ORIGINAL ARTICLE

The role of environmental chemistry as a solution for bridging disciplines and solving complex African challenges: A case study of northern Nigeria

Haliru Musa [1] & Sani Mamman Ibrahim [2]
[1]Department of Chemistry, School of Sciences, Federal College of Education, Zaria, Nigeria.
[1] Tel: +2348028535856, [2] Tel: +2348038060784

ABSTRACT

Sustainable development in Africa faces numerous challenges, including environmental degradation, resource depletion, and socio-economic inequalities. Environmental chemistry, as an interdisciplinary field, offers critical insights and solutions to these problems by addressing pollution, waste management, and resource efficiency. This paper explores the role of environmental chemistry in fostering sustainable development, particularly in northern Nigeria. It examines how integrating environmental chemistry with other disciplines can enhance the effectiveness of sustainable practices, proposing a framework for collaborative efforts among scientists, policymakers, and local communities.
Keywords: African challenges, Environmental chemistry, Northern Nigeria, Sustainable development

*Corresponding Author
Haliru Musa.; Department of Chemistry, School of Sciences, Federal College of Education, Zaria, Nigeria; +2348028535856

Citing this article
Haliru Musa & Sani Mamman Ibrahima. The role of environmental chemistry as a solution for bridging disciplines and solving complex African challenges: A case study of northern Nigeria. KIU J. Health Sci, 2025: 5(1);

Conflict of Interest: None is declared

INTRODUCTION

Sustainable development, as defined by the United Nations, involves meeting the needs of the present without compromising the ability of future generations to meet their own needs. In Africa, sustainable development encompasses addressing economic disparities, ensuring environmental protection, and fostering social equity (Carlsen et al., 2022).

Africa's rapid population growth and industrialization have heightened the demand for sustainable development strategies that balance economic growth with environmental preservation. Environmental chemistry, the study of chemical processes occurring in the environment, is pivotal in understanding and mitigating the impacts of human activities on natural systems (Hagen, 2023). By bridging disciplines, environmental chemistry can provide comprehensive solutions to Africa's environmental and developmental challenges specifically in northern Nigeria. The environmental chemistry discipline aligned with Sustainable Development Goal 6: To Ensure the availability and sustainable management of water and sanitation for all.

THE IMPORTANCE OF ENVIRONMENTAL CHEMISTRY IN SUSTAINABLE DEVELOPMENT

Environmental chemistry plays a crucial role in achieving sustainable development by helping to understand, monitor, protect, and improve the environment. It is an interdisciplinary field that combines elements of chemistry, biology, toxicology, hydrology, and other sciences to study the transport, sources, reactions, effects, and fate of chemicals in water, soil, and air (Sheoran et al., 2022). Environmental chemistry helps in identifying and quantifying pollutants in air, water, and soil. Understanding the chemical nature of pollutants and their interactions with the environment is crucial for developing effective remediation strategies. For instance, monitoring heavy metal contamination in water sources can inform policies for safe drinking water. Environmental chemistry can play crucial roles in achieving sustainable development in northern Nigeria as follows;

a) **Water quality monitoring:** A comprehensive review by (Imam et al., 2023) on "Progress on Drinking Water Quality Monitoring In the Northern Part Of Nigeria: A Catalyst To Achieving Sustainable Development Goals" found that 55.74% of water sources in northern Nigeria are unfit for consumption due to poor portability, while 31.14% require additional treatment to meet WHO standards. Monitoring water quality using environmental chemistry techniques is essential to identify contamination and ensure access to clean drinking water, a key component of sustainable development goal 6.

b) **Addressing environmental degradation:** Northern Nigeria faces significant environmental challenges including land degradation, water resource depletion, and loss of biodiversity (Mohammed et al., 2020). Environmental chemistry can help identify the causes and extent of degradation, enabling targeted interventions to protect natural resources and promote sustainable livelihoods.

c) **Pollution control:** Problems like air pollution, water pollution, solid waste mismanagement, and oil spills are major environmental health risks in Nigeria. Environmental chemistry is crucial for monitoring pollutant levels, assessing impacts, and developing strategies to mitigate pollution and protect public health (United Nations, 2020).

d) **Informing policy:** The Nigerian National Policy on the Environment aims to "ensure environmental protection and the conservation of natural resources for sustainable development". Environmental chemistry provides the scientific basis to set evidence-based environmental standards, track progress, and inform policymaking (Ogunba, 2015).

e) **Promoting sustainable practices:** Environmental chemistry can help develop green technologies, identify eco-friendly alternatives, and promote sustainable production and consumption patterns across sectors like agriculture, industry, energy, and waste management (Naik et al., 2024; Ogunba, 2015).

f) **Improving soil quality:** Environmental chemistry methods are used to protect soil quality by monitoring and remediating contamination. Indicators like

chemical and eco-toxicological tests to be used to assess soil health in Northern Nigeria.

THE ROLE OF ENVIRONMENTAL CHEMISTRY IN ENVIRONMENTAL IMPACT ASSESSMENT

Environmental chemists play a key role in the environmental impact assessment (EIA) process in the following ways:

a) **Identifying and studying chemical contaminants:**
Environmental chemists focus on the study of chemicals and how chemical contaminants interact with the ecosystem. They analyze the presence and impact of chemicals on the environment, animals, and human health.

b) **Assessing chemical risks:**
Environmental chemists use their knowledge of green chemistry principles to better assess the chemical risks of a proposed development project. They evaluate the potential environmental and health impacts of the chemicals involved.

c) **Developing mitigation strategies:**
With their understanding of green chemistry, environmental chemists help develop strategies to minimize the environmental footprint and reduce the risks posed by chemicals. This includes using green solvents, avoiding unnecessary derivatization, and designing chemicals that break down into innocuous products.

d) **Monitoring and control:**
Environmental chemists develop analytical methodologies that reduce or eliminate the use of hazardous chemical auxiliaries. This allows for real-time, in-process monitoring and control of chemical impacts.

e) **Providing data and expertise:**
Environmental chemists contribute critical data, analysis, and expertise to the EIA process. Their assessments of the chemical aspects of a project are essential for informing decision- makers about the potential environmental consequences

TO PROPOSE ACTIONABLE STRATEGIES FOR IMPLEMENTING SUSTAINABLE PRACTICES IN NORTHERN NIGERIA

Africa especially northern Ni geria can harness the power of environmental chemistry to drive sustainable industrial development and protect the environment through capacity building, provide incentives, and enforce regulations to make sustainability the norm across industries (Nriagu, 1992; Nriagu et al., 1994). Other actionable strategies may be as follows;

a) **Promote green chemistry education and training:**
Organize more training schools and workshops like the African Training School on Green Chemistry and Environmental Sustainability to raise awareness, train professionals on sustainability principles, and provide advanced know-how on green chemistry. This will help build capacity for sustainability in Northern Nigeria.

b) **Encourage the use of renewable feedstock and recycling:**
Provide incentives and support for using secondary resources as feedstock and adopting up cycling, down cycling, and reclaiming biomass and wastes into chemicals. This will reduce waste and dependence on non-renewable resources.

c) **Develop greener organic synthesis methods:**
Invest in emerging sustainable inorganic chemistry technologies like sol-gel process, organic templating, chemical vapor deposition, and low-temperature solid phase reactions. This will make chemical processes more environmentally friendly in Northern Nigeria.

d) **Transition to green solvents and media:**
Promote the use of bio-derived solvents, ionic liquids, and subcritical & supercritical fluids as alternatives to conventional solvents. Provide tools and metrics to help industries select greener solvents in Northern Nigeria.

e) **Optimize chemical processes for sustainability:**
Encourage the adoption of clean (bio) chemical processes, solvent-free processes, flow chemistry, and process intensification technologies. This will improve the environmental performance of industries. Example is the industrialized state in Northern Nigeria like Kano

State.

f) **Conduct life cycle and sustainability assessments:**
Develop capacity for Life Cycle Sustainability Assessment (LCSA) and Circular Economy analysis to evaluate the environmental impact of chemical products and processes. This will enable data-driven decision-making for sustainability.

g) **Increase investment in renewable energy for industry:**
African countries should double their investment in renewable energy technologies while gradually transitioning away from fossil fuels. Green loans at low interest rates can incentivize this shift.
Implement environmental taxes and regulations: Enact policies that tax pollution and environmental degradation to incentivize sustainable practices. Enforce regulations to ensure industries meet environmental standards.

h) **Promote sustainable urbanization:**
Manage urban growth in a way that minimizes environmental impact, such as through green buildings, sustainable transportation, and waste management.

i) **Collaborate internationally on green chemistry:**
Foster global partnerships and knowledge sharing to accelerate the adoption of sustainable chemistry practices in Africa. Participate in international green chemistry initiatives.

j) **Resource Efficiency:**
Environmental chemistry contributes to resource efficiency by developing sustainable materials and processes. For example, green chemistry principles promote the use of renewable resources and reduce hazardous substances in industrial processes, thereby minimizing environmental impact (Manahan, 2022).

INTERDISCIPLINARY APPROACHES

Integration with Ecology

Environmental chemistry can collaborate with ecology to understand the effects of pollutants on ecosystems. This integration can lead to more effective conservation strategies. For example, studying the bioaccumulation of toxins in food chains can help in designing measures to protect wildlife and human health (Fayiga et al., 2018; Mohammed et al., 2020).

Collaboration with Engineering

Environmental engineers use chemical principles to design systems for pollution control and resource recovery. Joint efforts can lead to innovations in water purification, air filtration, and waste treatment technologies (Anastas et al., 2000; Hildebrand, 2023).

Policy and Governance

Engaging with policymakers is essential to ensure that scientific findings translate into effective environmental regulations. Environmental chemists can provide the evidence base needed for crafting policies that promote sustainability (Ogunba, 2015; Okello et al., 2015).

Strategies for Implementation

1) **Education and Training**
Promoting education in environmental chemistry and related fields is crucial. Universities and research institutions should offer interdisciplinary programs that equip students with the skills needed to tackle sustainable development challenges.

2) **Community Engagement**
Local communities should be involved in the development and implementation of sustainable practices. Environmental chemists can work with community leaders to raise awareness about pollution and resource management.

3) **Funding and Support**
Governments and international organizations should provide funding for research and projects that integrate environmental chemistry with other disciplines. This support is vital for developing and scaling up sustainable solutions.

CONCLUSION

Environmental chemistry holds significant potential for advancing sustainable development in Northern Nigeria. By bridging disciplines, environmental chemists can address complex environmental issues more effectively. Collaborative efforts involving scientists, engineers, policymakers, and communities are essential for creating sustainable solutions that benefit both people and the planet.

REFERENCES

1) Anastas, P. T., & Warner, J. C. (2000). *Green Chemistry: Theory and Practice*: Oxford University Press.
2) Carlsen, L., & Bruggemann, R. (2022). The 17 United Nations' sustainable development goals: A status by 2020. *International Journal of Sustainable Development & World Ecology, 29*(3), 219-229.
3) Fayiga, A. O., Ipinmoroti, M. O., & Chirenje, T. (2018). Environmental pollution in Africa. *Environment, development and sustainability, 20*, 41-73.
4) Hagen, B. (2023). the Virginia Woolf Society. *Virginia Woolf Miscellany*(100), 72-71.
5) Hildebrand, J. (2023). *Novel Environments: Science, Description, and Victorian Fiction*: Oxford University Press.
6) Imam, N., Abdurrahman, N., Isah, A. L., & Lawal, O. S. (2023). Progress on Drinking Water Quality Monitoring in the Northern Part of Nigeria: A Catalyst to Achieving Sustainable Development Goals. *Fudma Journal of Sciences, 7*(2), 152-158.
7) Manahan, S. E. (2022). *Environmental chemistry*: CRC press.
8) Mohammed, D., Mudi, Y., Tijjani, H., & Timothy, E. (2020). Environmental Degradation and Sustainable Livelihoods in Northern Nigeria: A Review. *Journal of Agricultural Economics, Environment and Social Sciences, 6*(2), 97-111.
9) Naik, B. M., Singh, A. K., Maji, S., Venkatesan, P., & Shelar, R. (2024). Exploring farmers attitudes towards climate resilient agricultural technologies in Telangana State, India. *India (July 01, 2024)*.
10) Nriagu, J. (1992). 1.9 Growing Health Hazard from Toxic Metals in the African Environment. *Chemistry and Developing Countries*.
11) Nriagu, J. O., & Simmons, M. S. (1994). *Environmental oxidants* (Vol. 27): John Wiley & Sons.
12) Ogunba, A. (2015). An appraisal of the evolution of environmental legislation in Nigeria. *Vt. L. Rev., 40*, 673.
13) Okello, C., Tomasello, B., Greggio, N., Wambiji, N., & Antonellini, M. (2015). Impact of population growth and climate change on the freshwater resources of Lamu Island, Kenya. *Water, 7*(3), 1264-1290.
14) Sheoran , O., Sunder, S., & HR Kataria, S. (2022). Characterization of Rhizoctonia solani associated with root/collar rots and blights.