

Advances in 21st Century Human Settlements

Timothy Gbenga Nubi
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Basirat Oyalowo *Editors*

Housing and SDGs in Urban Africa

 Springer

Advances in 21st Century Human Settlements

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*For all those
who have strived through the years
for a greater Africa*

Foreword

For too long, African countries have been the poster child of spatial dysfunctionality, as poverty and slum proliferation rates, infrastructure deficiencies and a plethora of structural inefficiencies continue to define the region. Yet, African nations are in fact experiencing unprecedented rates of urbanisation and citizens are responding to existential challenges in a variety of ways, essentially recreating cities to serve their purposes.

In September 2000, leaders of over 150 countries—many of them African heads of state—signed the Millennium Declaration, thus affirming their commitment to attainment of sustainable development. By 2015, the eight Millennium Development Goals (MDGs) were expanded to 17 Sustainable Development Goals (SDGs), reflecting more global needs and, more specifically, concerns for environmental protection, social justice and economic development. The SDGs are the current development agenda designed to address the multiplicity of issues threatening global well-being.

The SDGs align directly with Africa's development priorities as articulated in Agenda 2063, dubbed 'The Africa We Want'. Therefore, it is imperative that African nations localise the goals, mainstream them into substantive policies and ensure they are implemented at subnational and local levels. This publication, coming at the outset of the 'UN Decade of Action' for the attainment of all 17 SDGs, is indeed timely.

The Centre for Housing and Sustainable Development at the University of Lagos, as the African Research Universities Alliance (ARUA) Centre of Excellence for Urbanisation and Habitable Cities, has consistently explored the concept of sustainability on various dimensions. Through research, advocacy and community engagement, the Centre actively works towards achieving the various targets and indicators of the SDGs.

In line with the Centre's objectives, therefore, this book focuses on the African built environment and housing sector, especially given the nexus between housing and all SDGs. Comprehensive in its outlook, this edited volume is an attempt to establish the nexus between a functional, equitable and accessible housing sector and national development. Using case studies from various African cities, it interrogates extant assumptions, challenges the status quo and provides evidence for strategic repositioning of city systems and processes. In addition, the authors have stressed

the fact that the development challenges of African cities are interconnected and so require systematic and holistic responses.

By interrogating old ideas and testing new ones empirically, this volume presents nuanced perspectives on the African housing sector as it relates to local, regional and international development. It is my fervent desire that the book will precipitate wide-ranging re-evaluation of the SDGs' progress in Africa, while also serving as a valued knowledge resource in the urgent quest for a socially just and environmentally friendly economic development model that citizens and governments can truly own.

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Professor Oluwatoyin Temitayo Ogundipe is Professor of Botany in the Department of Botany, Faculty of Science, University of Lagos, Nigeria. He holds a Ph.D. in Botany (Ife) and MBA (UNILAG). He has attended trainings at the University of Johannesburg, South Africa; University of Reading and University of Cambridge, both in the UK; Harvard University, USA; and Kunming Institute of Botany, China. His areas of research include molecular plant taxonomy/biosystematics, forensic botany, cytogenetics, ethnobotany, paleobotany and ecological conservation.

Since joining the University of Lagos in 1990, he has held different administrative positions. He was Head of Department of Botany, Sub-Dean of the Faculty of Science and Dean, School of Postgraduate Studies, where he attracted partnerships with industry resulting in vast improvements in infrastructure at the university. He was also Director of the Academic Planning Unit. In 2016, he was appointed the Deputy Vice Chancellor (Academics and Research).

Since his appointment as Vice Chancellor on 12 November 2017, the university has recorded a significant rise in demand-driven research and the university–industry relationship has been blooming. The university in fact patented 11 inventions within 18 months of his emergence as Vice Chancellor, with three of the patents being prototyped. His administration has been able to attract over 7 billion naira in research grants, including the grant for the African Research Network for Urbanisation and Habitable Cities, which is to provide a strategic platform for developing research capacities in African institutions in the drive towards achieving the Sustainable Development Goals. He has attracted funding for research through the Lagos State Science Research and Innovation Council (LASRIC). The LASRIC fund is aimed at making Lagos the hub of innovation and technology in the country, with emphasis on the promotion of Science, Technology, Engineering and Mathematics (STEM).

He instituted the Prof. Ogundipe Innovation Challenge (POIC), which, with cash rewards, aims to motivate young academics

to undertake research and innovation projects. He has also been working assiduously to promote entrepreneurship among students of the university. Moreover, he has identified staff homeownership as one of the priorities of his administration. In this regard, the university is collaborating with Family Homes Fund, an initiative of the Federal Government of Nigeria, to provide homes for staff from grade level 9 and below. Under his leadership, the University of Lagos TV station has debuted with news and entertainment coverage across West Africa.

He has over 90 publications in accredited academic journals in addition to co-authoring eight books. Two of his research collaborations are undergoing patenting.

Preface

Several agreements and policies have been signed at the international and regional levels to address the housing and urban development challenges facing Africa. Not surprisingly, even though these agendas are unique in their own rights with set goals and targets, they converge at the urbanisation nexus. This is because it is recognised that cities are supposed to advance economic, social and environmental development and present the laboratory for tackling most challenges confronting humanity today. Accordingly, in most of these agreements, the need to guide the growth and development of African cities has been paramount. From the Sustainable Development Goals (SDGs) and its precursor Millennium Development Goals (MDGs) to Agenda 2063 of the African Union and the Addis Ababa Action Agenda on Financing for Development, there has been a common attempt to set up policy frameworks for resolving the challenges facing Africa today. As we enter the last decade towards Agenda 2030 and given the challenges still dogging African cities, it has become imperative to empirically determine how far the continent's priorities align with global goals, as well as to undertake grounded interrogation of the linkages between these goals and policymaking in Africa.

The motivation for embarking on this book project came during a special strategic session of the management team of the University of Lagos Centre for Housing and Sustainable Development. As the African Research Universities Alliances (ARUA) Centre of Excellence for Urbanisation and Habitable Cities, with a strategic focus on African development, the Centre deemed it necessary to articulate, from a mainly African perspective, the linkages between the African housing sector and the global goals in housing. This thinking was due, first, to the centrality of housing as a dynamic and complex sector of any economy and, second, to the need to recognise the inherent linkages between various facets of housing and the socio-economic and environmental well-being of households, communities and even nations. We therefore decided to midwife a pan-African edited volume that would offer a platform for documenting often under-represented African scholarship on this all-important global discourse.

We invited chapter proposals exploring the interconnections, interactions and linkages between the SDGs and housing through original research, practice experience, case studies, desk-based research and other knowledge media. Expectedly,

we received contributions from academics, practitioners, policy actors and activists from within and outside Africa. The chapters address housing and SDGs linkages in African cities/countries and offer best practices, policy transfer and knowledge sharing for stakeholders in Africa.

While integrated and multidisciplinary approaches were strongly encouraged, authors were urged to present ideas in a systematic manner that is accessible to a general audience. Authors were also encouraged to support the capacity development drive of the Centre for Housing and Sustainable Development by collaborating with co-authors across institutional, gender and generational backgrounds. All submitted proposals underwent a double-blind peer review process. Selected proposals were then developed into full papers and subjected to double-blind peer review, resulting in the chapters that are included in this volume.

We therefore thank all the 24 contributors for sharing their research and perspectives with us. Authors come from a wide range of backgrounds: architecture, African studies, building, construction economics, development studies, ecotoxicology and conservation, ecosystem analysis (ESA), environmental management, housing studies, human resource management, real estate, as well as urban and regional planning, among others.

We also want to appreciate Prof. Bharat Dahiya, the 'Advances in 21st Century Human Settlements Series' editor, who has been quite enthusiastic and supportive of this book. We equally thank the team in Springer Nature, especially series publishing editor Loyola D'Silva and production editor Sanjeevkumar Mathiyazhagan, who both worked closely with us during the production process.

Our intention has been to show, via multidisciplinary research, the importance of housing to national development, urban management and attainment of the SDGs. We are convinced that the African housing challenge is best approached by engendering a reorientation of urbanisation in African cities along the lines of sustainability. In pursuit of this, we have embarked on the book project to present new ideas and to subject deep assumptions to reality checks in the context of African cities in a way that would be relevant for users in the academic, policy, development and civil society spaces.

Indeed, we hope that the book will promote broader understanding of the African urban reality and provoke deeper discourse on the diverse approaches to achieving sustainable development in Africa.

Lagos, Nigeria
Stirling, UK
Lagos, Nigeria
Lagos, Nigeria

Timothy Gbenga Nubi
Isobel Anderson
Taibat Lawanson
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About the Editors



Professor Timothy Gbenga Nubi leads the Centre for Housing and Sustainable Development at the University of Lagos. He has been Member of the Technical Board of Nigeria’s Federal Housing Authority (FHA). He also played a major role in the formation and development of Real Estate Development Association of Nigeria (REDAN), where he served as Executive Member (South-west Coordinator) and is currently, Member of the Board of Trustees. He has also served on the Advisory Council of Habitat for Humanity, Nigeria, and as well as that of First World Communities Ltd.

Between 2015 and 2017, he was Dean of the Faculty of Environmental Science, University of Lagos, as well as Chairman of the University’s Housing Unit. He was Founding Director, University of Lagos Centre for Housing and Sustainable Development. The Centre, which was established with a grant from the African Development Bank, conducts research and delivers capacity-building courses and academic programmes in the field of housing and real estate development and management. Under his leadership, the Centre won the rights to host a Centre of Excellence in Urbanisation and Habitable Cities in Africa under the auspices of the African Research Universities Alliance (ARUA) and the UK Research and Innovation’s (UKRI) Global Challenge Research Fund. He has a wealth of experience in engaging with government, communities, NGOs and private-sector organisations both locally and internationally and has over 60 publications. He is currently leading

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Professor Isobel Anderson is Chair in Housing Studies in the Faculty of Social Sciences at the University of Stirling, UK, where she has worked since 1994. Having held a range of leadership roles, she currently leads the Home, Housing and Community Research Programme. She is Chief Examiner for the M.Sc./Diploma in Housing Studies and chairs the University's Academic Panel for Postgraduate Research Students.

Her main research and Ph.D. supervision interests are in homelessness and access to housing, sustainable housing and communities, inequality and social exclusion, housing and health/well-being, participation and empowerment, international comparative housing studies and the use of evidence for policy and practice. She has held more than 40 research awards from research councils, charities and government bodies and has published widely for scholarly as well as practice audiences. She was previously UK researcher for the European Observatory on Homelessness (convened by FEANTSA, the EU association of national homelessness agencies) and remains on the international advisory committee of *The European Journal of Homelessness*.

She has been active in the European Network for Housing Research (ENHR) throughout her career. She founded the Working Group on Welfare Policy, Homelessness and Social Exclusion (WELPHASE), jointly coordinating it from 2004 to 2013. Since 2015, she has been joint coordinator of the working group on Housing in Developing Countries. She has collaborated with colleagues in Cuba, South Africa and Turkey, in addition to being privileged to be a UK partner of the Centre for Housing and Sustainable Development at the University of Lagos, Nigeria.



Dr. Taibat Lawson is Associate Professor of Urban Planning at the University of Lagos, Nigeria, where she leads the Pro-Poor Development Research Cluster and serves as Co-Director at the Centre for Housing and Sustainable Development. She holds a Ph.D. in Urban and Regional Planning from the Federal University of Technology, Akure, Nigeria.

Her research work is in the broad areas of urban informality, pro-poor development, governance and environmental justice. She is particularly interested in how formal and informal urban systems synthesise in emerging African contexts, especially Lagos. She has authored over 60 scholarly articles and received research funding from DFID, British Academy, UKRI, Africa Multiple of the University of Bayreuth and Cambridge-Africa ALBORADA Research Fund among others. She is published in leading urban study journals including *Habitat International* and *Area Development and Policy*. She is on the editorial board of *Urban Forum* and serves as International Corresponding Editor of *Urban Studies*. She is also Member of the international advisory board of UNHABITAT’s flagship ‘State of the World Cities’.

She is Member of the International Society of City and Regional Planners, a proud alumnus of the Rockefeller Foundation Bellagio Centre and a pioneer World Social Science Fellow of the International (Social) Science Council.



Basirat Oyalowo researches into contemporary issues in housing studies, informality and urban sustainability, with an interest in decolonisation, comparative African studies and mixed methods research. She lectures in the Department of Estate Management at the University of Lagos, where she obtained her Ph.D. with a thesis on the co-operative societies and housing supply in Lagos. Earlier, she had earned her master’s degree in Housing Policy and Management from the University of Northumbria at Newcastle, where she graduated in 2006 as the Best Full-Time Student in Housing Programme in the North-East, awarded by the Chartered Institute of Housing, North-East Branch, UK. She is also on the management team of the University of Lagos Centre for Housing and Sustainable Development, where she drives the Centre’s grants response, research, capacity-building and postgraduate

programmes, as well as housing advocacy activities. In the last decade, she contributed chapters on housing and human capital development to the 25-year Regional Development Plan of the Ogun State Government of Nigeria, aspects of which she was actively engaged in implementing, as an academic where she has linked research with teaching and practice. She was Lead Facilitator, Informality Discovery Working Group, and later Member of the Strategy Writing Group for the preparation of the Lagos Resilience Strategy. Individually and as part of a team, she has won capacity-building grants under the ESRC and AHRC of the UK Research and Innovation Global Challenge Research Fund (UKRI GCRF). She is a registered Estate Surveyor and Valuer.

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Adverse Impact of Human Activities on Aquatic Ecosystems: Investigating the Environmental Sustainability Perception of Stakeholders in Lagos and Ogun States, Nigeria



Temitope Olawunmi Sogbanmu, Opeyemi Anne Ogunkoya, Esther Iyanuoluwa Olaniran, Adedoyin Kehinde Lasisi, and Thomas-Benjamin Seiler

Abstract Environmental risk perception of stakeholders for various human activities is germane to the sustainable development of a society. In urban Africa, rising population rates pose environmental challenges for the management of aquatic resources. Examples of two metropolitan cities in urban Africa are Lagos and Ogun states, Nigeria, with their teeming populations. The proximity of the Lagos lagoon and Ogun River to human settlements predisposes their use as sinks for disposal of wastewaters from potentially polluting activities such as sawmills and livestock processing (abattoirs). This chapter evaluates the environmental risk perception of specific stakeholders in the states whose activities result in potential adverse impact on aquatic ecosystems and associated ecosystem services. Copies of a structured questionnaire were administered to stakeholders at selected anthropogenic sites, i.e. Okobaba Sawmills and Kara Cow Market, in Lagos and Ogun states respectively. At the Okobaba sawmills adjoining the Lagos lagoon, respondents stated that sawdust is the major (84%) waste generated, most (90%) of which is burnt. Over half (51–90%) of the respondents noted that air quality, water quality and aquatic animals are adversely impacted by the sawmill activities. At Kara Cow Market, which adjoins Ogun River, respondents reported that they utilise the river for domestic activities, such as source of drinking water and for washing of cows. Most respondents (70–82%) acknowledged that the river is polluted, wastes are deliberately disposed into the river and wastewater from the abattoir is never treated. It is suggested

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that stakeholder environmental education, advocacy, risk communication, as well as demand for, and implementation of, evidence-based policies for the management of these ecosystems are crucial steps to be taken in addressing the situation. Further, the planning of human settlements near aquatic ecosystems should be considered alongside the sustainability of aquatic resources and ecosystem services in urban Africa, given the need to support life below water (UN SDG 14).

Keywords Aquatic ecosystems · Sawmill wastes · Abattoir wastewater · Stakeholders' environmental risk perception · Sustainable Development Goal 14

1 Introduction

Environmental, social and economic capacity is a key component of sustainable development. While industrialisation plays a critical role in strengthening economic capacity, it also propels urbanisation and improves urban settlements [12, 37]. Since the 1900s, during the upsurge of the Industrial Revolution and mass production to satisfy the demands of the teeming population globally, there has been a decline in the integrity of ecosystem, thus resulting in environmental crisis [33]. This environmental crisis is the consequence of deliberate human activities as well as of unintentional exposure to pollutants from anthropogenic activities [33]. In most African countries, inappropriate management of industrial practices is one of the contributing factors to the pollution of the aquatic environment, leading to an increase in environmental challenges such as the prevalence of waterborne diseases in human settlements [44].

Huge volumes of waste generated by various anthropogenic activities such as industrial, pharmaceutical, agricultural, domestic and municipal activities are being disposed into the immediate environment, including coastal lagoons and rivers [14, 40, 49]. The relative proximity of these aquatic ecosystems to human settlements has often resulted in adverse impacts on ecosystem services, thereby rendering them unbecoming, unsafe and unsuitable for primary and/or secondary usage [24]. The discharge of untreated wastewater into water bodies leads to further severe consequences on ecosystems owing to the inherent pollutants in them [18].

No doubt, the improper management of waste and wastewater from anthropogenic activities such as livestock processing in developing African countries contributes to the environmental pollution of cities and communities [12]. This pollution leads to the availability of surplus nutrients in surface waters, thus causing eutrophication and accumulation of enteric pathogens [25]. The poor state of public infrastructures and the unhygienic conditions of these processing activities therefore require appropriate public health interventions by regulatory agencies [9, 16]. Another anthropogenic activity is sawmilling, which provides processed wood and wood products for housing demands and for other industrial activities [41]. These sawmill activities result in the production of large quantities of wood wastes, which are often burnt or deposited near surface waters such as the Lagos lagoon (Fig. 1). This has potential adverse effects on the ambient air quality of human settlements around the area



Fig. 1 Okobaba area near the Lagos lagoon, Nigeria showing the nature of anthropogenic activity (photo credit Temitope O. Sogbanmu, December 2017)

[20]. Relatedly, biomass burning from formal and particularly informal settlements around this area potentiate the risk to human health. Furthermore, the dumping of wastewater and solid wastes from human settlements within and around such anthropogenic activities potentially increases the ecological and human health risks [20]. Examples include the dumping or disposal of human excreta into the Lagos lagoon, as well as the poor sanitary facilities in the slum settlements at the Makoko end of the Lagos lagoon, which are close to the sawmills. The dysfunctional—even sometimes absent—sewerage systems in most settlements, especially the informal settlements or slums, further worsens public health risks [12]. The detection of pharmaceuticals and personal care products in surface water and sediments of the Lagos lagoon [3] and Ogun River [39, 40] could be linked to the existence of human settlements near these aquatic ecosystems, as well as to the anthropogenic activities around them. In order to sustainably manage coastal ecosystem resources, particularly in the face of current global climate change, there is a need to involve stakeholders in such management programmes [51]. Implementing wastewater management programmes and adopting sustainable urban planning systems to improve the environmental condition of urban settlements located around water bodies are more effective solutions to making cities sustainable, safe and affordable [46], based on SDG 11 (sustainable cities and communities). The stakeholders include coastal aboriginal communities who consume an average of 15 times more seafood per capita than non-aboriginal people [11, 22]. However, the level of stakeholder awareness about the environmental and human health risks of their direct or indirect potentially polluting activities on coastal ecosystems is very low, particularly in developing nations [47]. In Nigeria, there is limited information on the level of awareness of Okobaba community stakeholders

on the environmental and human health risks of their activities on the lagoon [27]. Further, the implications of these anthropogenic activities and consequent human and environmental health impacts on the design and management of urban settlements requires consideration for evidence-informed sustainable development interventions.

Consequently, this study aims to investigate stakeholders' risk perception of anthropogenic activities at Okobaba Sawmill and Kara Cow Market in Lagos and Ogun states respectively. The results will provide information on the nexus among the planning of urban settlements (SDG 11—sustainable cities and communities), anthropogenic activities impacting aquatic ecosystems and environmental sustainability (SDG 14—life below water) and SDG 15 (life on land), as well as the strategies for regulatory interventions in these areas.

2 Literature Review

Lagos epitomises the future challenges that African cities face but on a scale that amplifies the stresses and strains of urbanisation [12]. With an estimated population of 24 million [21], to which 3000 new migrants are added each day, Lagos represents both the promise of economic opportunity and the burden on the ecosystem services sustaining the urban ecology. Lagos is one of the three megacities in Africa, as confirmed in the United Nations World Urban Prospects Revision Report of 2014 [4]. The Okobaba slum in Lagos is one of the settlements bordering the Lagos lagoon and is located around in Ebute-Metta, Lagos, Nigeria. The lagoon has been the subject of various studies [13, 17, 48, 50] elucidating its state of pollution from anthropogenic releases. Small- to large-scale industries, residential houses and stormwater are diffuse sources of pollutants released into the lagoon. Examples of these diffuse sources include industrial effluent [7], domestic wastes and sewage [32], wood burning and associated atmospheric emissions, solid wastes [36], heated water discharges from thermal plants [38], and run-off from the over-lying Third Mainland Bridge [14], as well as toxic chemicals from boats and jetties.

At the Okobaba waterfront, a dominant and unique activity in the area is sawmilling, which has a direct impact on lagoon water quality as well as on aquatic animals and humans [26]. Typical wastes generated from sawmills include sawdust, woodchip, bark, planer shavings, pole shavings, solvents, paints, and wood coatings. These wastes are disposed directly into the lagoon [8]. Solid wastes such as high- and low-density polythene, empty cans of food/pesticide sprays, glass bottles, used needles and syringes (hospital wastes), used car tyres, worn clothes and a host of others have equally contributed to the high level of pollution found in the lagoon [7]. Wood preservation chemicals, for instance, may include polycyclic aromatic hydrocarbons (PAHs), pentachlorophenol pesticides, and compounds of chromium, copper and arsenic [29]. The effect of this is contaminated water mixing with the underground water that is the source of drinking water in the community, thus threatening the health of residents, especially the children. Air pollution in urban areas such as Okobaba, Lagos is indeed a major issue. Air quality has been continuously

degraded because of burning, which is the primary means of sawdust waste management in the area [1, 20]. Air pollutants associated with this burning include CO, NO_x, CO₂, SO₂, and H₂S, as well as volatile organic compounds (VOCs) [30].

A major challenge confronting environmental and public health authorities in developing countries like Nigeria is the continual pollution of surface water bodies by small- to large-scale livestock processing activities [35]. Abattoirs or slaughterhouses play a crucial role in livestock production, as they are established to receive and process livestock into consumable produce that is market-ready [34]. Typically, in Nigeria, most abattoirs are situated by riverbanks, where there is easy accessibility to water [34, 42]. Kara Cow Market, situated in Ojodu Berger, Ogun State, is one of many abattoirs in Nigeria; it is located along the Ogun River. It is a large processing facility that provides livestock produce to residents in Lagos and Ogun states, a fact that makes it not only important to the economy but also a major cause of environmental concern. As with other abattoirs such as the Bodija Abattoir in Ibadan, Oyo State, untreated wastewater laden with pollutants and solid wastes from abattoir or slaughterhouse activities are often discharged into surface waters such as Ogun River in Ogun State, Nigeria [2, 10, 44]. These wastewaters have been shown to have deleterious effects, including histological and biochemical alterations, in the tissues of *Clarias gariepinus* [40] and *Poecilia reticulata* [49]. The continuous discharge of abattoir wastewater into Ogun River has the potential to cause eutrophication and to put a burden on the health condition of the river's ecosystem, thus negatively affecting biodiversity in the area. Furthermore, contaminants such as heavy metals could leak into the waterbed that provides water supply to residential communities around the market [2, 40].

3 Methods

3.1 Study Areas

The Okobaba Sawmill is located in Ebute-Metta Local Council Development Area (LCDA) of Lagos State, Nigeria. The sawmill sources its wood from different locations in southwest Nigeria. The wood is transported by rafting through the Lagos Lagoon to the sawmill. Large quantities of sawdust are generated as waste products of the sawmill activities. The sawdust is consistently burnt (Fig. 1) to reduce the pile [20].

Kara Cow Market in Ogun State, Nigeria is located on the Ojodu/Isheri axis of Ogun River, at coordinates 6°38'48.0" N 3°22'46.5" E. Ogun River is an important river in the southwest of Nigeria that has its source close to Shaki in Oyo State, at coordinates 8°41" N 3°28" E. The river flows through Ogun State and discharges into the Ikorodu axis of the Lagos Lagoon at coordinates 6°38" N 3°22" E [40].

3.2 Questionnaire Administration to Stakeholders at Okobaba Sawmill (Lagos) and Kara Cow Market (Ogun)

A 5-point scale questionnaire was developed and administered. The questionnaire (Appendix 1) was developed to assess stakeholders' knowledge of the potential effects and risks of the sawmilling and cow market activities on their health and the aquatic environment [6, 52]. Aspects of the environment that were air quality, noise, land, water, lagoon ecosystem and waste disposal. The questionnaire was developed based on standards from both the British Medical Council questionnaire on occupational hazards and the Institute for Work and Health vulnerability questionnaire [5]. In the Okobaba community, 200 stakeholders received copies of the questionnaire, among whom were sawmillers, fishermen, residents, timber dealers, and traders.

The study population at Kara Cow Market, Ogun State consisted of herdsmen, butchers, fishermen, administrators, and traders. Fifty copies of the structured, pretested questionnaire (Appendix 2) were administered to respondents to obtain data on relevant socio-demographic variables of the stakeholders, the level of knowledge and awareness of pollution in their environment, as well as their practices and attitude towards their environment [19, 43]. The following formula [23, 53] was used to calculate the sample size:

$$\text{Sample size}(n) = \frac{Z^2 * (P) * (1 - P)}{C^2}$$

n = sample size

Z = Z statistic for a level of confidence

P = expected prevalence or proportion (in proportion of one; if 20%, P = 0.2)

C = precision (in proportion of one; if 5%, C = 0.05).

3.3 Data Analysis

The analysis of the response data from the questionnaire administration was carried out using MS Excel 2010, which data are presented in frequency distribution tables with percentages [15].

4 Results and Discussions

4.1 *Sociodemographics and Questionnaire Responses of Stakeholders at Okobaba Sawmills, Lagos, Nigeria*

The sociodemographics of the respondents showed a higher number of male respondents (62%) compared to females (38%). The age range with the highest number of respondents was between 36 and 45 years, with average age of respondents being 33 years (Table 1).

Responses to the questionnaire showed 56.5% of the respondents noted that sawdust contributes to wastes generated always, of which 82.5% is burnt and the run-off released into the lagoon. Other wastes include sewage (42%), wood chips (36%) and wood preservatives (26%). Ninety percent (90%) of respondents agree that air quality is the environmental component that is most affected by sawmilling activities. Moreover, 51 and 60% of the respondents noted that water and aquatic animals are always impacted by sawmill activities (Table 1).

Living conditions in urban slums and informal settlements such as Okobaba are particularly dire [37]. Limited access to education, good health care as well as water and sanitation results in endemic and high levels of poverty, inequality and deprivation [12]. In the case of Okobaba, where the predominant occupations of slum dwellers (timber dealing, fishing, saw milling) impact on the nearby lagoon, it is critical to consider the feedback from resident stakeholders on the sustainability of their practices. Responses from the questionnaire showed that sawdust contributes 84% of the waste, of which 90% (collated from % of respondents who ticked rarely to always) of the generated sawdust is burnt. Studies have shown that sawdust burning leads to the release of PAHs, which result in high particulate matter emission [31]. PAHs contained in charred sawdust also run off into the lagoon via winds and rainfall, thus exposing resident aquatic organisms to physiological changes as a result of this exposure [20]. Ninety percent (90%) of respondents perceived that air quality was the most impacted factor as a result of sawdust burning at the site. Consequently, the predominant health conditions often observed among residents were headaches (53%), fatigue (8%) and dermal conditions (7%).

4.2 *Sociodemographics and Questionnaires Responses of Stakeholders at Kara Cow Market, Ogun State, Nigeria*

The highest percentage of the respondents, i.e. 36%, fell within the age bracket of 30–45 years. Sixty percent (60%) of the respondents were males, 24% of whom were butchers and 18% of whom were herdsmen (Table 2). Sixty-two (62%) of the respondents temporarily reside in the market. The source of drinking water for 80% of the study group is sachet water while only 2% claim to drink water from the

Table 1 Sociodemographics and questionnaire responses of stakeholders at Okobaba Sawmills, Lagos, Nigeria

Variables		Number of respondents		Frequency (%)		
Gender	Male	124		62		
	Female	76		38		
Age range (in years)	15–25	44		22		
	26–35	56		28		
	36–45	64		32		
	46–55	24		12		
	56–65	5		2.5		
	66 and above	7		3.5		
Nature of business	Sawmilling	68		34		
	Fishing	18		9		
	Trader	36		18		
	Timber dealer	53		26.5		
	Civil servant	4		2		
	Others (student)	21		10.5		
Question group/description		% responses				
		Never	Rarely	Sometimes	Often	Always
Types of waste generated	Sewage	20	12	7.5	18.5	42
	Saw dust	16	8	12	7.5	56.5
	Wood chips	44	2.5	5.5	12	36
	Wood preservatives/chemicals	54	13	4	26	3
Sawmills waste disposal methods	Gutters	76	4	0	0	20
	Dump sites	48	0	32	20	0
	Lagos Waste Management Authority	44	8	20	17.5	10.5
	Cart pushers	56	17	12	8	7
	Burning	8	0	9.5	0	82.5
	Direct disposal into the lagoon	48	8.5	19.5	24	0
Predominant health issues for sawmillers	Headache	16	3	28	53	0
	Dizziness	56	36	7.5	0.5	0
	Fatigue	40	28	24	8	0
	Nausea/vomiting	52	40	8	0	0
	Abdominal pain	61	25.5	11	2.5	0
	Coughing with phlegm	75	20	5	0	0

(continued)

Table 1 (continued)

Question group/description		% responses				
		Never	Rarely	Sometimes	Often	Always
	Breathing difficulties	72	25.5	2.5	0	0
	Skin rashes	49	16	28	7	0
	Poor vision	95.5	1.5	0.5	2.5	0

n = 200 (number of administered questionnaires and received responses)

river. Thirty-four percent (34%) use water from the river for domestic purposes, including for washing the slaughter slabs and the slaughtered livestock. Although 56% of the respondents dispose their waste by discarding at dumpsites and utilising the services of contracted waste managers, 52% still prefer to always dump their waste directly into the river. Seventy-eight percent (78%) acknowledged that they deliberately dispose their animal waste into the river. The questionnaire survey also showed that 82% of the people present in the market acknowledged that the river is polluted (Table 2), while 68% acknowledge that the effluent is not treated. The breakdown for the 82% of respondents who acknowledged that the river is polluted is as follows: (38% = *the river is always polluted*, 18% = *it is usually polluted*, 20% = *it is occasionally polluted*, and 6% = *it is rarely polluted*).

The outcome of the study showed the poor sanitation behaviour of stakeholders in the market, as it was observed that, although a large number of the respondents (78%) acknowledged that the market is polluted, most of them deliberately dispose their waste into the river. These results support the conclusion of a study conducted in the Mekong Delta, Vietnam on perceptions of water sanitation and health, wherein it was found that people have a basic knowledge of proper hygiene and sanitation behaviour [28]. It was also observed that people in the market use the surface water for domestic activities such as general washing and cleaning, as well as for washing some of the animals after slaughter and as a source of drinking water for the animals. These practices reflect lack of understanding of the environmental and health consequences of waste management practices in the market or simply the lack of alternative options. Poor waste disposal practices in South Lunzu Township, an urban area in Malawi, have also been seen to have a negative impact on water quality, as copies of the questionnaire administered to residents reflect the adverse effects of the poor practices [45].

5 Conclusion

Findings from this study suggest that, although people are aware of the state of their immediate environment, they may not be much concerned about it because they may not understand the full implications of the environmental and human health risks of their activities. The adverse impact on aquatic resources is further exacerbated by the

Table 2 Sociodemographics and questionnaire responses of stakeholders at Kara Cow Market, Ogun State, Nigeria

Sociodemographics		Responses (%)			
Age (in years)	Under 15	4			
	16–29	30			
	30–45	36			
	>46	30			
Gender	Male	60			
	Female	40			
Occupation	Butcher	24			
	Fisherman	6			
	Trader	24			
	Cattle rearer	18			
	Others	28			
Residence in Kara	Yes	62			
	No	38			
Categories/responses	Never (%)	Rarely (%)	Sometimes (%)	Usually (%)	Always (%)
<i>Waste management</i>					
Frequency of animal wastes disposal into the river	32	4	8	2	54
Frequency of animal feed remains disposal into the river	42	10	22	4	22
Frequency of human faeces disposal into the river	36	6	16	22	20
Frequency of solid wastes (bones, plastics and nylons) disposal into the river	38	4	26	6	26
Frequency of treatment of wastes generated from the slaughter slabs	54	16	14	6	10
<i>Anthropogenic activities</i>					
Frequency of perception of offensive odour in the market	12	4	16	24	44
Frequency of water hyacinths appearance in the river	20	10	14	16	40

(continued)

Table 2 (continued)

Categories/responses	Never (%)	Rarely (%)	Sometimes (%)	Usually (%)	Always (%)
Frequency of animal disease outbreak in the market	40	26	24	6	4
Frequency of burning of animals at the slaughter slabs	18	8	24	28	22
Frequency of fish catch from the river	22	6	32	22	18
Frequency of administration of pharmaceuticals to animals in the market	10	2	16	20	52
Perception of pollution of the Ogun River	18	6	20	18	38
Waste management	Burning	Dumpsites	Cart pushers	Waste managers	Disposal into the river
Waste disposal methods	18%	56%	14%	56%	52%

N = 50

poor planning and citing of settlements such as 'urban slums' and sawmills at Makoko and Okobaba near the Lagos Lagoon as well as at Kara Cow Market near Ogun River. This is particularly worthy of consideration for the development of intervention and management strategies within the contexts of SDG 11 on ensuring sustainable cities and communities and SDG 14 on supporting the sustainability of life below water (aquatic organisms). The study demonstrates the roles of stakeholders such as sawmillers, market leaders, fishermen, livestock traders, local government officials and community residents in assuring the sustainability of aquatic ecosystems in urban Africa. Very crucial in the effort to reverse the situation are environmental education, advocacy and risk communication, as well as demand for, and implementation of, evidence-based policies for the management of these ecosystems. The achievement of sustainable development requires inclusive stakeholders engagement and effective management of resources.

6 Recommendations

It is therefore recommended to adopt targeted solid waste management approaches, especially by recycling sawmill wastes into economically useful products such as pellets, carbon sequestering biofuels, and wood blocks. Abattoir wastewater should be pre-treated before being discharged into Ogun River while the sludge and solid

wastes, especially livestock wastes, can be processed for the generation of biogas and manure. Further, there should be stakeholder education and involvement on the importance of sustainable use of the environment as well as targeted environmental interventions. Such efforts would fall within the framework of the UN SDGs 11 (resilient and sustainable cities and settlements), 14 (life below water) and 15 (life on land).

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Appendices

Appendix 1: Environmental Risk Assessment Questionnaire for Stakeholders at Okobaba Sawmills, Lagos

PUBLIC HEALTH RISK ASSESSMENT OF SAWMILLING ACTIVITY ON OKOBABA RESIDENTS

The purpose of this questionnaire is to assess stakeholders’ perception of the effects of sawmilling on the health and environment of Okobaba residents. This questionnaire serves as part of a research conducted by Ogunkoya, O.A and Sogbanmu, T.O of the Department of Zoology, University of Lagos, Akoka, Lagos, Nigeria.

Participation in this questionnaire is voluntary and you may withdraw at any time. Your responses will be treated as highly confidential and results of this study will be used for academic/ research purposes only.

Kindly tick boxes accordingly.

Demographic information

- i. Gender : Male Female
- ii. Age range 15– 25 26-35 36– 45 46- 55 56-65 66- Above
- iii. What is the nature of your business? Sawmilling Fishing Trader
 Timber dealer Civil servants Others (please specify) _____

Water sources

1. How often do you use drink water from the following sources?

	Never	Rarely	Sometimes	Often	Always
Tap water					
Sachet water					
Well water					
Rain water					
Lagoon water					

2. How often do you use domestic water (used for bathing, washing, cooking, cleaning e.t.c) from the following sources?

	Never	Rarely	Sometimes	Often	Always
Tap water					
Sachet water					
Well water					
Rain water					
Lagoon water					

3. How often do you treat your drinking water using the following methods?

	Never	Rarely	Sometimes	Often	Always
Filtration					
Boiling					
Coagulation (use of alum)					
Sedimentation(settling of particles at the bottom)					
Disinfection(e.g dettol)					
No treatment					

4. How often do you treat your domestic water (used for bathing, washing, cooking, cleaning e.t.c)?

	Never	Rarely	Sometimes	Often	Always
Filtration					
Boiling					
Coagulation (use of alum)					
Sedimentation(settling of particles at the bottom)					
Disinfection(e.g dettol)					
No treatment					

5. Are you satisfied with the quality of water you use (drinking/ domestic)?
 Very dissatisfied Satisfied Neutral Satisfied Very satisfied

Waste management

6. How often do you generate the following waste?

	Never	Rarely	Sometimes	Often	Always
Solid waste (paper,nylon,cans,plastics)					
Sewage(faecal and kitchen waste)					
Saw dust					
Wood chips					
Wood preservatives/ chemicals					

7. How often do you dispose **sewage** (faecal and kitchen waste) using the following methods?

	Never	Rarely	Sometimes	Often	Always
Gutters					
Water closet					
Pit latrine					
Dump sites					
LAWMA					
Cart pushers					
Burning					
Directly into the lagoon					

8. How often do you dispose **solid waste** (paper, nylon, can etc) using the following methods?

	Never	Rarely	Sometimes	Often	Always
Gutters					
Water closet					
Pit latrine					
Dump sites					
LAWMA					
Cart pushers					
Burning					
Directly into the lagoon					

9. How often do you dispose **saw millingwaste** using the following methods?

	Never	Rarely	Sometimes	Often	Always
Gutters					
Water closet					
Pit latrine					
Dump sites					
LAWMA					
Cart pushers					
Burning					
Directly into the lagoon					

10. How satisfied are you with your mode of waste disposal?

Very dissatisfied Satisfied Neutral Satisfied Very satisfied

Effect on health

11. How many times do you fall ill yearly Never Rarely Sometimes Often Always

12. How often do you engage in the following activities?

	Never	Rarely	Sometimes	Often	Always
Cigarette smoking					
Tobacco smoking					
Alcohol drinking					
Use of hard drugs					
Skin bleaching					
Use of candles					
Body exercise					

13. How often do you experience these symptoms:

	Never	Rarely	Sometimes	Often	Always
Headache					
Dizziness					
Fatigue					
Nausea/Vomiting					
Abdominal pain					
Diarrhea					
Coughing with phlegm					
Breathing difficulties					
Tremors and seizures					
Memory loss					
Stiff/Weak muscle					
Skin rashes					
Eye irritations					
Hearing difficulties					

14. How many people (including yourself) in your community do you have any of the following conditions?

	None	Few	Some	Many	Very many
Liver disease					
Kidney disease					
Nervous disorder					
Bronchitis					
Depression					
Dermatitis					
Diabetes					
High blood pressure					
Stroke					
Cancers					

15. How often do you visit a health center or hospital when you fall ill
 Never Rarely Sometimes Often Always

Effect of Anthropogenic activities

16. To what extent do you feel **sewage disposal** (faecal and kitchen waste) in your community affects the environment?

	Not much	Little	Somewhat	Much	Very much
Water					
Air					
Noise					
Land					
Aquatic animals					
Land animals					

17. To what extent do you feel **solid waste** (paper, nylon, cans, plastics etc)disposal in your community affects the environment?

	Not much	Little	Somewhat	Much	Very much
Water					
Air					
Noise					
Land					
Aquatic animals					
Land animals					

18. To what extent do you feel **saw milling** activities affect your environment?

	Not much	Little	Somewhat	Much	Very much
Water					
Air					
Noise					
Land					
Aquatic animals					
Land animals					

19. To what extent do you feel **burning** activities in your community affects the environment?

	Not much	Little	Somewhat	Much	Very much
Water					
Air					
Noise					
Land					
Aquatic animals					
Land animals					

20. How satisfied are you with the current state of the environment in Okobaba community?

Very satisfied Satisfied Neutral Unsatisfied Very unsatisfied

Appendix 2: Environmental Risk Assessment Questionnaire for Stakeholders at Kara Cow Market, Ogun State, Nigeria

QUESTIONNAIRE

Please answer the following questions by ticking the appropriate box.

1. Age: under 15yrs 16-29yrs 30-45yrs 46yrs and above
2. Gender: Male Female
3. Occupation: a. Butcher b. Fisherman c. Trader d. Cattle rearer Others
4. Do you reside in the Kara community? Yes / No
5. How often do you drink water from the following sources?

	Always	Usually	Sometimes	Rarely	Never
Tap water					
Well water					
Borehole water					
Sachet water					
Rain water					
River					

6. How often do you use the following sources for domestic purposes (bathing, washing, cooking, cleaning as so on)?

	Always	Usually	Sometimes	Rarely	Never
Tap water					
Well water					
Borehole water					
Rain water					
River					

7. How often do you treat your water source(s)?

	Always	Usually	Sometimes	Rarely	Never
Boiling					
Filtration					
Coagulation (use of alum)					
Disinfectant (Water Guard, Dettol etc.)					

8. How often are animals allowed to drink the water from the river?
 Always Usually Sometimes Rarely Never

9. Are you satisfied with the quality of water you use (drinking/ domestic)?
 Very satisfied Satisfied Indifferent Dissatisfied Very dissatisfied

10. How often do you use the following waste disposal methods?

	Always	Usually	Sometimes	Rarely	Never
PSP waste trucks					
Burning					
Dump site					
Cart pushers					
Direct disposal into the river					

11. How often do you dispose the following waste into the river?

	Always	Usually	Sometimes	Rarely	Never
Animal waste (blood, feces, entrails etc.)					
Animal feed remains					
Human wastes (feces)					
Solid waste (bones, plastics and nylons)					

12. How often do you treat the waste generated from the slaughter slabs?

Always Usually Sometimes Rarely Never

13. How satisfied are you with your method of waste disposal?

Very satisfied Satisfied Indifferent Dissatisfied Very dissatisfied

14. How often do you get sick in a year?

Always Usually Sometimes Rarely Never

15. How often do you have the following illnesses?

	Always	Usually	Sometimes	Rarely	Never
Cholera					
Typhoid					
Dysentery					
Skin rashes					
Breathing difficulties					

16. How many people (including yourself) in your community have any of the following conditions?

	Very many	Many	Some	Few	None
Cancer					
Stroke					
High blood pressure					
Bronchitis					
Liver disease					
Kidney disease					
Skin problems					
	Very many	Many	Some	Few	None
Nervous disorder					
Depression					

17. How often do you visit the health center or hospital for an illness?

Always Usually Sometimes Rarely Never

18. How often do you perceive an offensive odour in this community?

Always Usually Sometimes Rarely Never

19. How often do hyacinths appear in the river?

Always Usually Sometimes Rarely Never

20. How often are animals burnt at the slaughter slabs?

Always Usually Sometimes Rarely Never

21. How often do animal disease break out in the market?

Always Usually Sometimes Rarely Never

22. How often do animals receive medications in the market?

Always Usually Sometimes Rarely Never

23. How often do you catch fish in the river?

Always Usually Sometimes Rarely Never

24. Based on question 17, mention at least five (5) medications/drugs given to the animals.

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25. Based on question 18, mention at least five (5) fish and/or aquatic animals caught in the river.

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References

1. Adelagun ROA, Berezi EP, Akintunde OA (2012) Air pollution in a sawmill industry: the Okobaba (Ebute-Meta, Lagos) experience. *J Sustain Dev Environ Prot* 2(2):29–36
2. Adelegan JA (2002) Environmental policy and slaughterhouse waste in Nigeria. In: *Proceedings of the 28th WEDC conference, Kolkata (Calcutta) India, vol 1, pp 3–6*
3. Adeogun AO, Ibor OR, Chukwuka AV, Regoli F, Arukwe A (2019) The intersex phenomenon in *Sarotherodon melanotheron* from Lagos Lagoon (Nigeria): occurrence and severity in relation to contaminants burden in sediment. *Environ Pollut* 244:747–756
4. Adio-Moses D (2016) Smart city strategy and sustainable development goals for building construction framework in Lagos. In: *International conference on infrastructure development in Africa, Johannesburg, South Africa, pp 1–12*
5. Agbana BE, Joshua AO, Daikwo MA, Metiboba OL (2016) Knowledge of occupational hazards among sawmill workers in Kwara state, Nigeria. *Niger Postgrad Med J* 23:25–32
6. Agu AP, Umeokonkwo CD, Nnadu RC, Odusanya OO (2016) Health problems among sawmill workers in Abakaliki and workplace risk assessment. *J Commun Med Prim Health Care* 28:1–10
7. Ajao EA, Oyewo EO, Uyimad JP (1996) A review of the pollution of coastal waters in Nigeria. Nigerian Institute of Oceanography Technical Paper, no 107, 20 pp
8. Akhator P, Obanor A, Unege A (2017) Nigerian wood waste: a potential resource for economic development. *J Appl Sci Environ Manag* 21(2):246–251
9. Akinro AO, Ologunagba IB, Yahaya O (2009) Environmental implications of unhygienic operation of a city abattoir in Akure, Western Nigeria. *J Eng Appl Sci* 4(9):61–63
10. Alani R, Alo B, Ukoakonam F (2014) Preliminary investigation of the state of pollution of Ogun River at Kara Abattoir, near Berger, Lagos. *Int J Environ Sci Toxicol Res* 2(2):11–23
11. Alava JJ, Cheung WWL, Ross PS, Sumaila UR (2017) Climate change-contaminant interactions in marine food webs: towards a conceptual framework. *Glob Change Biol* 23:3984–4001
12. Aliyu AA, Amadu L (2017) Urbanization, cities and health: the challenges to Nigeria—a review. *Ann Afr Med* 16(4):149–158

13. Amaeze NH, Egonmwan RI, Jolaoso AF, Otitolaju AA (2012) Coastal environmental pollution and fish species diversity in Lagos Lagoon, Nigeria. *Int J Environ Prot* 2(11):8–16
14. Amaeze NH, Adeyemi RO, Adebessin AO (2015) Oxidative stress, heats shock protein and histopathological effects in the gills of African catfish, *Clarias gariepinus* induced by bridge runoffs. *Environ Monit Assess* 187(4):172
15. Awodele O, Popoola TD, Ogbudu BS, Akinyede A, Coker HAB, Akintonwa A (2014) Occupational hazards and safety measures amongst paint factory workers in Lagos, Nigeria. *Saf Health Work* 5:106–111
16. Ayoade F, Olayioye EO (2016) Microbiological assessment of housekeeping practices and environmental impact of selected abattoirs in Lagos and Ogun states of Nigeria. *J Appl Biosci* 99:9363–9372
17. Bawa-Allah KA, Saliu JK, Otitolaju AA (2018) Heavy metal pollution monitoring in vulnerable ecosystems: a case study of the Lagos Lagoon, Nigeria. *Bull Environ Contam Toxicol* 100(5):609–613
18. Bay S, Jones BH, Schiff K, Washburn L (2003) Water quality impacts of stormwater discharges to Santa Monica Bay. *Mar Environ Res* 56:205–223
19. Bradburn NM, Sudman S, Wansink B (2004) Asking questions: the definitive guide to questionnaire design. Wiley, New York
20. Buraimoh OM, Ilori MO, Amund OO, Michel FC Jr, Grewal SK (2015) Assessment of bacterial degradation of lignocellulosic residues (sawdust) in a tropical estuarine microcosm using improvised floating raft equipment. *Int Biodeterior Biodegrad* 104:186–193
21. Chikere C (2017) Nigeria's growing need for beach plastic audit. <https://www.thenigerianvoice.com/news/258031/nigerias-growing-need-for-beach-plastic-audit.html>
22. Cisneros-Motemayor AM, Pauly D, Weatherdon LV, Ota Y (2016) A global estimate of seafood consumption by coastal indigenous peoples. *PLoS ONE* 11:e0166681
23. Daniel WW (1999) *Biostatistics: a foundation for analysis in the health sciences*, 7th edn. Wiley, New York
24. Daso AP, Osibanjo O, Gbadebo AM (2011) The impact of industries on surface water quality of River Ona and River Alaro in Oluyole Industrial Estate, Ibadan, Nigeria. *Afr J Biotechnol* 10(4):696–702
25. Ekanem KV, Chukwuma GO, Ubah JI (2016) Determination of the physico-chemical characteristics of effluent discharged from Karu Abattoir. *Int J Sci Technol* 5(2):43–50
26. Elijah FB, Elegbede I (2015) Environmental sustainability impact of the Okobaba sawmill industry on some biogeochemistry characteristics of the Lagos Lagoon. *Poult Fish Wildl Sci* 3:131
27. Faremi OE (2018) Environmental risks knowledge, field evaluations and biological responses of macrobenthos and fish species at Okobaba area of the Lagos Lagoon, Nigeria. MSc thesis, University of Lagos, Nigeria, 75 pp
28. Herbst S, Benedikter S, Koester U, Phan N, Berger C, Rechenberg A, Kistemanmn T (2009) Perception of water, sanitation and health: a case study from the Mekong Delta, Vietnam. *Water Sci Technol* 60(3):699–707
29. Huff J (2001) Sawmill chemicals and carcinogenesis. *Environ Health Perspect* 109(3):209–212
30. Kar T, Keles S (2016) Environmental impacts of biomass combustion for heating and electricity generation. *J Eng Res Appl Sci* 5(2):458–465
31. Kim-Oanh NT, Nghiem-Le H, Phyu YL (2002) Emission of polycyclic aromatic hydrocarbons, toxicity and mutagenicity from domestic cooking using sawdust briquettes, wood and kerosene. *Environ Sci Technol* 36(5):833–839
32. Longe EO, Ogundipe AO (2010) Assessment of wastewater discharge impact from a sewage treatment plant on lagoon water, Lagos, Nigeria. *Res J Appl Sci Eng Technol* 2:274–282
33. Miller GW (2017) The international reach of toxicology. *Toxicol Sci* 157(2):274–275
34. Neboh HA, Ilusanya OA, Ezekoye CC, Orji FA (2013) Assessment of Ijebu-Igbo abattoir effluent and its impact on the ecology of the receiving soil and river. *IOSR J Environ Sci Toxicol Food Technol* 7(5):61–67

35. Nefarnda WD, Yaji A, Kubkomawa HI (2006) Impact of abattoir waste on aquatic life: a case study of Yola Abattoir. *Glob J Pure Appl Sci* 12:31–33
36. Nubi OA, Ajao EA, Nubi AT (2008) Pollution assessment of the impact of coastal activities on Lagos Lagoon, Nigeria. *Sci World J* 3:83–88
37. Nunez Collado JR, Wang HH, Tsai TY (2019) Urban informality in the Paris climate agreement: content analysis of the nationally determined contributions of highly urbanized developing countries. *Sustainability* 11:5228
38. Nwankwo DI, Chukwu LO, Onyema IC (2009) The hydrochemistry and biota of a thermal coolant water stressed tropical lagoon. *Life Sci J* 6:86–94
39. Oketola AA, Fagbemigun TK (2013) Determination of nonylphenol, octylphenol and bisphenol-A in water and sediments of two major rivers in Lagos, Nigeria. *J Environ Prot* 4:38–45
40. Olaniran EI, Sogbanmu TO, Saliu JK (2019) Biomonitoring, physico-chemical, and biomarker evaluations of abattoir effluent discharges into the Ogun River from Kara Market, Ogun State, Nigeria using *Clarias gariepinus*. *Environ Monit Assess* 191(1):44
41. Olawuni PO, Okunola OH (2014) Socioeconomic impacts of sawmill industry on residents. A case study of Ile-Ife, Nigeria. *J Econ Dev Stud* 2(3):167–176
42. Olowoporoku OA (2016) Assessing environmental sanitation practices in slaughterhouses in Osogbo, Nigeria: taking the good with the bad. *MAYFEB J Environ Sci* 1:44–54
43. Oppenheim AN (2000) Questionnaire design, interviewing and attitude measurement. Bloomsbury Publishing, London
44. Osibanjo O, Adie GU (2007) Impact of effluent from Bodija abattoir on the physico-chemical parameters of Oshunkaye Stream in Ibadan City, Nigeria. *Afr J Biotechnol* 6(15):1806–1811
45. Palamuleni LG (2002) Effects of sanitation facilities, domestic solid waste disposal and hygiene practices on water quality in Malawi's urban poor areas: a case study of South Lunzu Township in the city of Blantyre. *Phys Chem Earth, Parts A/B/C* 27(11–22):845–850
46. Parkinson J, Tayler K (2003) Decentralized wastewater management in peri-urban areas in low-income countries. *Environ Urban* 15(1):75–90
47. Shen H, Huang Y, Wang R, Zhu D, Li W, Shen G, Wang B, Zhang Y, Chen Y, Lu Y, Chen H, Li T, Sun K, Li B, Liu W, Liu J, Tao S (2013) Global atmospheric emissions of polycyclic aromatic hydrocarbons from 1960 to 2008 and future predictions. *Environ Sci Technol* 47:6415–6424
48. Sogbanmu TO, Nagy E, Phillips DH, Arlt VM, Otitolaju AA, Bury NR (2016) Lagos lagoon sediment organic extracts and polycyclic aromatic hydrocarbons induce embryotoxic, teratogenic and genotoxic effects in *Danio rerio* (zebrafish) embryos. *Environ Sci Pollut Res* 23:14489–14501
49. Sogbanmu TO, Sosanwo AA, Ugwumba AAA (2019) Histological, microbiological, physico-chemical and heavy metals evaluation of effluent from Kara Cow Market, Ogun State in Guppy Fish (*Poecilia reticulata*). *Zoologist* 17:54–61
50. Sogbanmu TO, Osibona AO, Otitolaju AA (2019) Specific polycyclic aromatic hydrocarbons identified as ecological risk factors in the Lagos lagoon, Nigeria. *Environ Pollut* 255:113295
51. Tompkins EL, Few R, Brown K (2008) Scenario-based stakeholder engagement: incorporating stakeholders' preferences into coastal planning for climate change. *J Environ Manag* 88(4):1580–1592
52. Ugheoke AJ, Wahab KW, Erhabor GE (2009) Prevalence of respiratory symptoms among sawmill workers in Benin City, Nigeria. *Int J Trop Med* 4:1–3
53. Young S, Goodwin wEJ, Sedgwick O, Gudjonsson GH (2013) The effectiveness of police custody assessments in identifying suspects with intellectual disabilities and attention-deficit hyperactivity disorder. *BMC Med* 11:248