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From source to shelves: A study of swan bottle water, 1983-2023

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Abstract

Water is one of the most essential natural resources for the survival of all forms of life. Spring-based bottled water has been used to address Nigeria's persistent water insecurity, especially amid failed public infrastructure. This research, titled Bottle Water Production in Nigeria: A case study of Swan Bottle Water in Kerang 1983-2023, examined the production and impact of Swan Bottle Water in Kerang, Mangu Local Government Area, Plateau State, Nigeria, from 1983 to 2023. The research adopts a qualitative approach, gathering data from both primary sources in the form of oral sources and government reports and secondary sources, mainly academic literature. The interdisciplinary approach from departments such as Economics, Sociology, and Geography was also used. Findings reveal that Swan Bottle Water contributes significantly to public health by providing microbiologically safe, mineral-rich drinking water, and to local socio-economic development through job creation, infrastructure improvement, and corporate social responsibility. Environmental concerns, such as plastic waste, the risk of aquifer depletion, and water access inequality due to pricing, are challenging Swan's good work. It concludes that while Swan Water offers a replicable model for water-based rural industrialisation, long-term sustainability requires policy reforms, stronger regulatory enforcement, and environmental innovation. This research contributes to the historiography of natural resource management in Nigeria.

Keywords: Swan Bottle Water, Socio-economic development, Kerang, Interdisciplinary approach

Introduction

Water is one of the most essential natural resources for human survival, health, and socio-economic development. Globally, access to safe and clean drinking water remains a critical issue. According to the United Nations, access to clean water is a fundamental human right, as declared in Resolution 64/292 of 2010.[2] Despite this recognition, countries continue to face challenges related to water scarcity, poor water quality, and the uneven distribution of water resources. These challenges and the demand for clean and safe drinking water have led to the rise of bottled water industries worldwide, which provide an alternative source of potable water. Gay Hawkins notes that the global bottled water industry, emblematic of modernity and convenience, is shaped by cultural practices, moral choices, and environmental consequences. Hawkins

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phone: +2348066632945
[2]United Nations General Assembly, A/RES/64/292, "The Human Right to Water and Sanitation". https://www.unwater.org 2010. Accessed on 19/02/2026.

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deconstructs bottled water as more than a commodity, framing it within a network of trust, risk, and consumer morality.[3]

In Europe, Evian Natural Mineral Water is a globally recognised brand sourced from Cachat Spring in the French Alps, located in Evian-les-Bains, France. The company has built a reputation for providing high-quality water with natural purity and a rich mineral profile.[4]In Asia, Nongfu Spring water, established in 1996, utilizes multiple natural water sources across China to produce bottled water. The company adheres to a strict "natural and healthy" philosophy by avoiding tap water and artificial mineral additives in its products and by using natural spring water.[5]

Africa has not been left out of the quest for safe, clean drinking water for its citizens. Water production in North Africa is heavily dependent on natural springs, which serve as vital sources of fresh drinking water. Among the various spring water brands in the region, Sidi Ali, a well-known Moroccan bottled water brand sourced from the Tarmilat in the Middle Atlas since 1978, stands out. It is located in the Oulmès region, an area renowned for its mineral-rich natural waters. Sidi Ali is produced by Les Eaux Minérales d'Oulmès, a company founded in 1933 by Abdelkader Bensalah through a concession granted by the French protectorate for the exploitation of the Ain Lalla Haya Spring.[6] Over the years, the brand has maintained its reputation by adhering to strict quality control measures and sustainable water management practices,, and it was the official water sponsor of the African Cup of Nations (AFCON) 2025, hosted by Morocco.[7] A notable spring water used for commercial production in West Africa is Ragolis Natural Spring Water, sourced from natural springs in Ikogosi, Ekiti State, Nigeria. The company began production in 1984 and operates multiple depots across the country, including Abuja, Port Harcourt, Enugu, Kaduna, and Kano. The company also supplies water to various catering firms and hotels within Nigeria.[8]

In Nigeria, the National Agency for Food and Drug Administration Control (NAFDAC) regulates bottled and sachet water under the NAFDAC Act, CAP N1 (LFN) 2004.[9] As Nigeria continues to grapple with challenges in providing safe and clean drinking water to its populace a two-face scenario emerges; while smaller unregulated brands which dominate 40% of the market and often endangering public health by pass protocols,[10] bigger regulated brands like

[3]Gay Hawkins, Emily Potter and Kane Race,*Plastic Water: The Social and Material Life of Bottle Water,* Massachusetts: MIT Press, 2015, 3-4.
[4]Evian Natural Spring Water, "Our Water Source". https://www.evian.com. Accessed on 19/02/2026.
[5]Nongfu Spring,"Natural Mineral Water (Glass Bottled)." https://en.nongfuspring.com. Accessed 19/02/2026.
[6]Thegateuchicago.com, "Everybody's Gota Have It: Morrocco Sidi Ali Water Scandal" https://thegateuchicago.com. Accessed 19/02/2026.
[7]Confederation Africaine de Football, "CAF and SISI Ali conclude an agreement making SIDI ALI the official TotalEnergies CAF Morocco 2025 Water Supplier" https://www.cafonline.com. Accessed 19/02/2026.
[8]Edward Salazar, "Ragolis Natural Spring Water". http://www.ragoliswaters.com. Accessed on 20/02/2026.
[9]NAFDAC "NAFDAC-Act" https://www.nafdac.gov.ng. Accessed 20/02/2026.
[10]J.O. Odion, "An Assessment of the Regulatory Powers of the National Agency for Food and Drug Administration Council in the Protection of Consumer of its Regulated Products

Swan Bottle Water adherence to NAFDAC and Standards Organisation of Nigeria (SON) guidelines including microbial testing and proper labeling aligns with calls for transparency.[11]

Despite Swanwater's promising role as a benchmark for safe water production, there is a paucity of research investigating the operational strategies and practices that have enabled Swan Bottled Water to achieve these standards. This paper attempts to fill that gap by exploring the methods, policies, and regulatory standards implemented by Swan Bottled Water between 1983 and 2024, with the goal of identifying replicable strategies to address broader water quality issues in Nigeria. The research methodology adopted was qualitative, with data obtained from primary and secondary sources. An interdisciplinary approach was utilized to integrate insights from disciplines such as environmental science, engineering, public health, sociology and economics to analyze Swan Water operations and their impact in Nigeria.

Kerang is a serene town in Mangu Local Government Area of Plateau State, Nigeria, celebrated for its picturesque landscape and natural resources, particularly its renowned spring water. Situated within Jos Plateau, the town has garnered national recognition as the home of Swan water, one of Nigeria's most trusted bottled water brands. The physical geography of Kerang is intrinsically linked to the Jos Plateau, a region of high-altitude plains and rugged volcanic formations. The town lies approximately 90 kilometers southeast of Jos, the Plateau State capital, and is elevated about 1,200 meters above sea level. This elevation contributes significantly to the town's cooler climate and unique hydrological features. The terrain is a product of ancient volcanic activities that shaped the region millions of years ago, leaving behind an array of rock formations and fertile soils.[12]A key geographical feature of Kerang is its abundant natural springs. These springs are fed by underground aquifers that are replenished by rainfall. The aquifers' volcanic rock filtration system ensures that the water is naturally purified, enhancing its quality and safety for human consumption. The purity of these springs has been a critical factor in establishing Swan water as a leading brand in Nigeria. Studies have shown that water sourced from Karang's springs contains essential minerals such as calcium, magnesium, and potassium, which contribute to its health benefits.[13]

Origin of Swan Water

In 1981, Swan Bottle Water, a premier brand owned and produced by United African Company (UAC) Foods Limited, a leading Nigerian food company and a subsidiary of UAC Nigeria PLC, was officially launched as one of the first bottled water companies in Nigeria. Its establishment marked a significant shift in the Nigerian beverage industry, introducing consumers to the concept of safe,

in Nigeria." *Global Journal of Management and Business Research*, Vol. XXII, Issue 10, 2017, 9-10.

[11]Peter Gleick, *Bottled and Sold; The Story behind our Obsession with Bottled Water*. Washington: Island Press, .2010, 39-40

[12]K.E. Adeyemi, "Geographical Features of the Jos Plateau". *Nigerian Journal of Geographical Survey*, Vol. 10. No. 1, 2015, 45.

[13]S. Adebayo and T. Ojo, "Mineral Composition of Natural Spring Waters in Plateau State, Nigeria". *Journal of Environmental Sciences*, Vol. 14, No.3, 2019, 215.

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hygienically packaged drinking water.[14]Swan Bottle Water traces its origins to the natural springs in Kerang, Mangu Local Government Area, Plateau State, Nigeria.[15] Oral histories from Kerang highlight the springs' cultural and historical significance, as they were regarded as sacred sources of life.[16]Over the decades, Swan Bottle Water has expanded its operations, incorporating advanced technology and infrastructure to meet growing demand, while its long-standing reputation for quality has made it a pioneer in the sector, influencing the development of Nigeria's bottled water standards.[17]

The mission statement of Swan Bottle Water is to provide premium quality bottled water to meet the hydration needs of individuals and organizations while upholding environmental sustainability. This mission is hoped to be achieved through: Commitment to Quality; Sustainability Initiatives; and Customer Satisfaction. The objectives of Swan Bottle Water include: to supply hygienically processed and mineral-rich water to consumers; to maintain leadership in Nigeria's bottled water industry through innovation and quality assurance; to promote environmental sustainability by using biodegradable and recyclable materials in packaging; to expand the brand's reach by increasing production capacity and distribution networks nationwide; and to contribute to community development through job creation and corporate social responsibility initiatives.[18] Swan Bottle Water holds certifications from the National Agency for Food and Drug Administration and Control (NAFDAC), Standards Organization of Nigeria (SON), and ensures compliance with local regulations and International Organization for Standardization (ISO) 22000 for food safety management.[19]

Source of Raw Materials

The primary raw materials include water from the Kerang springs, packaging materials, and additional production inputs. Kerang Springs serves as the primary source of water for Swan Bottle Water. These springs are renowned for their natural purity, mineral richness, and consistent flow rates year-round.[20] The water is naturally filtered through layers of rock and soil, which act as a natural purification system. Regular hydrogeological studies ensure the sustainability of the spring and verify that it meets the high-quality standards required for bottling.[21] The water's unique mineral composition includes essential elements like calcium, magnesium, and potassium, which are beneficial to human health. The pristine conditions of the Kerang environment

[14]Suleman Adamu, "Standards for Bottled and Packaged Water in Nigeria." NAFDAC https://nafdac.gov.ng. Accessed 20/02/2026.
[15]T. Adamu, A. Yusuf and R. Bako "Mineral Composition of Spring Water in Kerang, Plateau State." *Journal of Hydrology Research*, Vol. 8, No. 2,2021, 23-24.
[16]Kefas Pam, male, 70 years, famer, Kerang, 02/01/2026; Lakon Shasha, male, 60 years, village leader, Kerang, 02/01/2026 and Magaret Wuyep, female, 45years, trader, Kerang, 02/01/2026.
[17]Croker Modo "Nigeria Bottling Water Association: Bottled Water Standards in Nigeria. Lagos: NBWA, 2018. Accessed 20/02/2026.
[18]UAC Foods, "Swan Natural Spring Water"https://uacfoods.com. Accessed 20/02.2026.
[19]UAC Foods.
[20]Segun Olatunji, "Volcanic Springs and their Contributions to Bottle Water." *Journal of Geological Studies,* Vol.19, No.2, 2018,89-90.
[21]S. Bairagi and S. Wazid Ali, "Advance Filtration Technologies in Water Treatment." *Water Tech Journal,*Vol.15,No.3,2020, 45-47.

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contribute significantly to the water's unmatched quality. To preserve this natural resource, Swan Bottle Water collaborates with local authorities and environmental experts to implement sustainable water management practices.[22]

Production Process of Swan Bottle Water

The production of Swan Bottle Water involves several stages to ensure the water remains pure and safe for consumption. These stages include: Water sourcing, pre-treatment, filtration and packaging. Swan Bottle Water is sourced directly from the Kerang springs. The water undergoes minimal human interference, preserving its natural mineral composition. Scientific studies have shown that spring water in Kerang contains essential minerals, such as calcium, magnesium, and potassium, which are beneficial to human health.[23] Before filtration, the water undergoes pre-treatment to remove any large particles and organic matter. This process includes,[24]**Screening,** which removes debris and large contaminants; sedimentation, allowing heavier particles to settle to the bottom of a holding tank; and finally, **Coagulation and Flocculation,** which add chemicals like alum to aggregate fine particles into larger particles for easier removal. The filtration process ensures the water's purity by removing microscopic impurities, while the steps include[25]**Sand Filtration,** the process of removing larger particles and turbidity; **Carbon Filtration,** which removes chlorine, odour, and organic contaminants; and, lastly, **Micro-Filtration Membranes** to filter out microorganisms and fine sediments. Disinfection is achieved through UV Treatment, which involves exposing water to ultraviolet light to destroy bacteria and viruses. Ozonation: adding ozone gas to ensure long-term microbial stability.[26]

Bottling and Packaging of the Raw Materials

Bottling and packaging are critical stages in the production process for Swan Bottled Water, as they not only preserve the inherent quality of the natural spring water but also represent the company's commitment to sustainability and consumer safety. The process begins with the careful handling of raw water that has already undergone rigorous filtration and sterilization. At this stage, the water is stored in sanitized, temperature-controlled tanks to maintain its purity until it is ready for bottling.[27] The transition from raw water to a consumer-ready product involves a series of meticulously monitored steps that ensure every bottle meets strict quality standards and regulatory guidelines. These steps include cleaning and preparation, transferring to the filling station, sealing, labelling, and packaging in cartons.

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[22]T. Adamu, A. Yusuf and R. Bako, "Mineral Composition of Spring Water in Kerang, 34.
[23]T. Adamu, A. Yusuf and R. Bako, 34.
[24]World Health Organization, "Guidelines for Drinking Water Quality." Geneva 2017. Accessed 20/02/2026.
[25]W. Hui, Y. Zhang and C. Li, "Advances in Water Treatment Technologies: A Review." *Journal of Environmental Science and Engineering*, Vol.14,No.1, 2020, 56-58.
[26]Peter Steve and Susan Wiche, "UV and Ozone Sterilization in Bottling Water Production." Journal of Water Safety, Vol.9,No.1, 2019, 22-23.
[27]Ibrahim Yusuf, "Quality Assurance Testingin Bottled Water Production." *Food Safety Journal*, Vol.10, No.3, 2021, 68.

In the first step, the cleaning and preparation of the bottles, Swan utilizes automated cleaning systems that use high-pressure steam and food-grade sanitizers to remove contaminants from the bottle surfaces. This step is vital because even minute residues can compromise water quality, affecting its taste and safety. The cleaning process is followed by a thorough inspection using both manual checks and advanced sensor-based technology to ensure each bottle is free of defects and ready for filling.[28] Maintaining a sterile environment throughout these operations is of paramount importance, and this is achieved through the use of cleanroom technologies and continuous air filtration systems that minimize the presence of airborne particulates.

Once the bottles have been sanitized, they are transferred to the filling station, where state-of-the-art automated filling machines designed to minimize human contact with the water take over. The filling process is calibrated to ensure each bottle is filled to an exact volume, maintaining consistency throughout the production batch. During this phase, the water flows into the bottles under controlled conditions, and the process is monitored in real time to detect deviations from the set parameters. The precision of this automated system is critical not only for maintaining product uniformity but also for preserving the water's mineral composition, a key factor in the overall quality and taste of the bottled product.[29] After the bottles are filled, the next step is sealing. The sealing process is executed using high-speed capping machines that apply tamper-evident closures to each bottle. These caps are designed to provide an airtight seal, preventing the ingress of contaminants and preserving the water's freshness over time. The integrity of these seals is essential for ensuring that the product remains safe for consumption throughout its shelf life. In addition to sealing, the bottles undergo a secondary quality check, including automated and manual inspections to verify that the caps are secure and that the bottles are free of physical defects or contamination.[30]

Once sealed, the bottles move to the labelling station. Here, they are printed with essential product information, including the water source, production date, and quality certifications. The labelling process is not only an important component of product branding but also serves as a tool for traceability in the event of a quality control issue. Advanced labelling technologies ensure labels are applied consistently and adhere securely to the bottle surface, even under varying storage and transportation conditions. The use of high-quality, durable labels reflects the company's emphasis on product reliability and consumer trust.[31] The final stage of the production process is packaging. Bottled water is carefully packed into cartons or crates designed to protect the product during storage and transportation. The packaging materials are selected with a dual focus on durability and environmental impact. Swan Bottled Water has made significant investments in eco-friendly packaging, opting for recyclable, biodegradable materials whenever possible. This approach aligns with global trends toward sustainable packaging and helps reduce the company's overall

[28]Croker Modo, "Nigeria Bottling Water Association
[29]Y. Parang, E. Elimelech and T. Opher, "Eco-Friendly Packaging Solutions for Bottled Water." *Environmental Journal,* Vol.11,No.3, 2023, 70.
[30]Suleman Adamu, "Standards for Bottled and Packaged Water in Nigeria.
[31]Suleman Adamu,

environmental footprint.[32] The cartons are designed to optimize space and reduce the energy required for transportation, thus contributing to cost efficiency and environmental sustainability.

Throughout the bottling and packaging process, quality assurance is a continuous priority. Every stage, from the initial cleaning of the bottles to the final packaging, is governed by strict protocols and monitored by a dedicated quality control team. This team conducts regular sampling and testing of bottled water to ensure compliance with both national and international standards for drinking water quality. Techniques such as microbial analysis, chemical testing, and sensory evaluations are employed to monitor the water's quality, ensuring that it remains free from contaminants and retains its natural mineral balance.[33] Any deviation from expected quality parameters triggers an immediate investigation and, if necessary, corrective measures to prevent compromised products from reaching consumers. The automation of the bottling and packaging process has allowed Swan Bottled Water to achieve high levels of efficiency and consistency. However, the integration of human oversight remains crucial. Trained technicians continuously monitor the machinery and production lines, ensuring that all systems operate within the designated parameters. These professionals are also responsible for routine maintenance of the equipment, which helps prevent breakdowns and extend the lifespan of production assets. The combination of advanced technology and skilled human intervention creates a robust system that upholds the company's reputation for quality and reliability.[34]

Quality Control and Standards in Water Production

Quality assurance (QA) and quality control (QC) are integral to Swan Bottled Water production. These measures ensure compliance with both national and international standards. QA/QC Procedures include[35]: **Source Monitoring,** which involves regular testing of the Kerang springs for contamination; **Process Audits,** which is continuous monitoring of the pre-treatment, filtration, and bottling stages; and **Product Testing,** which is random sampling of finished products to verify compliance with standards.

Environmental Sustainability

Swan Bottle Water is committed to minimizing its environmental footprint, and the strategies adopted include[36]**Recycling Programs,** which involve partnering with communities to promote the recycling of used bottles; **Energy Efficiency** by utilizing energy-efficient equipment in production; and **Eco-Friendly Materials** through the development of biodegradable packaging solutions.

Compliance with Regulatory Standards

The company operates within a complex regulatory framework set by national bodies such as National Agency for Food and Drug Administration and Control

[32]Y. Parang, E. Elimelech and T. Opher, "Eco-Friendly Packaging, 71.
[33]Ibrahim Yusuf, "Quality Assurance Testing, 70
[34]Caleb Frutan, "Employee Training and Compliance in Food Production." *Vanguard Newspaper*. January 19th 2019, 6.
[35]Ibrahim Yusuf, "Quality Assurance Testing, 71.
[36]Paul Okereke, "Environmental Regulations for Bottled Water Production." *Journal of Nigeria Environmental Standards*, Vol.6,No. 4, 2019, 63.

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(NAFDAC), Standards Organization of Nigeria (SON), and World Health Organization (WHO). These standards govern every facet of production from water sourcing and treatment to bottling, labelling, and environmental management. At the core of Swan Bottled Water's compliance strategy is a robust internal quality assurance system that monitors adherence to all regulatory requirements. The company has implemented a comprehensive quality management framework that includes routine internal audits, employee training, and continuous monitoring of production processes. These measures ensure that each stage of production meets or exceeds the mandated safety and quality standards. For instance, periodic internal audits are conducted to verify that equipment cleaning, water testing procedures, and packaging processes conform to both national and international guidelines.[37]

In addition to internal monitoring, Swan Bottled Water collaborates closely with regulatory bodies such as NAFDAC, which routinely inspects production facilities to verify compliance with its guidelines on water quality and packaging safety. During these inspections, regulators review critical parameters, including microbial counts, chemical composition, and the integrity of sealing and labelling practices. The Standards Organization of Nigeria (SON) also plays a pivotal role by establishing benchmarks, particularly concerning labelling accuracy and packaging materials that the company must adhere to. Adhering to these standards is crucial not only for legal compliance but also for maintaining consumer confidence in the brand as a provider of safe, high-quality water.[38]

The compliance process at Swan Bottled Water extends beyond routine inspections and internal audits. The company employs advanced traceability systems that document every stage of production. From the moment raw water is sourced to the final packaging and distribution, every batch is recorded and tracked using sophisticated data management systems. This traceability ensures that if any issue arises, whether due to a quality defect or a regulatory non-conformity, the affected batches can be quickly identified, isolated and addressed, thereby minimizing risk to consumers. Such systems also support the company's commitment to transparency and accountability, making it easier to report compliance data during external audits and regulatory reviews.[39] Compliance with environmental regulations is another critical area. In addition to meeting potable water safety standards, Swan Bottled Water is committed to reducing its environmental footprint. The company adheres to environmental standards that regulate waste disposal, energy consumption, and the use of sustainable packaging materials. This includes complying with guidelines on plastic waste management and recycling issued by national and international environmental agencies. Through initiatives such as biodegradable packaging and efficient water management systems, the

[37]Giwa Ayuba, "Compliance Framework for the Beverage Industry in Nigeria." https://foodsafetyjournal.org. Accessed 20/02/2026.
[38]Markus Camrat and H. P. Furuta,"Regulatory Compliance in Nigeria Bottled Water Industry." Journal of Beverage Regulation, Vol.5,No. 2, .2020. 114.
[39]Nkiruka Obi and M. I. Saul, "Quality Assurance and Regulatory Audits in Water Production." *Food Safety Journal*, Vol.10,No. 3, 2021, 59.

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company strives to ensure its operations do not compromise environmental sustainability.[40]

Employee training is a vital element of the compliance strategy. Regular training sessions are conducted to update staff on new regulatory requirements, changes in quality control protocols, and best practices in hygiene and sanitation. This continuous professional development ensures that every employee, from production line workers to quality control managers, is well-informed and capable of upholding the company's rigorous compliance standards. By fostering a culture of compliance and continuous improvement, Swan Bottled Water not only meets current regulatory requirements but is also better prepared for future regulatory changes.[41]Technological innovation plays an important role in maintaining compliance.

The company has invested in state-of-the-art monitoring equipment that provides real-time data on critical production variables, including water temperature, pH levels, and microbial counts. This real-time monitoring enables immediate corrective action when any parameter deviates from established norms, thereby preventing potential breaches of regulatory standards. Automation in areas such as bottling and labelling further minimizes human error and enhances the overall reliability of the production process. These technological advancements have been instrumental in ensuring that Swan Bottled Water consistently meets high-quality standards while also achieving operational efficiency.[42]

External audits are conducted periodically by independent third-party agencies to assess the overall compliance of the production facility. These audits are comprehensive, covering every aspect of the operation—from water sourcing and treatment to bottling, packaging, and distribution. The audit process typically includes a review of the company's documentation, inspection of physical facilities, and testing of water samples to ensure compliance with all regulatory requirements. Findings from these audits are used to implement corrective measures and drive continuous improvements in production practices.[43] Documentation is another cornerstone of the company's compliance efforts. Every step of the production process is meticulously documented, from raw material testing and equipment maintenance logs to employee training records and quality control reports. This extensive documentation not only supports internal quality assurance but also serves as evidence during external regulatory audits and inspections. By maintaining detailed records, Swan Bottled Water demonstrates its commitment to regulatory compliance and operational transparency, which, in turn, reinforces consumer trust and confidence in the brand.[44]

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[40]Paul Okereke, "Environmental Regulations, 65.
[41]Adetunji Jethro, "Training and Capacity Building for Regulatory Compliance in Food and Beverage Industry." *Workplace Standard Review*, Vol.9,No. 2, 2020, 77. See also Caleb Frutan "Employee Training, 8-9.
[42]Frank Immanuel, "Impact of Technological Innovations on Regulatory Compliance in Food and Beverage Industries." *Industrial Sustainability Journal*, Vol.8,No.1, 2021, 34-36.
[43]M. Musa, "Traceability and Documentation in the Beverage Industry." *Supply Chain Management Journal*, Vol.9 No. 4, 2021, 111.
[44]M. Musa, "Traceability and Documentation, 115-117.

One challenge in maintaining regulatory compliance is the dynamic nature of regulatory standards. As new scientific findings emerge and public health concerns evolve, regulatory bodies often update their guidelines and standards. Swan Bottled Water is proactive in this regard, maintaining an active liaison with regulatory agencies and industry associations to stay abreast of any changes. This proactive approach enables the company to swiftly implement necessary modifications to its production processes, ensuring compliance at all times. The company's research and development team are also involved in exploring innovative methods to enhance water quality and safety in line with emerging regulatory requirements.[45] Compliance with regulatory standards is further reinforced through a continuous improvement system. The company regularly reviews its compliance procedures and incorporates feedback from both internal audits and external inspections. This iterative process ensures that any identified gaps or weaknesses are promptly addressed. Regular management reviews and stakeholder consultations are conducted to evaluate the effectiveness of the compliance program, and the insights gained are used to refine operational procedures and enhance overall performance.[46]

The impact of compliance extends beyond just meeting legal requirements; it is integral to the company's competitive advantage. In a market where consumers are increasingly concerned about product safety and environmental sustainability, a robust compliance program sets Swan Bottled Water apart from competitors. It reassures consumers that the water they consume is produced under stringent quality controls and in full adherence to regulatory standards. This commitment to compliance not only minimizes the risk of regulatory sanctions and reputational damage but also creates a strong foundation for sustainable growth and market leadership.[47]Moreover, the company's focus on regulatory compliance has broader socio-economic implications. Swan Bottled Water contributes to public health and safety, which in turn supports the well-being of local communities, helps to foster trust among consumers, regulators, and other stakeholders, thereby strengthening the overall integrity of the bottled water industry in Nigeria and setting a benchmark for other players in the industry by encouraging widespread adoption of best practices in water quality and safety management.[48]

Compliance with regulatory standards is not merely a legal requirement for Swan Bottled Water; it is a strategic imperative that underpins the company's commitment to quality, safety, and environmental sustainability. By implementing robust internal controls, leveraging advanced technological solutions, and proactively engaging with regulatory bodies, the company ensures its operations consistently meet the highest standards of excellence. The integration of continuous improvement processes, comprehensive documentation, and regular training further reinforces its compliance framework, enabling the company to adapt swiftly to regulatory changes and

[45]C. Hang, "Challenges in Regulatory Compliance for Bottled Water Producers. "*International Journal of Water Policy*, Vol.8,No. 2, 2020, 95.
[46]U.I. Zion and Ohira Gate, "Continuums Improvement in Regulatory Compliance: A Case Study of Nigerian Bottled Water Producers." *Journal of Business and Environmental Studies*, Vol.14, No3,2022, 98-100.
[47]Columbus John and U. Ilya, "Corporate Governance and Regulatory Compliance in the Water Sector." *Journal of Corporate Ethic*, Vol.12,No.3,2020, 65.
[48]M. Musa, "Traceability and Documentation,115-117.

maintain its competitive edge. As the regulatory landscape continues to evolve, Swan Bottled Water remains dedicated to enhancing its compliance practices, thereby safeguarding consumer health and contributing to the overall sustainability of the bottled water industry.[49]

Impacts Of Swan Water Production

The expansion of bottled water production – exemplified by Swan Natural Spring Water's operations in the Kerang hills of Mangu- carries significant environmental, socio-economic, and public health implications. Which are discussed below

Environmental Impact

Bottled water production affects the natural environment through both resource extraction and waste generation. Although Plateau State sits atop abundant volcanic aquifers, local water systems are not immune to over-extraction and pollution, especially as government reports note a "water crisis" and "epileptic" dam supplies even in the Plateau region.[50] This is because SWAN bottled water is primarily sourced from springs, which draw from limited aquifers. A UN report notes that while bottled-water withdrawals are small relative to overall water use, local impacts can be significant, especially in water-stressed areas.[51] Hydro chemical analyses find Plateau Spring water to be neutral (pH ≈7.3), low in dissolved solids, and rich in calcium/magnesium (Mg-Ca-HCO_3 type).

This value falls within World Health Organization (WHO) drinking-water standards, suggesting that the raw source water is of "potable quality."[52] Likewise, radiological tests of Kerang-area spring water show gross alpha and beta activity well below the World Health Organization (WHO) limits of 0.5 and 1.0 Bq/L, respectively,[53] indicating that the natural water is not contaminated with radionuclides. However, the very abundance of these springs can be undermined if extraction outpaces recharge. Plateau State is relatively wet, with over 1000mm of annual rainfall in the north. However, unsustainable pumping can lower water tables during the dry season. While Swan claims to source "naturally filtered" spring water, responsible practice demands careful monitoring of spring yields and limits on abstraction during dry periods since Swan's Spring feeds agricultural wetlands used for dry-season farming in the Panyam volcanic area. At the time this paper was written, no public data on Swan's extraction rates were available.

[49]U.I. Zion and Ohira Gate, "Continuums Improvement. 98-100.
[50]Dagwon Pam, "Governor Mutfwang Signs N30 billion Contract to Tackle Water Challenges in Plateau South." https://calebmutfwang.org/2025/03/governor-mutfwang. Accessed 20/02/2026.
[51]United Nations General Assembly, A/RES/64/292.
[52]C. Q. Dokabo and F. Ottoh, "Hydrogeology and Origins of Waters of the Panyan Volcanic Line Springs, Jos Plateau Nigeria." *Journal of Earth Science*, Vol.3, No.1 and 2,2000, 14.
[53]Shilligag Dankyes, "Determination of Gross Alpha and Beta Concentration and Annual Committed Dose in Drinking Water Sources of Ampang West and Kerang in Mangu LGA, Plateau State Nigeria." *Daily Guide*, December 12, 2023,.12.

Aside from water volumes, bottled water production generates solid waste that burdens the environment. Industry observers report that about 70% of Nigerian adults drink at least one sachet or bottle of water per day, corresponding to 50–60 million single-use water packets disposed of daily nationwide.[54]Even if Swan only bottles a fraction of that total, the impact in Plateau is nontrivial because Swan has no formal recycling infrastructure. While researchers have linked the accumulation of bottle and sachet waste to blocked drains, clogged waterways, and even flooding, accumulation in street corners and streams not only mar the landscape but also degrade into microplastics.[55] The International Union for Conservation of Nature (IUCN) notes that microplastics from such pollution "often find their way into tap water" and even bottled drinks, posing chronic health and ecosystem risks.[56]

Similarly, further studies warn that open dumping of water sachets and bottles has extended "environmental pollution" nationwide.[57] In Plateau State specifically, a focus group discussion in Jos confirmed reports of debris piles in the Jos watershed near bridges and informal landfills, especially plastic waste.[58] While no study has yet quantified Swan-specific waste, the broader pattern in Nigeria suggests that each brand of packaged water contributes to this problem. Without effective waste management, including public collection and recycling initiatives, Swan's bottling will contribute to persistent plastic pollution.[59]

Furthermore, the chemical quality of the bottled product and its packaging also matter for the environment. Since Swan treats its spring water either through Ultraviolet (UV) or ozone before bottling, the byproducts are minimal. However, the plastic Polyethene Terephthalate (PET) bottles themselves, if mishandled and exposed to heat and sunlight, can increase antimony or bisphenol-A in water over time, a major concern in Nigeria's climate. Though specific data on Swan are unavailable, global literature confirms that "prolonged storage, exposure to high temperatures and sunlight can lead to harmful chemicals" seeping from bottles into drinking water.[60]

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[54]Ijaermr, "Economic Impact of Packaged and Bottled water Business in Nigeria." https://www.ijaerm.com. Accessed 21/02/2026.

[55]Ziliyat Gida, "Solution for Plastic Pollution in Nigeria: A Collective Responsibility". https://ijecm.co.uk/wp.content. Accessed 21/02/2026.

[56]Ziliyat Gida,

[57]K.U. Donuma, "Environmental and Human Health Risk of Indiscriminate Disposal of Plastic bottles and Sachets in Nigeria." https://www.sciencedirect.com. Accessed 21/02.2026.

[58]Kwafin Darwa, male, 50 years, environmental officer; Ladi Bot, female,40 years, health concerned resident and Nkechi Onyemelukwu, female, student, all interviewed in Jos 01/01/2026.

[59]In response to this challenge, some major companies like Coca Cola have announced sustainability initiatives by installing effluent treatment plants with a pledge to cut plant water usage by 20% by 2025 in water-risk areas. Such measures demonstrate industry awareness but also means that smaller firms like Swan will need a large sum to implement a similar system. See Aisha Sule, "Bottle Firms Reinforces Commitment to Sustainable Clean Water." *EnviroNews,* February 1st, 2015, 7.

[60]H. Zang, I. Chai and Y. Wang, "Release of Antimony and Eisphenol A form Polyethylene Terephthalate PET) Bottled Water under Common Storage Conditions." *Environmental Pollution*, Vol.192, No. 1, 2014, 113.

The environmental impact of Swan's operations hinges on sustainable resource management and waste handling. On the positive side, the Kerang spring appears naturally pure and abundant at least seasonally, and if bottled responsibly, it can supply clean water without adding contaminants. On the negative side, the extraction still uses finite groundwater, and the plastic packaging generates pollution if not recycled. The state government's efforts to invest N30 billion to address persistent water challenges mean that even regions with springs can still suffer from a lack. In this context, Swan's footprint should be measured against the yardstick of effective environmental stewardship, which requires monitoring aquifer levels, minimizing water waste in production, and participating in plastic recycling programs. These are practice some global studies urge as best practices for the bottled-water sector.[61]

Socio-Economic Impact

The socio-economic impacts of Swan's bottling operation encompass both development opportunities and social challenges. In Plateau State, Swan's presence in Mangu indirectly improves social outcomes by employing dozens of local workers as bottling-line operators, drivers, and vendors, many of whom may not have had formal employment otherwise, making clean water easier to obtain and reduce the time and labour that rural families spend fetching or treating water, thereby giving women and youths more hours to engage in schooling or income-generating work."[62] Lakon Shasha has noted that "convenient drinking-water access via sales points or home delivery improves privacy and security for women and girls, since they no longer have to spend long hours walking to distant wells which reduces their risk of harassment during water collection.[63] Also, it is worth mentioning that self-employed vendors who sell Swan bottles in Jos and nearby towns would count as indirect beneficiaries, it is in this way that Swan bottle water contributes to Plateau's economic base by circulating economic benefits and supporting ancillary businesses including retailing and trucking. and also sourcing materials locally through hiring local truckers or sourcing cardboard crates. Thus, any money that Swan pays for water rights, land, or taxes provides revenue to the local government and helps the state's finances.[64]

On the flip side, one concern is affordability and equity since bottled water is more expensive per litre than the subsidised public taps or sachets, low-income households may still forgo it or depend on cheaper sources. Moreover, since almost 70% of Plateau State consumers consume bottled or sachet water daily, the social problem of waste disposal, including littering and pollution, is technically a negative externality of the industry that communities must bear.[65]There is also the question of water-use equity and resource fairness since local farmers and villagers traditionally rely on the same springs for irrigation and domestic use. Smallholder farmers perceive that Swan's extraction reduces

[61]Dagwon Pam, "Governor Mutfwang Signs N30 billion Contract
[62]Ladi Bot, female,40 years, health concerned resident, Jos, 01/01/2026.
[63]Lakon Shasha, male, 60 years, community leader, Kerang, 01/01/2026.
[64]Isreal Nwosu, "The Socio-Economic Impact of Swan Water Production in Plateau State." *African Journal of Development Studies*, Vol.19, No. 2, 2021, 111-113.
[65]T. Akanbi, "Drinking Water and Economics in Rural Nigeria." Journal of Water Problems, Vol. 17, No.2, 2019, 113.

water for their needs, which causes social tensions, especially since Plateau agricultural produce like maize and potatoes depends heavily on the same highland wetlands that the springs feed.[66] Overall, the socio-economic impact of Swan Water production in Kerang appears largely positive, since to date Swan Bottle Water remains a symbol of quality, trust, and innovation in Plateau state and Nigeria

Health Impact

The health implications of Swan's bottled spring water involve both the intrinsic quality of the source water and the manufacturing conditions. On the plus side, as already noted, Plateau's volcanic springs yield water in full compliance with World Health Organisation (WHO) mineral standards, the trace minerals (Mg, Ca) contribute modestly to dietary needs.[67] This means that before bottling, Swan's water does not require extensive chemical treatment beyond routine UV or microfiltration. This is because spring water is free of chlorine, lead or rust found in some piped systems. As Swan maintains high standards of purification and sterilisation, its product will confer health advantages over untreated local water. Nigerian surveys repeatedly find pathogenic bacteria in packaged water samples. This indicates that many bottled or sachet waters in Nigeria fail to meet basic microbiological standards, hence calls for improved hazard monitoring.[68] In practical terms, this means there is a real risk that Swan's product could become contaminated at some point in production or storage if strict quality control and regular laboratory testing are compromised. Although data on Swan's microbiological safety are lacking, the fact that clinics have not reported any Swan-related illnesses to date is encouraging.[69]

In addition to microbes, chemical safety is a concern, as Swan uses plastic bottles, and residual chemicals or leachates can affect health. Polyethene Terephthalate (PET) itself is generally regarded as safe, but additives such as antimony catalysts or plasticisers can migrate into water when heated. For example, prolonged sun exposure can raise antimony levels above recommended limits in some bottled waters. Another hazard is re-use, as Swan bottles, like bottles from other companies, are refilled by vendors, potentially introducing bacteria or chemical residues. Overall health impacts also depend on how bottled water fits into the local water landscape. In many areas in Plateau, bottled water has undeniably filled a gap left by an inadequate municipal supply that is either unreliable or contaminated.[70] In this sense, Swan's product, by combining a clean spring source with impeccable factory hygiene, can improve public health by supplying clean water, a provision

[66]G, M Ayuba and M.S. Ayuba, "Agricultural Water Use in Plateau State: Challenges and Opportunities." *Journal of Agriculture and Environmental Sustainability*, Vol.8, No.1, 2022, 49-51.
[67]Ibrahim Yusuf "Quality Assurance Testing, 70.
[68]Past incidents in Nigeria suggest that packaged water of unknown origin has on occasion been implicated in water-borne illnesses. See Bolaji Akin, "Bacteriological Safety of Packaged Drinking Water Sold in Nigeria: Public Health Implications." *Journal of Health,*Vol.3, No. 5, 2010, 15.
[69]Ziliyat Gida, "Solution for Plastic Pollution in Nigeria:
[70]E. N Nafinwu, Safe Governance and Regulatory Compliance in the Water Sector." *Journal of Water Control*, Vol. 9, No. 3, 2001, 21.

acknowledged as essential to sustainable development. But the need for monitoring and enforcement by the National Agency for Food, Drug Administration and Control (NAFDAC) must continue so that Swan water does not become substandard.

Challenges Facing Swan Bottle Water

Swan faces numerous operational and strategic challenges. Firstly, Swan suffers from high input costs and infrastructure deficits due to unreliable electricity supply. This means that Swan has had to budget heavily for fuel and invest in solar backup to avoid production interruptions.[71]This is compounded by high interest rates and limited access to credit in Nigeria, which makes scaling up production expensive. Secondly, distribution is another hurdle as Plateau State is hilly and receives heavy rains, delivering Swan bottles to Jos, Bauchi, Kaduna, or Lagos requires trucking over long distances. The extra fuel, vehicles, and potential spoilage (if bottles are exposed to heat) inflate prices.[72] Thirdly, competition from sachet water, since they are small plastic pouches of water, cheaper to transport and sell, and many Nigerians favour them for cost and convenience. Moreover, there is intense competition within the bottled-water segment itself, as large companies like Dasani and Aquafina, as well as indigenous brands, have established distribution networks and marketing budgets.[73] As a local Plateau brand, Swan must carve out market share against these incumbents. Expanding nationally will require strategic partnerships or investment

Fourthly, regulatory compliance poses its own challenges as Nigerian law mandates that all packaged-water factories register with NAFDAC, pass inspections, and maintain hygienic standards. These requirements protect public health but add bureaucratic burdens. The literature notes that government regulatory bodies are frequently inefficient, leading to inconsistent enforcement.[74] While this might allow some fly-by-night operators to evade costs, it also means that reputable companies like Swan must frequently demonstrate their compliance to satisfy both regulators and cautious consumers. Since quality lapses can lead to costly factory shutdowns or bad publicity. Fifthly, public and Non-Governmental Organisations (NGOs) are under increasing scrutiny in Nigeria. When citizens perceive that a company is harming local water sources or polluting, there can be backlash.[75] Swan managers must therefore be prepared to engage transparently with regulators and communities to avoid conflicts over environmental permits or the siting of bottling operations. Sixthly, industry-wide issues, such as the lack of robust recycling policies in Nigeria, affect Swan.[76] So, Swan must either accept that its

[71]Susan Rayit, "Power Sharing in its Local Context: The Case of Mangu LGA, Nigeria." https//edepot.war.nl/449398. Accessed 21/02/2026.
[72]Isreal Nwosu, "The Socio-Economic Impact of Swan Water, 112.
[73]Abdulazeez Musa Jibrin, Husiafa Agida Abubakar and Hauwa Yunusa, "Effect of Brand Personality on Consumer Buying Decision of Swan Bottle Water in North Central Nigeria." *NSUK Journal of Management Research and Development,* Vol. 1, Is. 2, 2025, 1-2.
[74]J.O. Odion, "An Assessment of the Regulatory Powers, 11.
[75]Ziliyat Gida, "Solution for Plastic Pollution in Nigeria.
[76]Modupe Adelaja, "Lack of Adequate Policies, Regulations Discourages Investment in Recycling Business." *Independent News Paper Nigeria*, 25 August 2023.https://independence.ng. Accessed 20/02/2026.

bottles become litter or join costly voluntary recycling efforts, especially with the growing public pressure to reduce plastic use. Climate change poses a long-term challenge, as changes in Plateau rainfall patterns could alter spring recharge.[77] In summary, Swan Bottle Water's path forward requires navigating Nigeria's daunting business environment. Success will hinge on efficient operations, strong quality control, and perhaps collaboration.

Conclusion

Swan Bottle Water's operations in Kerang encapsulate the promise and challenges of resource-based industrialisation in Nigeria. By leveraging the region's natural springs, Swan has provided clean, mineral-rich water, generated employment, and fostered community development, offering a viable model for addressing Nigeria's water crisis. However, environmental sustainability, equitable access, and operational constraints remain critical concerns. Collaborative governance, integrating corporate responsibility, community engagement and effective regulation, is essential to maximising the benefits of bottled water production while preserving natural resources. The conclusion that this paper brings to the fore is that Swan's experience provides valuable lessons for Nigeria's beverage industry and public water management, emphasising the need for private-sector innovation to complement, not replace, state-led efforts toward universal access to safe water, as outlined in Sustainable Development Goal 6. Greater investment in biodegradable packaging, renewable energy, and community water stations can further align Swan's model with evolving sustainability and equity expectations, ensuring its continued contribution to Nigeria's development.

Figure 1. A picture of three sizes of Swan bottled water



[77]T. Adamu, A. Yusuf and R. Bako, "Mineral Composition of Spring Water in Kerang,25.