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Why African Estuaries Matter? An Expert Perspective on Regional and Global Sustainability

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Abstract

African estuaries are critical ecosystems that serve as vital interfaces between terrestrial and marine environments, playing indispensable roles in regional and global sustainability. Africa possess the second largest river in the world, the Congo river. This review article synthesizes expert perspectives on the multifaceted importance of these dynamic systems, highlighting their ecological, economic, and social contributions. We explore their significance as biodiversity hotspots, nurseries for commercially important species, natural filters for pollutants, and buffers against climate change impacts. Furthermore, the article examines the threats facing African estuaries, including pollution, habitat degradation, overexploitation, and climate change, and discusses the implications for human well-being and ecosystem resilience. By integrating current research and expert insights, we underscore the urgent need for integrated management strategies and conservation efforts to safeguard these invaluable natural assets for present and future generations.

Keywords: African estuaries, sustainability, biodiversity, ecosystem services, climate change, conservation, coastal management.

1. Introduction

Estuaries, where freshwater from rivers meets and mixes with saltwater from the ocean, are among the most productive and biologically diverse ecosystems on Earth (Manning, 2025). In Africa, these transitional zones are particularly crucial, supporting a vast array of flora and fauna, and providing essential services to millions of people (Freeman *et al*., 2019). The continent's diverse coastline, stretching over 30,000 kilometres, is punctuated by numerous estuaries, ranging from large, well-developed systems fed by major rivers like the Nile, Congo, and Zambezi, to smaller, more ephemeral systems (Dube *et al*., 2025). These estuaries are not merely geographical features; they are dynamic ecological engines that underpin regional economies, cultural practices, and environmental stability (Carvalho Jr, 2025; Vasconcelos *et al*., 2024). Understanding "Why African Estuaries Matter?" requires a comprehensive examination of their ecological functions, the socio-economic benefits they provide, and the increasing pressures they face in an era of rapid environmental change and population growth (Barnes *et al*., 2026; Booi *et al*., 2022). This article aims to provide an expert perspective on these critical issues, drawing upon the latest scientific understanding and highlighting the imperative for their sustainable management.

2. Major rivers in African

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Africa possesses a vast number of rivers, over 150 rivers, out of which seven major rivers, as follows (Figure 1): Nile, Congo, Niger, Zambezi, Orange, Limpopo and Ubangi (a tributary Congo) rivers (Dube *et al*., 2025). Congo river is ranked second-largest river in the world, after the Amazon, with an average annual discharge of approximately 1,293 km^3/year (Olson & Omoyajowo, 2025).

Global freshwater discharge to the ocean is estimated to be around 40,000 to 45,000 cubic kilometres per year (Qin, 2022). African rivers, while numerous, generally have lower average discharge rates compared to those in South America and Asia, primarily due to climatic factors, including extensive arid and semi-arid regions, and different topographic characteristics that influence runoff (Onyari *et al*., 2025). The Congo River, the second world largest river, is contributing by about 2.8-3.2% of the global freshwater input onto the oceans (Olson & Omoyajowo, 2025). Other significant African rivers contributing to estuarine freshwater input include the Nile, Niger, and Zambezi, but their individual contributions are considerably less than the Congo's.

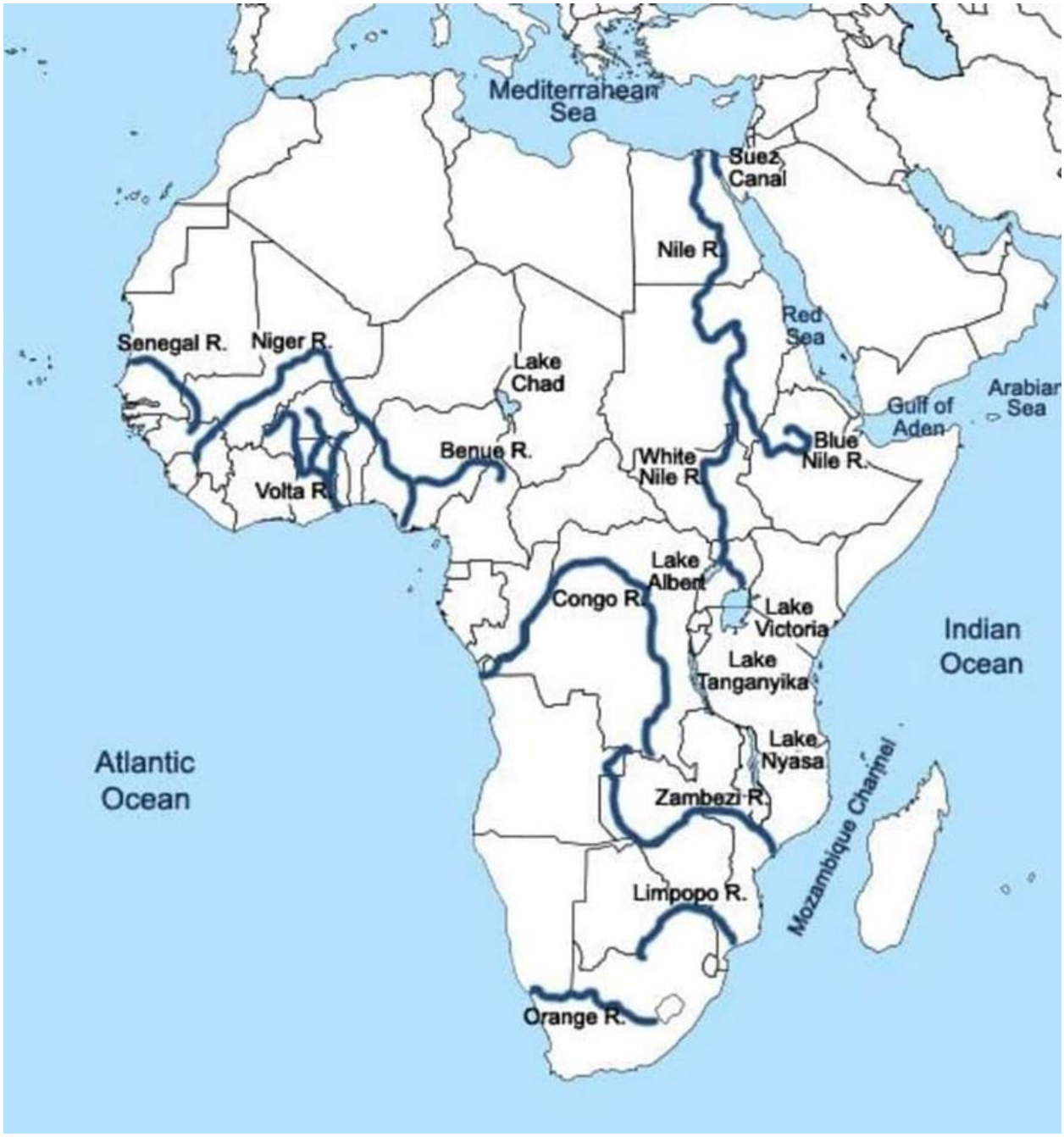

Figure 1. Location map of the African major rivers. Source: lizardpoint.com. https://www.tuko.co.ke/396797-7-major-rivers-africa-location.html

3. Ecological Significance

African estuaries are renowned for their exceptional biodiversity, serving as critical habitats for a wide range of species, many of which are endemic or endangered (Barnes *et al*., 2026; Niekerk *et al*., 2020). The mixing of fresh and saltwater creates unique environmental conditions that support specialized plant and animal communities, including mangroves, salt marshes, seagrass beds, and diverse invertebrate and fish populations (Ujwala, 2025).

- **Biodiversity Hotspots**: These ecosystems are often referred to as biodiversity hotspots due to the high concentration of species they support (Fortune *et al*., 2023; Wang & Kurata, 2024). For instance, mangrove forests, a characteristic feature of many African estuaries, provide crucial breeding grounds and nurseries for numerous fish, crustacean, and bird species (Pimentel *et al*., 2023). The East African mangroves are particularly diverse, hosting a significant proportion of the world's mangrove species (Naidoo, 2023).
- **Nursery Grounds**: Estuaries act as vital nursery grounds for a multitude of marine species, including many commercially important fish and shellfish (Rakib *et al*., 2022; Lewis *et al*., 2020). Juvenile fish and crustaceans find refuge and abundant food resources in the sheltered, nutrient-rich waters of estuaries, increasing their survival rates before migrating to the open ocean (Groeneveld *at al*., 2021; Dutton *et al*., 2019). This function is critical for maintaining healthy fish stocks and supporting coastal fisheries (Sheaves & Johnston, 2009).
- **Water Quality Regulation**: Estuarine ecosystems, particularly wetlands and mangroves, play a crucial role in filtering pollutants and excess nutrients from terrestrial runoff before they reach the marine environment (Rasmussen *et al*., 2024; Nataniel *et al*., 2022). This natural purification process helps to maintain water quality, protect coral reefs, and support other sensitive marine habitats (Carlson *et al*., 2021). The mangrove forests of the Rufiji Delta in Tanzania are an excellent example of this ecosystem service, trapping sediments and absorbing pollutants (Loyce *et al*., 2022; Monga *at al*., 2022).
- **Carbon Sequestration**: Coastal wetlands within estuaries, such as mangroves and salt marshes, are highly effective at sequestering atmospheric carbon dioxide, making them significant "blue carbon" ecosystems (Sadat-Noori *et al*., 2025; Choudhary *et al*., 2024). They store large amounts of carbon in their biomass and sediments, contributing to climate change mitigation efforts (Gomis *et al*., 2025; Choudhary *et al*., 2024). The mangrove ecosystems along the West African coast are estimated to store substantial quantities of carbon, with an estimated total stock of 854 million metric tons of carbon across approximately 1.97 million hectares (Bryan *et al*., 2020). These stocks vary by location and forest structure, with an average ecosystem carbon density of approximately 799 Mg C ha^{-1} in the West-Central Africa region (Kauffman & Bhomia, 2017).
- **Coastal Protection**: Estuaries, with their associated wetlands and vegetation, act as natural buffers against coastal erosion, storm surges, and tsunamis (Gedan *et al*., 2011; Rowland *et al*., 2025). The dense root systems of mangroves and salt marsh grasses stabilize sediments, reduce wave energy, and protect coastal communities and infrastructure from the impacts of extreme weather events (Jayson-Quashigah *et al*., 2025; Justine *et al*., 2025). The mangrove belts in Mozambique have been shown to significantly reduce the impact of cyclones (Camilla *et al*., 2025; Macamo *et al*., 2016).

4. Socio-Economic Importance

Beyond their ecological value, African estuaries provide a wide array of socio-economic benefits that are fundamental to the livelihoods and well-being of millions of people. They host a variety of cities and support significant economic infrastructure due to their rich biodiversity and the numerous ecosystem services they provide. These coastal areas are often centres of human activity, leading to both development and environmental challenges (Mumuni, 2025). Some of the major cities in estuaries in Africa include Durban and Cape Town, in South Africa, which are prominent coastal cities with significant economic infrastructure that interact with

estuarine systems**.** Beyond South Africa, other African cities which are also intrinsically linked to estuarine and coastal environments are Dakar in Senegal, Maputo in Mozambique**,** Lagos in Nigeria, Accra in Ghana's. These cities demonstrate the critical role estuaries play in supporting large urban populations and their economies, while also highlighting the vulnerabilities they face from environmental degradation and climate change.

Estuaries in South Africa contribute an estimated R4.2 billion per annum (around US$250 million to US$300 million annually (Turpie & Clark, 2007; Turpie, J.K. & Letley, G. 2019). The economic value of the ecosystem services of Algoa Bay alone was estimated to have grown from USD 613.4 million to USD 1695.9 million for local beneficiaries and from USD 1127.7 million to USD 2787.9 million for global beneficiaries between 2000 and 2019 (Orolowitz *et al*., 2025).

The major economic activities undertaken in African estuaries include the followings:

- **Fisheries and Aquaculture**: Estuaries are the backbone of many coastal fisheries, providing direct sustenance and income for local communities. The abundance of fish, crabs, shrimp, and other seafood supports artisanal and commercial fishing activities. Furthermore, the sheltered waters and nutrient availability make estuaries ideal locations for aquaculture, contributing to food security and economic development. The estuaries of Ghana are vital for their artisanal fishing communities (Kutir *et al*., 2024}.
- **Tourism and Recreation**: The scenic beauty and rich biodiversity of African estuaries attract tourists, supporting ecotourism, birdwatching, and recreational fishing. These activities generate revenue, create employment opportunities, and contribute to local economies (Butler et al., 2020; Olisah & Adams, 2021). The Okavango Delta, while an inland delta, shares many estuarine characteristics in its ecological processes and tourism appeal (Matlhola *et al*., 2022; Mbaiwa, 2025).
- **Transportation and Trade**: Many major African cities and ports, such as, Dakar, Abidjan, Lagos, Alexandria, Durban, Mombasa, and Maputo are located on or near estuaries, serve as crucial waterways for transportation and trade (Olukoju, 2020). The navigability of these systems facilitates the movement of goods and people, connecting inland regions to global markets.
- **Cultural Heritage**: Estuaries often hold deep cultural significance for local communities, being integral to traditional practices, spiritual beliefs, and historical narratives (Amanze, 2024; Olaopa, 2025). They are sites of traditional resource management, knowledge transfer, and cultural identity. The fishing communities along the Rufiji Delta have a rich cultural heritage tied to the estuarine environment (Ntibona *et al*., 2022; Shaghude, 2016).

5. Threats and Challenges

Despite their immense value, African estuaries are facing unprecedented threats from a combination of anthropogenic pressures and climate change impacts (van Niekerk *et al*., 2022).

- **Pollution**: Industrial, agricultural, and domestic pollution poses a significant threat to estuarine health (Olisah & Adams, 2021). Runoff containing pesticides, fertilizers, heavy metals, and untreated sewage degrades water quality, harms aquatic life, and can lead to eutrophication and oxygen depletion (Sidondi *et al*., 2025). The estuaries of the Nile Delta are particularly affected by agricultural runoff and industrial discharge (Shetaia *et al*., 2025).

- **Habitat Degradation and Loss**: Coastal development, urbanization, and infrastructure projects often lead to the destruction and degradation of critical estuarine habitats such as mangroves, salt marshes, and seagrass beds (Fendoung *et al*., 2025). Dredging, land reclamation, and dam construction alter natural hydrological regimes, impacting sediment flow and freshwater input, which are vital for estuarine function (Lubke *et al*., 2016). The mangrove forests of the Niger Delta have experienced significant degradation due to oil exploration and exploitation (Onyena & Sam, 2020).
- **Overexploitation of Resources**: Unsustainable fishing practices, including overfishing and the use of destructive gear, can deplete fish stocks and disrupt estuarine food webs (Bi et al., 2023; Wallner-Hahn *et al*., 2016). The unregulated harvesting of other estuarine resources, such as timber from mangroves, further exacerbates habitat degradation.
- **Climate Change Impacts**: African estuaries are highly vulnerable to the impacts of climate change, including sea-level rise, increased frequency and intensity of extreme weather events, and changes in precipitation patterns (James *et al*., 2013). Sea-level rise can lead to inundation of low-lying estuarine habitats, saltwater intrusion into freshwater sources, and increased erosion (van Niekerk *et al*., 2022). Changes in river flow due to altered rainfall patterns can disrupt the delicate balance of freshwater and saltwater, affecting estuarine productivity (Gillanders *et al*., 2002). The estuaries along the West African coast are particularly susceptible to sea-level rise (Dada *et al*., 2024).

6. Conclusion and Recommendations

African estuaries are undeniably critical for regional and global sustainability, providing an unparalleled suite of ecosystem services that support biodiversity, human livelihoods, and climate resilience. Their ecological functions as biodiversity hotspots, nursery grounds, natural filters, and carbon sinks are indispensable. Economically, they underpin fisheries, tourism, and trade, while culturally, they are integral to the identity of countless communities.

However, these vital ecosystems are under severe threat from pollution, habitat destruction, overexploitation, and the escalating impacts of climate change. The degradation of African estuaries has profound implications for food security, economic stability, and the well-being of coastal populations.

To safeguard these invaluable natural assets, a concerted and integrated approach to management and conservation is urgently required. Key recommendations include:

1. **Integrated Coastal Zone Management (ICZM)**: Implementing comprehensive ICZM plans that consider the interconnectedness of terrestrial, estuarine, and marine environments is crucial. This involves cross-sectoral collaboration, stakeholder engagement, and policy coherence to address multiple pressures simultaneously.
2. **Pollution Control and Waste Management**: Strict regulations on industrial and agricultural discharges, coupled with improved urban waste management and wastewater treatment, are essential to reduce pollution loads entering estuaries.
3. **Habitat Restoration and Protection**: Prioritizing the protection of intact estuarine habitats and undertaking large-scale restoration efforts for degraded areas, particularly mangroves and salt marshes, can enhance ecosystem resilience and services.
4. **Sustainable Resource Management**: Promoting sustainable fishing practices, regulating resource extraction, and empowering local communities in co-management initiatives can ensure the long-term viability of estuarine resources.

5. **Climate Change Adaptation and Mitigation**: Developing and implementing adaptation strategies to cope with sea-level rise and extreme weather events, alongside enhancing the carbon sequestration capacity of estuarine ecosystems, is vital.
6. **Research and Monitoring**: Continued investment in scientific research and long-term monitoring programs is necessary to better understand estuarine dynamics, assess the impacts of threats, and inform effective management decisions.
7. **Capacity Building and Awareness**: Strengthening the capacity of local communities and government agencies in estuarine management and raising public awareness about the importance of these ecosystems are fundamental for fostering stewardship.

By recognizing the profound importance of African estuaries and committing to their sustainable management, we can ensure that these dynamic and productive ecosystems continue to provide their invaluable services for the benefit of both nature and humanity, contributing significantly to regional and global sustainability.

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