapted for the research work is mixed-method approach which includes the following;

- Focus Group Discussion (FGD) Select members of the community for anticipation of getting qualitative information (Data) , otherwise called purposive sampling techniques
- Participatory Vulnerability and Capacity Assessment (PVCA), members of the community engaged in data collection
- Direct observation tools were used in data collection. Otherwise called Physical Form Survey or Transient

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Walk of Cross section of the study area methods were also used in conducting the assessments

- Key Informant Interview (KII) Methods was used in conducting the assessment by interviewing

✓ Mai Angwa (Ward Head)
✓ Wakilin Sarki (Baale) (Emissary)
✓ Questionnaires were enumerated. (172 questionnaires were enumerated)

➢ *Research Design*

"The study adopts the Mixed-Methods Research Design Approach; that is the combination of both quantitative and qualitative data collection and analysis. In parallel form"(concurrent mixed method design in which two types of data are collected and analyzed) in sequential form (sequential mixed method design in which one type of data provides a basis for collection of another) (WIKEPEDIA 9 Jan 2018) https/edutechwiki.unige.ch. The Mixed-methods design approach (quantitative and qualitative) allow for triangulation in one study, enabling Comparative study design for two or more different types of data in one location. For instance, experts experiences information, focus group discussion and climate change or survey data. (Usman MD et al 2024)

(Dovetail 20 Feb 2023) "A mixed methods research design is an approach for collecting and analyzing both qualitative and quantitative data in a single study. Mixed methods design approaches are most appropriate for handling and analyzing triangulation research work" (Dovetail et al 2023).

Scholars like *Donald T. Campbell and Julian C. Stanley* are often cited as key figures who significantly contributed to the development and theoretical foundation of this research methodology, (mixed-methods design approach) particularly through their work on triangulation and the integration of qualitative and quantitative data collection methods. (A.I Overview 2023)

"Their work on triangulation, which involves using multiple data sources to verify findings, is considered a foundational concept in mixed methods design. There is high degree of evolution of the field as mixed methods research gained prominence, other researchers further developed and refined its methodologies and applications and put into use" (Dovetail 20 Feb 2023)

➢ *Methods of Data Collection:*

These will include data types, sources and methods of acquisition. Data will be collected through a well-structured questionnaires, interviews, field survey, observations, split plot design/paired plot design and focus group discussion as primary sources. While secondary sources will include data from; Journals, Publications, Text books, Standard Authority/Reference offices, e.g. Auditor General, National Population Commission, (NPC, NBS) National Bureau of Statistic, Metrological Centers, etc.

➢ *Data Collection*

For environmental factors, e.g. Climate, Vegetation, temperature, humidity, relief and soil etc. data: will be collected using standard equipment and techniques, e.g. Metrological Centre, Survey and interview, While others as afore mention above.

➢ *Types and Sources of Data*

These will include data types, sources and methods of acquisition. Data will be collected through a well-structured questionnaires, interviews, field survey, observations, split plot design/paired plot design and focus group discussion as primary sources. While secondary sources will include data from; Journals, Publications, Text books, Standard Authority/Reference offices, e.g. Auditor General, National Population Commission, (NPC, NBS) National Bureau of Statistic, Metrological Centers, etc.

➢ *Population Size*

The population of Ilorin the state capital of Kwara, western Nigeria as at 2006 Census it had the population of 777,667.00 making the 7th largest city, by pop in Nigeria. Wikipedia

Commercial activities they are mainly traders, with Ilorin the Capital city taken advantage of its close proximity to Lagos. There is a well define transportation network within and outside Ilorin (Inter and intra-Urban transportation system)

➢ *Sample Technique*

The samples afore mention, we will consider Random sampling, but adopt split plot design/paired plot design for climate, soil data and related variables. While Purposive sampling for expert opinions and farmer experiences for this study

➢ *Method of Data Analysis*

This study wish to adopt the appropriate statistical techniques for data analysis, for instance:

- *Descriptive Statistics:*

To calculates mean, median, mode, standard deviation, and variance to understand the distribution of variables in the Study Area. For example objective (1) to assess the effect of environmental factors on Jatropha seed yield for optimal biodiesel production. Below is the outline of the method of data analysis (e.g., statistical tests, thematic analysis) For example: Data will be analyzed using descriptive statistics, inferential statistics, and thematic analysis." To determine the relationship between temperature and yield of Jatropha or crops, several statistical tests can be employed, depending on the nature of the data and research question.

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IV. DATA PRESENTATION AND DATA ANALYSIS

A. Introduction

Data obtained from the questionnaires are presented in tabular form, showing the number of respondents, frequencies, and percentages of responses to each questionnaire administered. This method of presentation enables clear summarization, easy comparison, and effective interpretation of respondents' views and characteristics.

B. Bio-Data of Respondents

Table 1 Distribution of Respondents by: Age Bracket

Response	Frequency	Percentage
18 -29Yrs	30	17.4
30 -39Yrs	39	22.7
40 -49Yrs	71	41.3
50-yrs and above	33	19.2
Total	**172**	**100.0**

Source: Field Work, 2025

As displayed in Table 1, 17.4% of the respondents fall within the age bracket of 18–29 years, while 22.7% is aged 30–39 years. A larger proportion of the respondents, 71 individuals representing 41.3%, are within the 40–49 years age group, and 19.2% are aged 50 years and above. This age distribution indicates that data were collected from respondents across all major age categories within the local Community, thereby ensuring broad representation. The dominance of respondents aged 30 years and above suggests that the study largely captured the views of mature and experienced individuals who are more likely to be knowledgeable about community dynamics and the effect of hazard and disaster risk management. This is particularly important, as older age groups often have greater exposure to governance structures, environmental health practices, and peaceful resolution mechanisms. Consequently, the age composition of the respondents enhances the reliability of the findings regarding the role of governance in the study area.

Table 2 Distribution of Respondents by: Gender

Response	Frequency	Percentage
Male	123	71.5
Female	49	28.5
Total	**172**	**100.0**

Source: Field Work, 2025

As shown in Table 2, the gender distribution shows 123 of respondents representing 71.5% were male, while 49 respondents representing 28.5% were female. This suggests that males constituted the majority of participants in the survey. The higher proportion of male respondents implies that men were more readily available or more willing to participate in the study, possibly due to socio-cultural factors, occupational engagement, or greater involvement in activities related to the subject matter of the research. Consequently, the responses obtained may reflect male perspectives more strongly than female viewpoints, which should be considered when interpreting the findings of the study.

Table 3 Distribution of Respondents by: Religion

Response	Frequency	Percentage
Islam	96	55.8
Christianity	76	44.2
Total	**172**	**100.0**

Source: Field Work, 2025

From the responses presented in Table 3, 106 respondents representing 55.8% are Muslims, while 84 respondents (44.2%) are Christians. This distribution indicates that Muslims constitute the majority religious group in the study area. The findings therefore reveal that the study area is predominantly Muslim, although there is also a substantial Christian population, reflecting religious diversity within the area.

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Table 4 Distribution of Respondents by: Occupation

Response	Frequency	Percentage
Student	23	13.4
Civil Servant	49	28.5
Business	36	20.9
Farmers	56	32.6
Others	8	4.7
Total	**172**	**100.0**

Source: Fieldwork, 2025

The table 4 presents the occupational distribution of the 172 respondents surveyed during the 2025 fieldwork. Farmers constitute the largest proportion of respondents with 56 individuals (32.6%), indicating that agriculture remains the dominant livelihood activity in the study area. This high representation of farmers is significant, as it reflects the largely agrarian nature of the area and suggests that a substantial share of the population may be directly exposed to occupational and environmental hazards associated with farming activities while the civil servants account for 49 respondents (28.5%), representing the second-largest occupational group. This indicates a notable presence of formal sector employment, which may be associated with relatively stable income and potentially better awareness of safety regulations and risk management practices. Business operators form 36 respondents (20.9%), highlighting the importance of trading and small-scale entrepreneurship in the local economy. Students constitute 23 respondents (13.4%), suggesting a moderate level of educational engagement within the population, while the "others" category, comprising 8 respondents (4.7%), represents miscellaneous occupations not captured in the main groups. Overall, the occupational structure shows a predominance of farming and civil service, underscoring the need for hazard risk management strategies that are sensitive to both agricultural and formal-sector of the environments.

Table 5 Distribution of Respondents by: Educational Qualifications

Category	Frequency	Percentage
Secondary	53	30.8
Tertiary	104	60.5
Others	15	8.7
Total	**172**	**100.0**

Source: Field Work, 2025

Table 5 shows the educational qualifications of the 172 respondents surveyed during the 2025 fieldwork. The results indicate that respondents with tertiary education constitute the majority, accounting for 104 individuals (60.5%). This suggests a relatively high level of educational attainment within the study area, which may positively influence awareness, understanding, and adoption of hazard risk prevention and safety measures.

Respondents with secondary education account for 53 individuals (30.8%), representing a substantial proportion of the population with basic formal education. This group is likely to possess foundational knowledge that can support effective communication and training on hazard risk reduction. Meanwhile, respondents classified under other forms of education (such as primary education, informal, or vocational training) constitute 15 individuals (8.7%), forming the smallest group. Overall, the dominance of tertiary-educated respondents implies that the study findings are informed by participants with relatively high literacy and analytical capacity, which strengthens the reliability of responses, particularly on issues related to hazard awareness, risk perception, and mitigation strategies.

C. The Frequency of the Hazard Risk

The frequency of the disaster that occurred in the study area from 2020 to 2025 is presented in figure 2, 3 and figure 4 below:

Figure 2 showing the percentage distribution of hazard risk frequency from 2020 to 2025.

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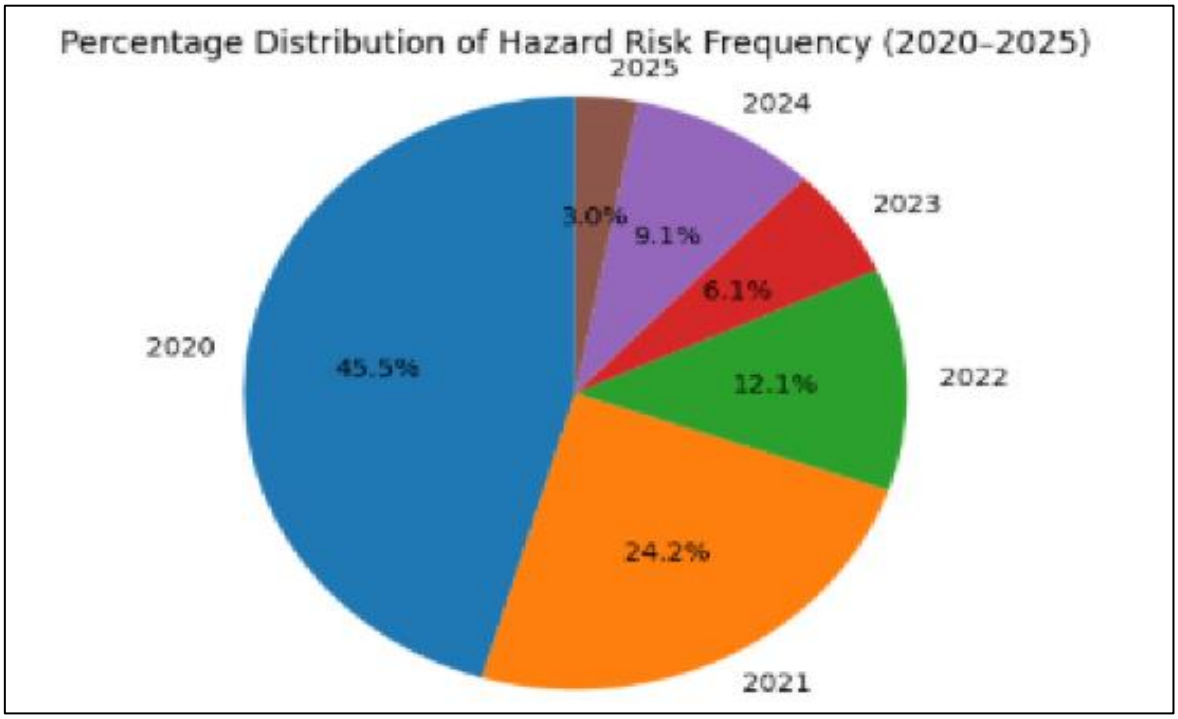

Fig 2 Presents the Percentage Distribution of Hazard Risk Frequency in the Study Area Between 2020 and 2025.
Source: Author's Field Work, 2025

The figure reveals that the year 2020 accounted for the highest proportion of hazard occurrences, representing 45.5% of the total recorded cases. This was followed by 2021 with 24.2%, indicating a notable decline in hazard frequency. The downward trend continued in subsequent years, with 2022 contributing 12.1%, 2023 accounting for 6.1%, and 2024 representing 9.1% of total occurrences. The year 2025 recorded the least share of hazard risk at 3.0%, confirming a substantial reduction in hazard incidents toward the end of the study period. Overall, the pie chart clearly illustrates a consistent decline in hazard frequency over time, suggesting improvements in safety measures or risk management within the study area.

Figure 3: Show the distribution of hazard.

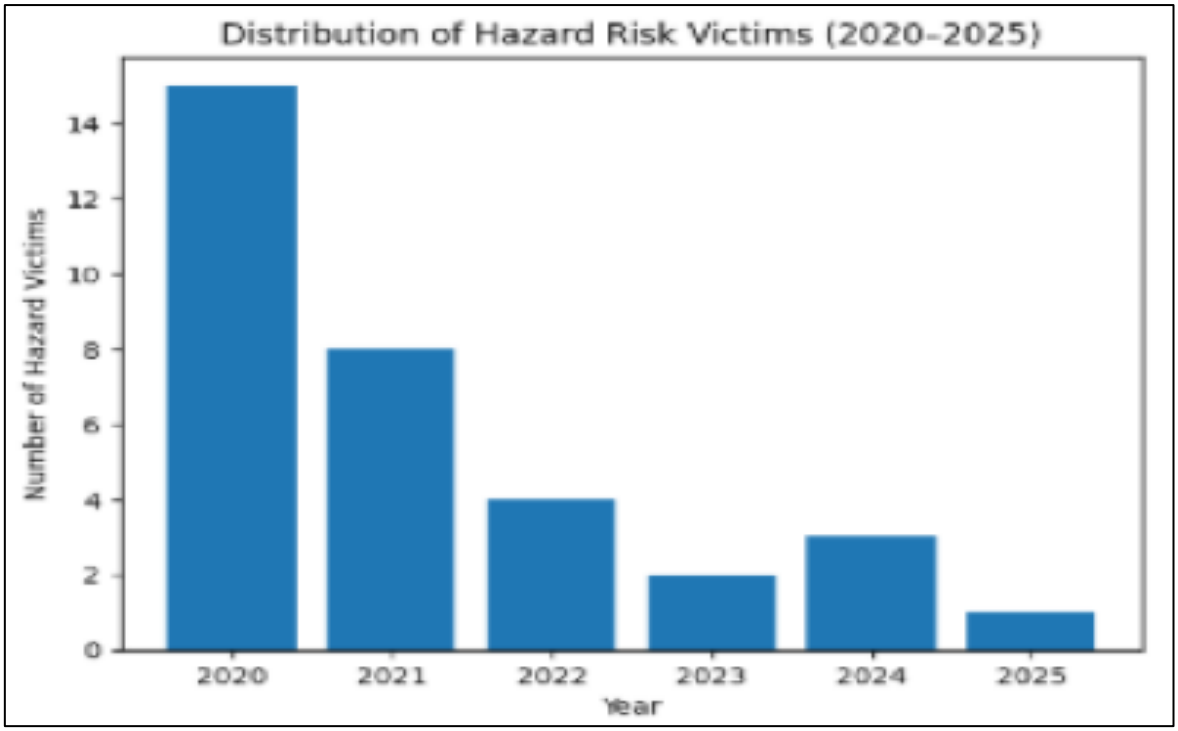

Fig 3 The Hazard Risk for Different Years is Displayed on a Bar Chart.
Source: Author's Field Work, 2025

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Figure 3 illustrates the variations in the occurrence of hazard risk victims in the study area between 2020 and 2025. The bar chart clearly shows that the highest number of hazard victims was recorded in 2020 with 15 victims, indicating a peak period of hazard occurrence. However, this high incidence did not persist, as a significant decline was observed in 2021 with 8 victims, attributed to the introduction of additional administrative and safety measures aimed at mitigating hazard risks. The downward trend continued in 2022 with 4 victims, and further reduced in 2023 to 2 victims. Although a slight increase was recorded in 2024 with 3 victims, the year 2025 recorded the lowest number of hazard victims (1). Overall, the results demonstrate a substantial reduction in the frequency of hazard victims over the study period, suggesting improved hazard control and risk management strategies in the study area.

Figure 4: Shows the distribution of hazards in percentage.

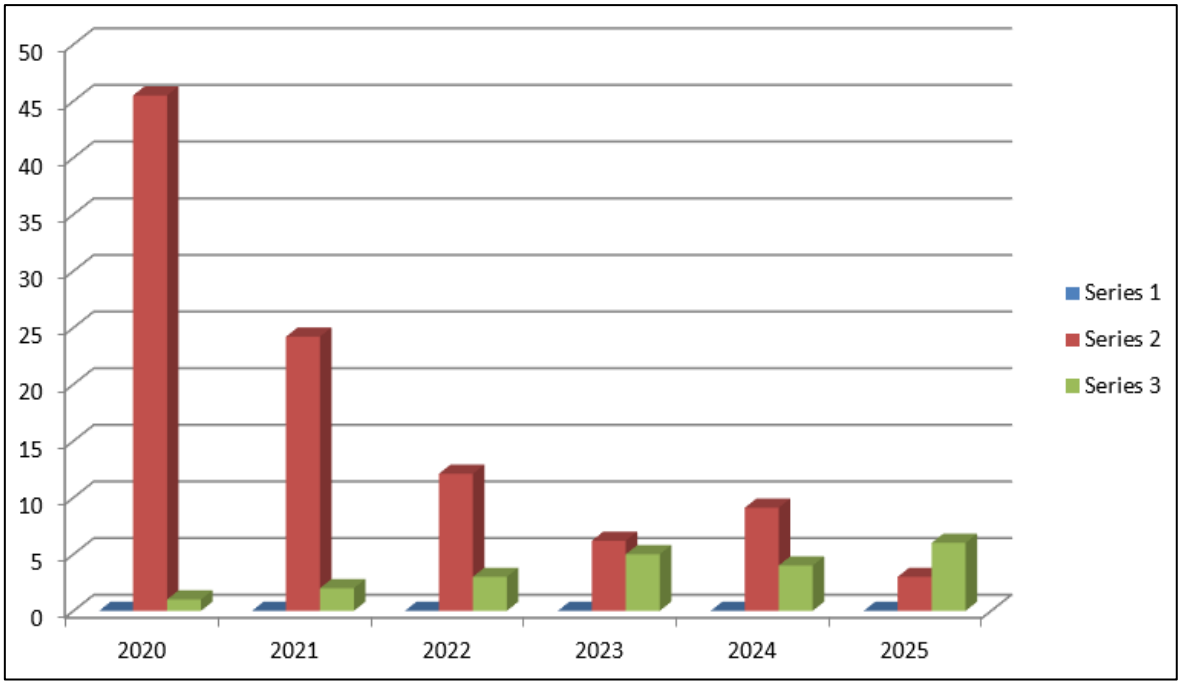

Fig 4 Represents the Outcome of Hazards Risk in Terms of Percentage for Different Years
Source: Author's Field Work

As shown in Figure 4, the distribution of hazard risk by year reveals marked variations in the frequency of hazards within the study area between 2020 and 2025. The year 2020 recorded the highest proportion of hazard risk at 45.5%, indicating a period of heightened vulnerability and frequent hazard occurrences. This was followed by 2021 with 24.2%, suggesting a noticeable reduction compared to 2020, though hazard incidents remained relatively high. The declining trend continued into 2022, which accounted for 12.1% of the total hazard risk, reflecting further improvement in hazard management and control within the study area.

In contrast, the later years of the study period recorded comparatively lower levels of hazard risk. The year 2023 contributed 6.1%, while 2024 accounted for 9.1%, indicating relatively minimal hazard occurrences despite a slight increase in 2024. The lowest hazard risk was recorded in 2025 with only 3.0%, confirming a substantial reduction in hazard frequency towards the end of the study period. Overall, these findings clearly demonstrate that the study area experienced significant year-to-year variations in hazard risk between 2020 and 2025, with a general downward trend over time. This pattern suggests the effectiveness of improved safety measures, administrative interventions, and increased awareness, which collectively contributed to the reduction of hazard risks during the later years of the study.

- *Seasonal Calendar Showing Yearly Distribution of Hazard*

Table 6 Showing General Effects of Pollutant Discharge on Jimba Oja, ARMTI, and NCAM Communities

S/N		KS staff	ARMTI staff	ARMTI staffsch	JIMBA traders	JIMBA farmers	JIMBA B. men	JIMBA H,wives	NCAM staff
1	Air Pollution	H	H	H	H	M	M	H	L
2	Environmental Pollution	M	H	M	M	M	M	M	L
3	Water Pollution	N	N	N	L	L	N	N	N

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4	Soil Pollution	M	L	L	L	L	N	N	N
5	Toxic Waste Deposit	M	L	L	M	L	L	L	L
6	Water Contamination	M	L	L	L	M	L	N	N
7	*Agricultural p*	M	L	L	L	M	L	L	L
8	*Veterinary costs*	L	L	L	L	L	N	N	N

Source; Field Work 2025

- *Key*

✓ H= Highest impact on personal
✓ M= Medium impact on personal
✓ L= Low impact on personal
✓ N=Minimal impact on personal

The Table 6 shows the intensity of hazard impacted among the respondent, the result of the research work indicated that, there are higher impact on KAM Steel staff, than ARMTI Staff, ARMTI Staff School, JIMBA Business Men, Traders, Farmers, House Wives, and NCAM Staff. Consequently it implies that, those closer and constant interacting to the source of hazard, one become more Vulnerable to disaster.

Added to the above elucidation there are series of consequential glitches of pollutants and toxic effluents shown in the table 6 above, thus outline below:

- Environmental Impacts: The community has experienced environmental degradation, including soil contamination and water pollution, due to the release of toxic pollutants from the smelting industry.
- Health Impacts: Residents of Jimba Oja have reported health problems, including respiratory diseases and skin conditions, which may be related to exposure to pollutants from the smelting industry. 3) Soil Contamination: Heavy metals from smelting activities can accumulate in soil, posing risks to human health and ecosystems. The contamination of soil can also affect agricultural productivity and food security. 4) Water Pollution: Uncontrolled release of toxic heavy metals and pollutants can contaminate nearby water sources, waterways, harming aquatic life and ecosystems affecting human consumption, agricultural use, and aquatic life. 5) Habitat destruction: air pollution can lead to acid rain, which can harm aquatic, ecosystems and destroy habitats. 6) Loss of biodiversity: water pollution can lead to the loss of aquatic species and ecosystems. 7) Air Pollution: Particulate matter and toxic gases from smelting activities can cause respiratory problems and other health issues in nearby communities. 8) Domestic Animals Respiratory problems: domestic animals experienced respiratory problems due to inhalation of toxic fumes. 9) Increased risk of disease: exposure to toxic substances can weaken the immune system of domestic animals, making them more susceptible to disease. 10) Veterinary costs: owners may incur additional veterinary costs to treat domestic animals affected by air pollution. The devastating consequences of smoke and toxic oxidation from smelting factories can be far-reaching and have long-term effects on human health, the environment, and the economy. It's essential to implement measures to reduce emissions, protect the environment, and ensure the health and safety of people and animals.

Table 7 Shows Specific Health Consequence on Concurrent Interaction with Gaseous Toxic from Smelting Plants; 2020-2025

S/N		**KS staff**	**ARMTI staff**	**ARMTI staff sch.**	**JIMBA traders**	**JIMBA farmers**	**JIMBA B. men**	**JIMBA H, wives**	**NCAM staff**
1	Carcinogenic	H	H	H	H	M	M	H	L
2	Skin Cancer	M	H	M	M	M	M	M	L
3	Breast Cancer	N	N	N	L	L	N	N	N
4	Lungs Cancer	L	L	L	L	L	N	N	N
5	Tumor Form.	L	L	L	M	L	L	L	L
6	Genetic Mutation	L	L	L	L	M	L	N	N
7	Respiratory P.	L	L	L	L	M	L	L	L
8	Skin Diseases	L	L	L	L	L	N	N	N
9	HPV	L	M	L	L	N	N	N	N
10	COPD	L	M	L	L	N	N	N	N
11	Asthma	L	M	L	L	N	L	L	N
12	Neurological Diseases	L	M	L	L	L	L	L	N
13	Dizziness	L	M	M	L	L	L	L	L
14	Tremors	L	L	L	N	L	N	N	L
15	Reproductive	L	M	M	N	L	L	N	N
16	Fertility	L	M	M	L	L	L	L	N
17	VOC		L	L	L	N	N	L	L

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18	Asphyxiation		L	L	L	N	L	L	L
19	Respiratory F		M	L	N	L	L	L	N
20	Hypoxia		L	L	N	L	L	N	N
21	Blockage of A		L	L	L	L	L	N	L
22	Suffocation		L	L	L	N	N	N	N
23	Cyanosis		L	L	N	L	L	N	N

Source; Field Work 2025

- *Key*

✓ H= Highest risk impacted on personal/community
✓ M= Medium risk impacted on personal/community
✓ L= Low risk impacted on personal/community
✓ N=Minimal risk impacted on personal/community

The Table 7 shows the intensity of hazard impacted among the community, the result of the research work indicated that, there are higher impact on nearest and more interactive community and their personnel, such as KAM Steel staff, than ARMTI Staff, ARMTI Staff School, JIMBA Business Men, Traders, Farmers, House Wives, and NCAM Staff. Consequently it implies that, those closer and constant interacting with the source of hazard is more Vulnerable to disaster.

In a related development Health Risks on human beings and other lives are greatly affected; EHSO 2024 and Meta AI 2024 provide thus; Exposure to heavy metal's smoke and particulate matter from smelting activities causes respiratory problems, skin diseases, and cancer. Children and adults living near smelting sites are at higher risk of non-carcinogenic and carcinogenic health effects. Carcinogenic health effects refer to the potential of a substance or agent to cause cancer. Carcinogens are substances or agents that can lead to the development of cancer, either by damaging DNA or disrupting cellular processes, examples of Carcinogenic Health Effects include: Cancer: Carcinogens can cause various types of cancer, including lung, skin, breast, and colon cancer. Tumor Formation: Carcinogens can lead to the formation of tumors, which can be benign or malignant. Genetic Mutations: Carcinogens can cause genetic mutations, which can increase the risk of cancer development. Medecine.net 2024 some common examples of Carcinogens are: Chemicals: Benzene, formaldehyde, and asbestos are known carcinogens. Radiation: Ionizing radiation, such as X-rays and gamma rays, can cause cancer. Viruses: Certain viruses, such as human papillomavirus (HPV), can cause cancer

Non-carcinogenic health effects refer to adverse health effects that are not related to cancer. These effects can occur due to exposure to various substances or agents and can affect different organs and systems in the body .examples of Non-Carcinogenic Health Effects: include Respiratory Problems: Exposure to certain substances can cause respiratory problems, such as asthma or Chronic Obstructive Pulmonary Disease (COPD). Added to this above, is Neurological Effects: Since exposure to certain substances have caused neurological effects, such as headaches, dizziness, or tremors. Relatively is the Reproductive Effects: Exposure to certain poisonous substances affect reproductive health, including fertility and fetal development. Medecine.net & Meta AI 2024

In a seemingly consequential analysis Cardiovascular Effects due to exposure to certain emitted pollutant discharged substances increase the risk of cardiovascular disease. Some common examples of Non-Carcinogenic Substances: include Particulate Matter whose exposure causes respiratory problems and cardiovascular disease. Volatile Organic Compounds (VOCs): whose exposure causes respiratory problems, headaches, and other health defects? Heavy Metals exposure such as lead and mercury causes neurological and developmental effects. (OHSA 2024 et al)

Air Pollution: Smelting industries release particulate matter, sulfur dioxide, nitrogen dioxide, and carbon monoxide, contributing to air pollution and negatively impacting human health and the environment. The toxic substances inhaled gradually accumulate in the respiratory system causing blockage and difficulties in breathing resulting to….

Asphyxiation, Respiratory failure, Hypoxia e.g. reduction of oxygen supply to the body tissues leading to organ damage and failure a condition where the body, or a part of the body, is deprived of oxygen. Which occur due to various reasons, such as:

- Blockage of the airway: Obstruction of the trachea or bronchi, preventing air from reaching the lungs.
- Inhalation of toxic gases: Breathing in gases that displace oxygen or interfere with oxygen utilization
- Suffocation: Lack of oxygen due to compression of the chest or obstruction of the nose and mouth.
- Drowning: Aspiration of water, leading to asphyxiation. This has the Symptoms to include

✓ Shortness of breath
✓ Difficulty breathing
✓ Confusion
✓ Loss of consciousness

- Cyanosis (blue discoloration of the skin) Victims of asphyxiation, it's crucial to: 1. Call for emergency help 2. Remove the cause of asphyxiation (if possible) 3. Provide rescue breathing or CPR (if trained for (Cardiovascular Protection & Restoration) Prompt medical attention is essential to prevent long-term damage or even death. (OHSA 2024 et al) (Medecine.net & Meta AI 2024)

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Cardiovascular diseases (CVDs) refer to conditions that affect the heart and blood vessels, including cardiovascular problems e.g. straining the heart and blood vessel resulting in heart failure, Stroke, Hypertension (High Blood Pressure) elevated blood pressure that may lead to stroke, heart diseases and kidney damage & failure. (Meta AI 2025) (Medicine.net 2025)

Highlights on these diseases include 1. Coronary Artery Disease (CAD): Narrowing or blockage of coronary arteries, reducing blood flow to the heart.2. Heart Failure: The heart's inability to pump enough blood to meet the body's needs.3. Stroke: Interruption of blood flow to the brain, causing damage to brain tissue & body organ 4. Hypertension (High Blood Pressure): Elevated blood pressure that can lead to heart disease, stroke, and kidney damage.5. Peripheral Artery Disease (PAD): Narrowing or blockage of blood vessels in the legs, arms, or other areas. (Meta AI 2025) (Medicine.net 2025)

CVDs are often caused by a combination of factors, including 1. High Blood Pressure 2.High Cholesterol 3.Smoking 4.Diabetes 5.Obesity6. Physical Inactivity 7.Family History (Meta AI 2025) (Medecine.net 2025)

The common symptoms may include:1. Chest pain or discomfort 2.Shortness of breath 3.Fatigue 4.Swelling in legs or ankles 5.Dizziness or lightheadedness .Prevention and management strategies include ensuring the application and administration of OSHA in work places and also; 1.Healthy Diet 2.Regular Exercise 3.Stress Management 4, Monitoring and Managing Blood Pressure and Cholesterol 5. Quitting Smoking and smoke areas early detection and treatment can help manage CVDs and reduce complications. Chronic Respiratory Diseases e.g. Chronic Obstructive Pulmonary Disease (COPD) Hypertension (High Blood Pressure) elevated blood pressure can lead to stroke, heart diseases and kidney damage & failure. (Meta AI 2025) (Medecine.net 2025)

Table 8 Shows Other Health Consequence on Interaction with Gaseous Toxic from Smelting Plants on a Monthly Basis;

Hazard Risk 2023													
Hazards	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Remark**
Blockage of the airway	X	X	X	X	X	X	X	X	x	X	X	X	12
Conc. Of the toxic gas													N
Suffocation													N
Drowning													?
Shortage of breath			X	X	X	X	X	X	x	X			8
Confusion													?
Loss of consciousness													?
Cyanosis													N
Carcinogenic health problem				X	X	X	X	X	x	X			7
Skin Cancer													N
Lungs cancer													N
Breast Cancer													N
Colon cancer													N
Tumor formation													N
Genetic mutation													N
TOTAL													27

Source; Field Work 2023

- *Key*

✓ X =Monthly distribution of Hazard
✓ N=Minimal distribution of Hazard
✓ ?= No information about Hazard type

The Table 8 shows monthly spread of hazard impacted along the community, The result of the research work indicated that, there are higher impact on KAM Steel staff, than ARMTI Staff, ARMTI Staff School, JIMBA Business Men, Traders, Farmers, House Wives, And NCAM Staff. Consequently it implies that, those closer and are constant interacting with the source of hazards are more Vulnerable to disaster.

Table 9 Show Seasonal Calendars Showing Monthly Distribution of Hazard Impacting on the Community

Hazard Risk 2024													
Hazards	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Remark**
Air pollution	X	X	X	X	X	X	X	X	X	X	X	X	12
Water contamination			X	X	X	X	X	X	X				7
Soil degradation	X	X	X							X	X	X	6
Resource depletion	*	*	*	*	*	*	*	*	*	*	*	*	N
COPD			X			X							2
Cancer	*	*	*	*	*	*	*	*	*	*	*	*	N

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Neurological		X							X				2
Cardiovascular													?
Non cardiovascular	X	X	X	X	X	X	X	X	X	X	X	X	12
Carcinogenic health problem	X	X	X	X	X	X	X	X	X	X	X	X	12
Genetic mutation													N
Tumor													N
Breast Cancer													N
Colon cancer													N
Total													53

Source; Field Work 2024

- *Key*

✓ X =Monthly distribution of Hazard
✓ N=Minimal distribution of Hazard
✓ *= No information about Hazard type

The Table 9 shows the monthly distribution of hazard impacted along the community, the result of the research work indicated that, there are higher impact of Air pollution, Carcinogenic and non-Carcinogenic diseases among KAM Steel staff, than ARMTI Staff, ARMTI Staff School, JIMBA Business Men, Traders, Farmers, House Wives, And NCAM Staff. In a related development Health Risks on human beings and other lives are greatly affected; EHSO 2024 and Meta AI 2024

The table shows exposure to heavy metal's smoke and particulate matter from smelting activities causes respiratory problems from Air pollution throughout the year (12months) water, soil contamination and resource depletion are very common and count 7, 6 and null months respectively. Leading to skin diseases, Children and adults living near smelting sites are at higher risk of non-carcinogenic and carcinogenic health problems. Carcinogenic health effects refer to the potential of a substance or agent to cause cancer. Carcinogens are substances or agents that can lead to the development of cancer, either by damaging DNA or disrupting cellular processes, examples of Carcinogenic diseases are virus that cause various types of cancer, including lung, skin, breast, and colon cancer. Non-carcinogenic health effects refer to adverse health effects that are not related to cancer. From the table these effects can occur due to exposure to various substances or agents and can affect different organs and systems in the body .examples of Non-Carcinogenic Health Effects: include Respiratory Problems: Exposure to certain substances can cause respiratory problems, such as asthma or Chronic Obstructive Pulmonary Disease (COPD) which was recorded in 2 months. Added to this above, is Neurological Effects 2 months. In a seemingly consequential analysis cardiovascular problems were not registered. Effects due to exposure to certain emitted pollutant discharged substances increase the risk of cardiovascular disease. Some common examples of Non-Carcinogenic diseases were registered in 12months i.e. throughout the year and same with Carcinogenic 12months and Tumor Formation was not visible, Breast Cancer Nil, Colon Cancer Nil. From the table carcinogens can lead to the formation of tumors, which can be benign or malignant and so Genetic Mutations, and could cause neurological effects such as headaches, dizziness, or tremors. Relatively is the Reproductive health, including fertility and fetal development.

Smelting industries release particulate matter, sulfur dioxide, nitrogen dioxide, and carbon monoxide, contributing to air pollution and negatively impacting human health and the environment. The toxic substances inhaled gradually accumulate in the respiratory system causing blockage and difficulties in breathing resulting to Asphyxiation, Respiratory failure, Hypoxia e.g. reduction of oxygen supply to the body tissues leading to organ damage and failure.

Table 10 Of Seasonal Calendars Showing Monthly Distribution of Hazard Impacting on the Community

Hazard Risk 2025													
Hazards of pollution	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Remark**
Staff	X	X	X	X	X	X	X	x	X	X	X	x	12
School Children	X	X	X	X	X	X	X	x	X	X	X	x	12
Adults Supplier	X	X	X	X	X	X	X	x	X	X			10
Commercial Activities	X	X	X	X	X	X	X	x	X	X			10
Eateries	x	X	X	X	X	X	X	x	X	X	X		11
Water body	x	X	X	X	X	X	X	x	X	X	X	x	12
Aquarium Life	x	X	X	X	X	X	X	x	X	X	X		12
Crops				X	X	X	X	x	X				7
Domestic Animals	x	X	X	X	X	X	X	x	X	X	X	x	12
Storages	x	X	X	X	X				X	X	X		8
Human Brain	x	X	X	X	X	X	X	x	X	X	X	x	12
Toxic accumulation	x	X	X	X	X	X	X	x	X	X	X		11
Neurological damage	x	X	X	X					X	X	X		7
Neurodegenerative	X	X	X						X	X	X		6
Total													152

Source; Field Work 2025

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- *Key*

✓ X =Monthly distribution of Hazard
✓ N=Minimal distribution of Hazard
✓ ?= No information about Hazard type

The table 9 Shows Monthly Distribution of Hazard Impacting on the Host and neighboring Communities with the outline of personals involved. 1, staff, 2,school children, 3,Adault, 4, Commercial activities, 5, Eateries, 6, water body 7.aquarium live, 8,Crops, 9, Domestic animals, 10, storages, 11, Human's brain, functioning and severe deposits of toxic. 12, Toxic accumulation in tissues 13, Neurological damage 14, Neurodegenerative

The Staff of ARMTI, KAM STEEL AND NCAM are vulnerable to Respiratory problems: due to 12months inhalation of toxic fumes and particles which could cause asthma and lung damage prolonged exposure to toxic substances can lead to long-term health problems, including cancer and neurological damage. Consequently the School Children also are exposed for 12months, children's developing lungs are more vulnerable to damage from air pollution, increasing the risk of respiratory problems cognitive impairment and could affect cognitive development and academic performance.

The results also indicate Adults exposed for barely 10months and may experience respiratory issues, such as bronchitis and emphysema, due to prolonged exposure to toxic fumes. Increased risk of chronic diseases: such as cancer and cardiovascular disease.

In a related development this survey results indicate Commercial Activities are affected for 10months causing Economic losses damage infrastructure, reduce property values, and impact local businesses reduced productivity increased absenteeism among workers. So also the Eateries are affected for 11months toxic substances can contaminate food and water, posing a risk to human health losses of business deters customers and damage the reputation of eateries.

It was also revealed that water body exposed throughout the 12months causing water pollution, toxic substances can contaminate waterways, harming aquatic life and ecosystems. So also the Aquarium Life being exposed for complete 12months Causing Habitat destruction harming aquatic ecosystems and destroy habitats.

In the case of Crops the result indicate it being affected for7months during planting till storage Reduced crop yields, damage crops, reducing yields and impacting food security. Due 8months Damage to stored goods such as food and other products causing contamination risk, toxic substances can contaminate stored goods, posing a risk to human health. toxic substances can contaminate soil, affecting soil quality and fertility.

It is imperative to mention that results indicate Domestic Animals being affected for 12months causing respiratory problems due to inhalation of toxic fumes increased risk of disease: exposure to toxic substances weaken the immune system of domestic animals, making them more susceptible to disease. In the case of Human Brain Functioning and Severe Deposits of Toxic Substances the results of the survey indicates 12months of continues infection, relatively causing neurological damage, including cognitive impairment and neurodegenerative diseases.5-7months or prolonged exposure to toxic substances can lead to accumulation in the body, causing long-term health problems. Increasing the risk of neurodegenerative diseases, such as Alzheimer's and Parkinson's.

The effects of smoke and toxic oxidation from smelting factories can be devastating and far-reaching. It's essential to implement measures to reduce emissions, protect the environment, and ensure the health and safety of people and animals.

V. SUMMARY, CONCLUSION AND RECOMMENDATIONS

The siting of a smelting industry in a community poses significant economic benefits but also stance environmental, health, and socio-economic risks. To mitigate these risks, it is essential to implement environmental regulations, adopt cleaner technologies, provide health protection measures, and engage with local communities. By taking these steps, we can minimize the negative impacts of smelting activities and promote sustainable development.

➢ *Recommendations*

- Conduct Environmental Impact Assessments: Conduct thorough environmental impact assessments to identify potential risks and develop strategies to mitigate them.
- Develop Emergency Response Plans: Develop emergency response plans to address accidental releases of toxic pollutants.
- Provide Compensation and Support: Provide compensation and support to communities affected by smelting activities.
- Promote Sustainable Development Plan: Promote sustainable development practices that balance economic growth with environmental protection and social responsibility. By implementing these recommendations, we can reduce the risks associated with smelting activities and promote a healthier, more sustainable environment for local communities.
- Use Cleaner Technologies and Implement Environmental Regulations: Adopt cleaner production technologies to reduce emissions and waste generation. Enforce strict environmental regulations and monitoring to minimize pollution.
- Provide Health Protection: Offer health protection measures, such as personal protective equipment and medical check-ups, to workers and nearby residents.
- Introduce Community Engagement: Engage with local communities to raise awareness about the risks

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associated with smelting activities and involve them in decision-making processes.

- Measures To Mitigate The Effects Of Air Pollution From Smelting Factories Include:

Implementing emission controls, installing scrubbers, electrostatic precipitators, or other emission control technologies to reduce toxic emissions. Ensuring adequate ventilation in workplaces and homes to reduce exposure to toxic substances, providing personal protective equipment, such as masks and respirators, to workers and individuals exposed to toxic substances. Regularly monitoring air quality to identify areas of high pollution and implement measures to reduce emissions promoting sustainable practices, such as recycling and reducing waste, to minimize the environmental impact of smelting factories.

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