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Mitigating the Effects of Climate Change on Fisheries, Aquaculture, and Aquatic Biodiversity:

Building Community Resilience for Sustainability and Livelihoods

CONSERVING AQUATIC BIODIVERSITY
AFRICA BLUE ECONOMY STRATEGY

FishGov 2 Project

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Abstract:

This policy outlook explores discourse on the intricates of **Mitigating the Effects of Climate Change on Fisheries, Aquaculture, and Aquatic Biodiversity and how Building Community Resilience for Sustainability and Livelihoods** could innovatively provide solutions necessary to addressing the climate change threatens on fish supplies and the livelihoods of coastal and inland communities. It is observed that rising ocean temperatures, pollution, and severe storms damage wild habitats and fish farms. Hence, robust policy is required to support the building of community resilience that involves restoring natural environments like mangroves and shifting to sustainable, climate-smart farming to protect food and jobs.

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Declaration on Conflict of Interest

The study was conducted in accordance with the professional standards of AU-IBAR and the AU Commission.

1.0 Introduction

The effects of climate change on fisheries, aquaculture, and aquatic biodiversity are influenced by environmental variability and pose significant threats. Climate change and environmental shocks, whether positive or negative, are an integral part of fisheries, aquaculture, and aquatic ecosystems.

These impacts will be felt at three fundamental levels: on the fish stocks and their habitats, on the critical marine and coastal ecosystems on which they depend, and on the vulnerable fishing communities exposed to more-frequent extreme weather events.

They affect the drivers that influence aquatic systems' biological processes through changes in water quantity and quality, temperature, salinity, oxygen levels, acidity, fishing pressure and natural habitats. In addition, they influence drivers of change that affect human choices in the use of aquatic resources, including changes in governance structures, input and output prices, technological change, emergencies and cultural aspects.

In addition to the environmental changes brought about by climate change, the livelihoods of those who depend on aquatic ecosystems for aquaculture will be indirectly affected by climate-related events. These events include changes in habitats and physical/chemical conditions that will require adjustments to farming practices and aquaculture operations, including selecting or adapting species and strains to new growing conditions, with implications for the training and educational support needed.

In response to these complex environmental, social, and economic changes, there is a need for a robust strategy to manage aquatic resources. Threats from pollution, overexploitation, Illegal, Unregulated and Unreported (IUU) fishing and conflicting use of resources cause damage and destruction of habitats and expose aquactic ecosystems to the adverse effects of rising ocean temperatures and sea-level rise resulting from climate change. This experience has already begun, resulting in tangible effects of climate change, including rising sea levels, inceasing acidity, changes in alkalinity, frequent flooding, and coastal erosion.

Blue ecosystems such as mangroves, seagrass, seaweed and coral reefs serve as natural defences by reducing physical vulnerability along coastlines. Inland lakes and wetlands help mitigate flood risks and regulate microclimates. Moreover, seagrass beds and mangroves offer entry points into rapidly growing blue carbon credit markets, attracting investors seeking to offset emissions. These factors make the blue economy a compelling investment proposition, as it combines climate resilience with emerging financial opportunities.

1.1 Climate Change Impacts on Africa's Aquatic Systems

Aquatic ecosystems are a significant source of food that comprises fish, seaweed, and other foods that account for over 20% of the global human food intake by weight.

Already, the impact of Climate change on the African aquatic ecosystems and biodiversity is affecting the livelihoods and welfare of the population depending on these services.

- Coral bleaching and ocean acidification;
- Sea-level rise and habitat level rise and habitat shift;
- Depletion of living marine resources and loss of biodiversity;
- Degradation, modification and destruction of critical marine habitats; and,
- Decline in water quality with its associated problems of eutrophication, anoxia, and algal blooms are of transboundary in nature and require regional effort in addressing them.

Climate change has serious negative impacts on habitat-forming species such as corals, sea grass, mangroves, salt marsh grasses, and oysters; which are among the most obvious and profound, with expected loss of these species and habitats. These organisms collectively provide habitat for thousands of other species. Their combined effects on coastal areas are especially relevant as they impact on the livelihood and welfare of fishing communities through: (a) coastal erosion; (b) coastal flooding; (c) inland flooding; (d) saltwater intrusion, affecting both surface and groundwater, and by extension the low-lying paddy rice fields that would also undermine aquaculture systems. Natural and human activities exacerbate the impact of climate change on large marine and freshwater ecosystems where small changes in water and air temperature can cause a delay or anticipate seasonal events such as upwelling currents that create the conditions for the productivity of marine and freshwater organisms.

Freshwater ecosystems are among the most vulnerable to global climate change. Many Great African Lakes have experienced the growth of alien species such as the water hyacinth, predatory fishes, pelagic fish that are substituting the local biodiversity. In Lake Chad, the main threats of climate change are the growing scarcity of freshwater, increased levels of salinity for coastal communities, possibility of worsening health from air pollution concentration, heat stress and increased flooding (rainfall events may become fewer but heavier).

As global climate change progresses, the effects on Africa's aquatic biodiversity, fisheries, and aquaculture have shifted from projections to tangible realities, affecting livelihoods, food systems, and the economies of all 55 African Union Member States (AU-MS). Across the continent, changing rainfall patterns, floods, rising temperatures, prolonged droughts, sea-level rise, salinity intrusion, and ocean acidification are increasingly disrupting fish production systems and the communities that depend on them.

The African Union Inter-African Bureau for Animal Resources (AU-IBAR) serves as the main office coordinating the continent's response to these challenges. By aligning its 2024-2028 Strategic Plan with the AU Agenda 2063, the Policy Framework and Reform Strategy (PFRS) for fisheries and aquaculture in Africa (PFRS, 2014), and the Africa Blue Economy Strategy (ABES, 2019), AU-IBAR has a roadmap shaping the continental approach to a sustainable and inclusive blue economy. Key to these efforts is the implementation of the Comprehensive Africa Agriculture Development Program (CAADP), the central tool for agricultural transformation in Africa.

With the AU-IBAR Fisheries Governance Management Programme, efforts to address climate change through adaptation resilience are constituted in the mainstreaming activities, including building resilience and mitigating the impact of climate change and environmental randomness or shocks on fisheries and aquaculture. The randomness or shocks whether positive or negative, are integral part of fisheries and aquaculture systems and impact those drivers that would affect the aquatic systems' biological processes through, changes in water quantity and quality, temperature, salinity, oxygen, acidity, fishing pressure and natural habitats, as well as drivers of change that impact human choices in their use of aquatic resources, such as changes in governance structures, input and output prices, technological change, emergencies and cultural aspects.

Failure to integrate climate change and environment into the fisheries and aquaculture management system, the resulting effect of change may be highly negative effects on long-term sustainability, as capture fisheries and aquaculture would decline and collapse the sector. Climate change and environmental degradation put pressure on fisheries and aquaculture, and the question of how to meet increasing demand for fish in the face of climate change and environmental degradation poses great threats to fisheries and aquaculture management. Most aquatic animals are cold-blooded; their metabolic rates are strongly affected by environmental conditions, especially temperature. Temperature changes have a significant influence on the reproductive cycles of fish, including the speed at which they reach maturity. Temperature-related impacts specific to aquaculture would be related to temperature-suitable zones of farmed species and the increased spread of farmed fish diseases directly linked to increased temperatures. While environmental pollution affects the habitat ecosystem and breeding grounds.

Greenhouse gas (GHG) accumulation is also increasing the acidification of oceans, with potentially severe consequences for shellfish and squid, mangroves, tropical coral reefs and cold-water corals. Among other services, coral reefs are home to 25% of all marine fish species, but changes in water quality directly impact on their ability to produce their skeletons, directly impacting reef-based fisheries alongside tourism, medicine, among others. Rising sea levels would displace brackish and fresh waters in river deltas, wiping out some freshwater aquaculture practices and destroying wetlands, but also creating new environments and some opportunities (e.g. for brackish aquaculture species). Increased storm activity (intensity and occurrence) endangers the lives of fishers, fish farmers and coastal/riparian/lacustrine communities directly, can cause damage to fisheries and aquaculture infrastructure and housing, and presents additional threats for coral reefs and mangroves. Storms and floods would also increase the risks that farmed species escape, having potential impacts on farm profitability and genetic biodiversity in the natural systems.

The AU-IBAR Fisheries Governance project seeks to restore and build resilience and mitigate the impact of climate change and environmental randomness or shocks on fisheries and aquaculture. The ecological system's natural resilience, the fisheries and aquaculture sector may also rely to a certain extent on risk spreading or reduction tactics, such as livelihood diversification, disease and disaster risk management, and creative combinations of public and private insurance tools. To adapt to climatic variables or by explicitly incorporating decision-making under uncertainty into management plans would need to evaluate how shifts from an open access situation towards defined and stable access rights might affect fishers' use of

migration as an adaptation strategy when facing changes in species distributions. At the regional level, regional agreements among countries sharing transboundary stocks will also need to be adjusted as shifts in stock distributions and changes in productivity occur.

Technical innovation provides some mitigation measures and adaptation actions, such as the breeding of saline-resistant aquaculture species to confront sea level rise, the development of storm-resistant fish farming systems (e.g., fish cages), and the widespread use of information technology to share weather as well as market information. Fishing vessels of all sizes may be rendered more stable to allow for fishing further away from the coastal area to follow targeted species and resist inclement weather, but also equipped with pollution management tools. Fish aggregating devices may be used to lure fish back within the traditional fishing grounds. Proper aquaculture zoning mechanisms at the watershed level, biosecurity frameworks, risk analysis, and strategic environmental assessments that take into account the added effects on aquaculture farms would enable the sector to better face potential threats such as new diseases, invasive species, and eutrophication-related problems that can be exacerbated by climate change (e.g. increased water temperature and salinity). Diversification within aquaculture, and especially exploring new opportunities in mariculture, potentially offers new adaptation options. By moving away from freshwater systems, both the impacts on water resources and the competition with other sectors for its use would be reduced.

1.2 Blue Economy, Nature-Based Solutions, and Resilience Building

The Africa Blue Economy Strategy (ABES) was established as an inclusive model to support governance and management of the ecosystem health of Blue Ecosystems in the continent. However, blue ecosystems are continually threatened by climate-induced stressors such as more extreme weather events, rising ocean temperatures, and ocean acidification, which disrupt aquatic biodiversity, fish productivity, and aquaculture.

Hence, to bridge that gap, AU-IBAR has increasingly supported the use of Nature-Based Solutions (NbS) and gender-responsive approaches to empower women and youth. This article examines the multifaceted impacts of climate change on the fisheries and aquaculture sector, outlining strategies to improve resilience, and draws on evidence from across the continent and guiding African Union policy directives with practical actions to empower women and the youth.



Figure 1: *Mangrove restoration training for the local community in Gazi Bay, Kenya*

1.3 Definitions

To provide harmony in understanding this discussion on aquatic biodiversity conservation and climate resilience and adaptation, it is vital to define the following major concepts guiding the AU-IBAR strategies:

Table 1: Concepts and Definitions on Aquatic Biodiversity, Climate Resilience, Adaptation within the AU Framework

Term	Definition within the African Union Framework
Blue Economy	An inclusive and sustainable economic system utilizing oceans, seas, coasts, lakes, rivers, and groundwater resources to improve livelihoods, boost the economy, and ecosystem health, while maintaining the health of aquatic ecosystems.
Blue Carbon	Carbon is stored by oceans and coastal ecosystems such as grasses, mangroves, and salt marshes, which are vital for climate change mitigation.
Nature-Based Solutions (NbS)	Activities that sustainably manage, protect, and restore ecosystems while addressing societal challenges such as food scarcity, climate change, biodiversity loss, and livelihood challenges.
Resilience **Adaptation**	The ability of a community, system, or society to anticipate, resist, accommodate, absorb, transform, adapt to, and recover from hazardous shocks in an efficient and timely manner. Climate change adaptation refers to the practical steps communities, businesses, and governments take to adjust to the current and future impacts of climate change. It is about preparing for unavoidable hazards, disasters, and risks—such as extreme heat, sea-level rise, and droughts, as well as landslides or mudslides—to minimize harm to property and life and take advantage of new opportunities for financing and investments (UNDP, Climate Promise, 30 January 2024).
Climate Mainstreaming	The practice of assimilating climate change deliberations into the planning and implementation of policies and development programs across the aquaculture and fisheries sectors.
Aquatic Biodiversity	The wide range of life and ecosystems that encapsulate fresh, marine, and brackish aquatic systems, and include ecosystems, genetic, and species diversity.

Source: *Adapted from AU-IBAR (2022); AU PFRS (2014); and ABES (2019).*

1.4 Overview of the Fisheries and Aquaculture Sector and Climate Change Impact

The fishery sector is estimated to contribute about 24 billion dollars to the African economy and create direct employment of about 13 million people. In Africa, per capita fish consumption is about 10 kg. The coastal and marine areas are richly endowed with abundant but rapidly depleting marine resources, especially of commercially valuable fish, as well as other living and non-living resources on which the economies of most African countries largely depend. These coastal and marine areas are repositories of rich and unique biodiversity of global importance and contribute significantly to the world's annual catches of fish and fisheries, about 7 million metric tonnes of fish. The sector is a major source of employment, providing livelihoods for over 200 million and a SafeNet for many Africans. However, the threats of climate change and other environmental phenomena loom large.

The impacts on the fisheries have been linked to changes in average water temperature, erratic rainfall variability, and increased occurrence of extreme weather events. The rising sea temperatures and changes in the oceans' water currents and other dynamics, such as acidification and loss of nursery areas, are going to reduce fish populations. The impacts of CC on marine fisheries would affect attainment of the SDGs, including SDG 1 (No poverty), SDG 2 (Zero hunger), and SDG 3 (Good health and well-being) in fishing

communities that are especially vulnerable to climate change because of their economic dependence on fisheries for their livelihoods and for food and nutrition security.

Within the seas, climate warming is affecting the reproduction of several species. Shifts in the latitude of fish species have already been noted. Species that need colder temperatures migrate poleward of the ocean with warming oceans. Climate change has an impact on fisheries production by influencing primary production, food web interactions, and target species life history and distribution. Temperature is directly related to seasonal changes in the hydrography and plays a key role in the distribution pattern of plankton during the major upwelling.

The changes in physical and chemical environment influence changes in primary production, while changes in the food web are also influenced by primary production availability. Key effects of Climate change on fisheries include reduced productivity, loss of fish habitats, displacement of stocks and or species, interference with reproduction and migratory patterns of fish species, and loss of species, among others. The decline in plankton abundance, as a result of climate change, thus affects the abundance of fish and other living marine resources.

The African Union's work on sustainable animal resource production is supported by a set of high-level policy frameworks aimed at transforming the continent's food systems. The AU Agenda 2063, the Policy Framework and Reform Strategy (PFRS) for fisheries and aquaculture in Africa (PFRS, 2014), and the Africa Blue Economy Strategy (ABES, 2019) provide key frameworks on the development and management of the fisheries and aquaculture sector in Africa and a strategic pathway for mitigating climate change and environmental randomness.

2.0 Impacts on Aquatic Ecosystems

Aquatic ecosystems are vital sources of food, including white meat/ fish, seaweed, and other foods that account for over 20% of global human food consumption by weight. Climate warming is impacting these ecosystems in several ways. Rising sea temperatures, changing rainfall patterns, droughts, flooding, and ocean salinification are affecting aquatic habitats and reducing the overall productivity of our ecosystems.

Climate change affects fisheries production by influencing primary production, food web interactions, and target species' life histories and distributions. Among the most vulnerable ecosystems are seagrass beds, wetlands, mangrove forests, and coral reefs. These habitats are vital nursery and breeding grounds for fish species while preserving coastlines from storm surges and erosion. Climate change is reducing the capacity of these ecosystems to protect coastal communities and provide ecosystem services, such as carbon storage.

Hydrological and water temperature changes are similarly affecting fish breeding cycles, migration, feeding behaviors, and species distribution. Fish migration has, for instance, been observed in response to ocean warming; species that need cold temperatures migrate poleward. Reduced dissolved oxygen levels and changing salinity patterns place additional pressure on aquatic species. In several coastal and inland water bodies, prolonged flooding and drought events have contributed to a decline in biodiversity, habitat loss, and ecosystem instability.

Healthy ecosystems are vital to sustaining fisheries production, supporting tourism, maintaining water quality, and strengthening climate resilience. Hence, protecting aquatic biodiversity is essential for socio-economic development and ecological sustainability.

3.0 Impacts on Fisheries and Aquaculture

The fisheries and aquaculture sectors, which play vital roles in the African economy, are increasingly being affected by climate change, threatening the livelihoods of millions and increasing operational risks to these aquatic resources. The fisheries sector, for instance, contributes approximately 1% to the African economy, while aquaculture accounts for 17% of total African fish production, reflecting a higher unit export value from the industry, primarily to Europe and other developed markets.

Fisheries

Changes in average sea temperatures, erratic rainfall patterns, and increased frequency of extreme weather events are reducing fish productivity, displacing fish stocks, disrupting reproduction and migratory patterns of fish species, and causing the loss of fishery habitats, among other impacts. In traditional fishing grounds, changes in fish stocks are making it challenging for communities to predict fish harvest and sustain stable income streams. Small-scale fisheries are especially vulnerable due to their dependence on scarce resources and inadequate options for adaptation.

In Lake Tanganyika in East Africa, for instance, warming has diminished fish production by up to 20%, resulting in a consequent reduction in fish yield by up to 30%. In West Africa, climate change has altered species composition in fisheries catches and in other marine and freshwater ecosystems, including the Mozambique Channel region and the Benguela Current Large Marine Ecosystem (BCLME). Here, fishers have had to adapt by using new fishing gear, targeting new species, migrating, or expanding their fishing grounds to safeguard food security and their livelihoods.

Fishing infrastructure such as landing sites, boats, storage facilities, and market systems has faced significant levels of damage from extreme weather events such as cyclones, floods, and storms. These disruptions reduce market access and increase post-harvest losses. Declining water levels due to drought and rising temperatures, in addition, affect production in inland fisheries and reduce fish habitats.

Aquaculture

Aquaculture exploitation in Africa largely consists of freshwater tilapia and catfish farming, followed by shellfish, crustaceans, and algae. Aquaculture faces specific climate-change risks that seem more dramatic than those for fisheries due to its more time-bound exploitation and intensive nature.

In aquaculture, rising temperatures expose cultured species to thermal stress, making them more susceptible to disease and harmful algal blooms and reducing reproduction. The high temperatures during summer similarly reduce oxygen levels, causing fish to die. Low water temperatures during winter, on the other hand, reduce fish growth rate and appetite, leading to poor growth. Climate change is also accelerating pathogen evolution, increasing disease outbreaks, and promoting the spread of invasive species. In addition, changes in water quality and harmful algal blooms are threatening aquaculture production.

Flooding damages cages, ponds, water supply systems, and hatcheries, while droughts limit production capacity and reduce water availability due to difficulty replenishing supplies. Feed supply and affordability are compounding challenges, particularly where producers depend on imported ingredients. These combined stressors reduce overall profitability and increase production costs. To strengthen resilience and ensure continued growth in the sector, there is a need for improved biosecurity measures, climate-smart aquaculture practices, sustainable feed systems, and adaptive management methods.

4.0 Socio-economic Impacts

Climate-induced changes across Africa are already affecting traditional livelihood systems. In Angola, rising water levels have affected the distribution of vital pelagic species such as Sardinella and Trachurus. With rising water levels, most small-scale fishers who rely on nonmotorized dugout canoes are unable to follow the fish stocks into the cooler, deeper waters, resulting in reduced catches and income. In addition, seasonal changes in fish availability affect artisanal fishers who combine fishing and agriculture, increasing livelihood vulnerability and reducing food security.

These challenges are being experienced in similar ways across different areas of the continent. For instance, in Mali, fishers are forced to travel longer distances to follow fish stocks and to cope with receding water levels after flooding events. Lagoon and marine fishers in Sierra Leone's Bonthe Lagoons have had to adjust their fishing activities to seasonal ocean conditions, shifting their operations to safer lagoon areas during periods of high wave activity. These adaptations demonstrate the increasing uncertainties that face these fishing communities and the growing need for adaptable livelihood strategies.

Climate change is also affecting other broader economic sectors that rely on aquatic ecosystems. Rising temperatures, water scarcity, and extreme weather damage have an impact on industries that depend significantly on aquatic ecosystem goods and services, such as transport and communication, insurance, banking, and construction, among others, which suffer losses and damages from climate change effects, with severe economic consequences, especially for communities with inadequate adaptive capacities.

Communities in these marginal regions, particularly women and youth, are usually the first to experience the adverse effects of these disruptions because of the vital roles they play in fish harvesting, processing, marketing, and value chain activities. A reduction in fish production and market instability limits economic opportunities and increases social inequalities. Individuals with asset bases (such as money, homes, household items, savings, pensions, food security, and social assets, i.e., support networks) have often experienced damages with severe economic consequences. People with low incomes, on the other hand, are forced to live in marginal areas due to their low capacity to adapt to the effects of climate change. These disruptions also encourage seasonal or permanent migration of communities in search of alternative livelihoods.

5.0 AU Responses and Best Practices

Recognizing these growing effects of climate change, the African Union and AU-IBAR have developed policy frameworks and practical interventions to strengthen resilience across fisheries, aquatic ecosystems, and aquaculture. At the policy level, AU Agenda 2063, ABES, the PFRS, and CAADP provide guidance for biodiversity conservation, sustainable aquatic resource management, climate adaptation, and blue economy development. These frameworks emphasize inclusion, resilience, community participation, and inclusion.

Seaweed Farming in Zanzibar, Tanzania

One major example is seen in the AU-IBAR collaboration with the Zanzibar Seaweed Cluster Initiative (ZaSCI) to strengthen local coastal communities in Zanzibar. AU-IBAR and ZaSCI sensitized local communities/farmers on climate change mitigation; conducted field surveys to identify tree species most commonly used as pegs on the Unguja and Pemba islands of Zanzibar, and to identify practices that contribute to coastal pollution and environmental degradation in seaweed farming areas.



Figure 2: Seaweed restoration efforts in Zanzibar, Tanzania

In the region, seaweed farming is supporting livelihoods, especially for women, while supporting ecosystem stewardship and climate adaptation. By diversifying sources of income and reducing pressure on natural resources, seaweed farming is contributing to sustainable development and resilience.

Mangrove Restoration in Gazi Bay, Kenya

Within the framework of ABES, AU-IBAR has similarly supported mangrove restoration in Gazi Bay, along Kenya's Indian Ocean coastline, through Nature-Based Solutions (NbS). The project entailed training 50 individuals in mangrove restoration techniques, planting 10,000 fast-growing trees and 1,000 fruit trees, and replanting 10,000 mangrove seedlings in degraded areas of Gazi Bay.



Figure 3: Mangrove restoration efforts in Gazi Bay, Kenya

The training focused on championing nature-based enterprises as alternative livelihoods to reduce overreliance on mangrove resources. In addition, emphasis was placed on involving women and youth and strengthening regulatory frameworks for conserving mangroves/coral reefs. These efforts have subsequently promoted climate resilience, community well-being, and biodiversity, as restored mangroves now improve biodiversity conservation, enhance coastal protection, support fish nurseries, and contribute to blue carbon sequestration.

Gender Mainstreaming in Dusornu, Ghana

In addition, AU-IBAR has supported gender mainstreaming in the protection, management, and conservation of the fragile mangrove ecosystem within the context of the Keta Lagoon Complex Ramsar Site (KLCRS), through the Dusornu Community Resource Management Area (CREMA).



Figure 4: Gender-sensitive community training on mangrove ecosystems in Ghana

The initiative has enhanced the role of vulnerable groups, including women and youth, in aquatic biodiversity conservation and in the implementation of climate-resilient adaptation strategies, particularly nature-based solutions (NbS). The initiative has improved the community's governance systems by championing women's participation in natural resource management, decision-making, and ecosystem restoration initiatives. Emphasis was placed on electing women officials in critical decision-making roles to ensure their voices are heard and to foster more sustainable and equitable conservation practices. This inclusion of women is expected to lead to a more holistic understanding of community needs and perspectives, ultimately strengthening the CREMA's approach to mangrove management.

Small-scale octopus' fisheries in Comoros and Madagascar

In Madagascar and Comoros, AU-IBAR supports small-scale fisheries demonstrating the effectiveness of community-based fisheries management. The initiatives strengthen the resilience and sustainability of these fisheries, which are among the most economically significant fisheries in the Western Indian Ocean Region.

A major outcome in the region has been the establishment of the Western Indian Ocean Network on Sustainable Octopus Fisheries (WION-SOF), which is promoting inclusive, sustainable, participatory fisheries governance, as well as sustainable harvesting practices and local stewardship, to contribute to improved livelihoods, biodiversity conservation, and enhanced resilience to climate challenges. The initiative has similarly encouraged community-based management, knowledge sharing, and supported the participation of women and youth along the value chain.



Figure 5: Training on Harvesting, Handling and Processing of Small -scale octopus fisheries in Comoros and Madagascar

These examples demonstrate the significance of integrating community engagement, policy support, social inclusion, and ecosystem restoration into climate resilience strategies.

5.1 Gender, Women, Youth, and Social Inclusion

Social inclusion is a vital pillar for establishing climate resilience in the aquatic sector. Women and youth possess valuable innovative and knowledge potential. Across the continent, women play major roles in the processing, smoking, drying, retail, informal trade, and transport value chains. In some regions, they are also resource stewards and producers. Yet, these women are often the most vulnerable to climate shocks. They face discrimination, including greater exposure to post-harvest losses, limited access to financing, restrictions in asset ownership, unequal market opportunities, exclusion from leadership, and heavy unpaid care burdens.

The AU-IBAR Continental Strategy for Gender Mainstreaming, released in 2023, provides a reliable blueprint to empower women in environmental sustainability.

As discussed above, in the Dusorno CREMA community in Ghana, active participation of women in the management of Community Resource Management Areas (CREMAs), and in mangrove restoration has shown that gender inclusivity is effective in achieving sustainable outcomes. In addition, the project has also shown the significance of alternative livelihood for vulnerable populations, assisting in reducing reliance on already over-exploited natural resources.

In Zanzibar, seaweed farming has created opportunities for coastal women to earn income while participating in ecosystem services and climate adaptation.

In addition, the inclusion of youth is important. Africa's profile means that millions of young people need opportunities to participate in the production process in sectors such as fisheries technologies, digital marketing, logistics, hatcheries, feed production, eco-tourism, and restoration enterprises, all of which offer pathways to good jobs. For youth, the focus therefore remains on creating entrepreneurial opportunities across the value chain to ensure the sector remains attractive.

5.2 Building Resilience for Sustainability

Building resilience for sustainability requires a shift from "business-as-usual" systems to an integrated approach that combines innovative financing, behavioral change, and community engagement. The Continental Strategy for Nature-Based Solutions (CS-NbS) is established on four major pillars designed to support NbS adoption across the continent.

Table 5: CS-NbS Pillars and Priority Actions for Sector Resilience and Sustainability

CS-NbS Pillar	Priority Action
Conceptual Reshaping	Simply NbS and align it with continental priorities.
Community Engagement	Empower the local community, especially women and youth, as leaders in environmental restoration.
Knowledge as Engine	Support behavioral change initiatives and strengthen knowledge management.
Combining Approaches	Align policies across sectors and develop collaborative finance models.

Source: *Adapted from AU-IBAR, PFRS, 2014; ABES, 2019 synthesis.*

Based on previous examples, Seaweed farming in Zanzibar is a good example of an NbS that is building resilience. By mainstreaming climate concerns into seaweed farming, local communities can effectively mitigate the negative effects of environmental change while maintaining a steady source of income that is less dependent on traditional farming.

Building resilience in aquaculture, fisheries, and aquatic biodiversity across Africa requires a shift to inclusive, ecosystem-based, and knowledge-driven strategies. Data from AU-IBAR studies highlight that resilience is interconnected across socio-economic, technological, and institutional facets of aquatic ecosystems, necessitating strategies that integrate environmental sustainability with human development outcomes.

- **Nature-Based Solutions:** Ecosystem-based solutions such as watershed protection, wetland conservation, mangrove restoration, and seaweed farming are identified as a cornerstone of climate resilience in the sector. These solutions generate multiple benefits, including habitat restoration, shoreline defense, carbon sequestration, and livelihoods support in ecosystems such as seagrasses, wetlands, mangroves, and coral reefs, which act as natural buffers against the impacts of climate change.
    - Mangroves, for example, play a dual role by acting as significant carbon sinks and protecting coastlines from erosion; thereby contributing to mitigation and adaptation objectives.
    - Climate-smart production: Reduced post-harvest losses, better feeds, efficient cold chains, diversified livelihoods, and blue finance instruments strengthen household resilience.

- **Investment and Finance:** Climate funds, blue finance instruments, blended finance, and targeted public expenditure are required. CAADP's commitment to agricultural investment should explicitly include aquaculture and fisheries.

- **Innovation, data, and science:** Information sharing and knowledge management are equally important. Despite the availability of successful pilot projects across Africa, their impact remains inadequate due to ineffective dissemination and weak coordination. Enhancing sub-regional and regional platforms to improve the exchange of data, innovations, and best practices can accelerate the proper scaling of effective solutions. Remote sensing devices, digital tools, and technologies such as climate risk mapping, hatchery research, satellite monitoring, digital extension services, and operational fisheries databases are vital and offer opportunities to enforce sustainable practices and monitor aquatic ecosystems.

- **Adaptive Management practices** are vital for enabling aquaculture and fisheries systems to respond to the changing climate. These practices include adjusting fishing zones and seasons, integrating early warning systems for extreme weather events, promoting climate-smart aquaculture, and diversifying target species. Such measures align with the PFRS and ABES, which advocate for building resilience through sustainable intensification, innovation, and improved governance mechanisms.

- **Community-based approaches** further improve resilience by strengthening social cohesion and local ownership. To ensure adaptation strategies are both sustainable and inclusive, it is vital to empower the community. Training local institutions, extension workers, cooperatives, fishers, youth, and women is essential for positive change. Other community-based approaches include providing access to finance and ensuring their participation in decision-making processes.

Women play a vital role in ecosystem restoration activities, such as mangrove restoration and post-harvest fisheries value chains, yet they remain affected by the impacts of climate change. Tackling these inequalities is vital in achieving CAADP indicators on poverty reduction and inclusive agricultural growth.

6.0 Challenges, Gaps, and Constraints

Despite the progress made so far, some major barriers remain that can undermine sustainability in the sector:

- **Inadequate Data and Monitoring:** Inadequate high-quality data on fisheries and aquaculture make it challenging to track progress against the CAADP indicators.
- **Weak Institutional Capacity:** Many Member States have limited financial and technical resources, affecting their ability to implement continental frameworks.
- **Climate Vulnerability of Input-Mechanisms:** Dependence on climate-sensitive feed ingredients and on aquaculture creates high production risks.
- **Limited Financial Access:** Women-led enterprises and small-scale operators often lack access to the investment and credit needed to adopt climate-smart innovations.
- **Gender-Blindness in Policy:** Many national-level programs and policies remain gender-blind despite several high-level strategies; most fail to acknowledge women's roles and needs within value chains.
- **Biosecurity Risks:** Inadequate transboundary health protocols and a lack of robust diagnostic services increase the risk of disease outbreaks in the aquaculture sector.

Other challenges include: weak coordination across ministries; low public expenditure in the sector; poor infrastructure on farms and at landing sites; weak insurance markets; informality in value chains; low processing capacity and value addition; and continued habitat degradation.

Unless these challenges are addressed, they will limit advancement toward the Kampala CAADP agenda and Agenda 2063 aspirations.

7.0 Conclusion and Recommendations

The impact of climate change on the continent's aquatic biodiversity, fisheries, and aquaculture is profound and multi-faceted, demanding a coordinated response at national, regional, and continental levels.

This review has highlighted the potential effects of climate change and environmental degradation on aquaculture production and implications for the sector's sustainability. Despite being considered the only solution to meeting the continued rise in demand for aquatic products, the aquaculture sector is increasingly being threatened by human-driven climate change effects that are both a present and future reality.

These effects on aquaculture are expected to be both positive and negative, although the negative outweighs the positive ones. Besides, although climate change is a global food production risk, the associated risks on aquaculture are expected to differ across geographical or climatic zones, national economy, water environment, production systems, the scale of production, and cultured species of the aquaculture producers. To build resilience and sustain production in a changing climate, the aquaculture producers must adapt to the available options in the short-term while mitigating the effects by making necessary adjustments in their production practices in the long-term.

This article has highlighted that, though the challenges may be significant, the frameworks established by the African Union, especially the PFRS and ABES, play a key role in the much-needed transformation.

Integrating these sectors into the CAADP Biennial Review Process ensures that aquatic resources contribute to the overall goals of Food security and agricultural transformation.

To improve resilience and sustainability, the following recommendations are proposed:

- **Mainstream NbS into National Policies:** African governments should include NbS such as seaweed and mangrove farming into their NDCs and National Agricultural Investment Plans (National Agricultural Investments Plans (NAIPs).
- **Institutionalize AFAData:** AU-MS should focus on institutionalizing AFAData to advance well-informed decision-making based on credible, transparent data.
- **Expand Gender-Responsive Interventions:** Domesticate the Continental Strategy for Gender Mainstreaming at the national level, with secure funding for women and youth-led interventions in the blue economy.
- **Modernize the Aqua-feed Sector:** Promote PPP models to develop an affordable domestic feed industry that will reduce vulnerability of the aquaculture supply chain disruptions and global price shocks.
- **Promote Transboundary Cooperation:** Regional Economic Communities (RECs) should lead initiatives to coordinate regulatory frameworks for managing aquatic resources and mitigating transboundary environmental hazards, such as plastic pollution.

- **Strengthen Aquatic Animal Health Frameworks:** MSs should work with AU-IBAR to implement the Aquatic Animal Health Strategy with a focus on improving diagnostic abilities and disease surveillance.

By pursuing these actions, the continent can establish a sustainable and resilient aquatic and fisheries sector that mitigates climate shocks while driving regional prosperity. With the right climate-smart investment, policy choices, and inclusive governance, they can drive prosperity while conserving biodiversity for future generations.

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