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From Oil Economy to Blue Economy: The Untapped Potential of Mangroves in the UAE's Sustainability Transition: A Review

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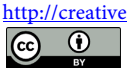

Abstract

The United Arab Emirates, historically dependent on hydrocarbons, is now repositioning itself toward a diversified and sustainable future under the framework of the blue economy. Mangroves, often overlooked in national development narratives, represent a critical natural asset with immense ecological, economic, and climate value. This paper explores the untapped potential of UAE mangroves in advancing the country's sustainability transition, shifting from an oil-based to a blue economy paradigm. It examines mangroves as carbon sinks, coastal protectors, biodiversity hotspots, and enablers of climate resilience, while also assessing their role in supporting fisheries, ecotourism, and sustainable livelihoods. Drawing on regional case studies, carbon stock assessments, and policy initiatives, the study evaluates how mangrove conservation and restoration can contribute to the UAE's climate commitments, including net-zero ambitions and nature-based solutions. Furthermore, it emphasizes the need for integrated governance, innovative financing, and community engagement to unlock the full value of mangroves in national and regional sustainability agendas. Ultimately, this research underscores mangroves as a cornerstone of the UAE's blue economy vision, bridging ecological stewardship with economic diversification.

Keywords

Blue Economy, Mangrove, Sustainability Transition, Carbon Sequestration, Coastal Protection, Climate Resilience

1. Introduction

For over half a century, the United Arab Emirates (UAE) has relied heavily on

hydrocarbons as the foundation of its economic growth, modernization, and geopolitical influence. While oil and gas revenues have provided stability and prosperity, they have also created structural vulnerabilities. Global energy transitions, volatile price cycles, and the accelerating urgency of climate change now demand a profound rethinking of economic models. The pursuit of resilience, diversification, and sustainability has therefore become central to the UAE's long-term strategic vision.

Within this context, the blue economy has emerged as a transformative pathway. Defined as the sustainable use of ocean, marine, and coastal resources to drive economic growth and improve livelihoods while preserving ecosystem integrity, the blue economy offers the UAE a unique opportunity to reposition itself in a post-oil era. With more than 1300 km of coastline and a maritime heritage that predates its oil wealth, the nation is naturally situated to lead in this space. Its policy directions, including the UAE Net Zero by 2050 Strategic Initiative and the launch of the Mangrove Alliance for Climate (MAC) in 2022, underscore the importance of aligning ecological stewardship with economic innovation.

A decisive policy milestone came with the UAE Climate Law (Federal Law No. 11 of 2024), the first comprehensive climate legislation in the Middle East. The law mandates climate neutrality by 2050, institutionalizes nature-based solutions (NbS) as central to national mitigation and adaptation strategies, and requires the integration of carbon sequestration ecosystems, such as mangroves into climate accounting and national reporting. This legal framework firmly establishes mangroves not only as ecological assets but also as compliance enablers, linking local conservation efforts with international climate obligations under the Paris Agreement.

Among the diverse assets of the blue economy, mangrove ecosystems stand out as strategic natural infrastructures. These coastal forests not only serve as "green lungs" that sequester carbon at rates exceeding many terrestrial ecosystems, but also act as living barriers against sea-level rise, coastal erosion, and intensifying climate shocks. Their socioeconomic benefits, spanning fisheries, ecotourism, cultural heritage, and emerging carbon markets position them as multifunctional contributors to the UAE's sustainable development trajectory.

Despite these strengths, mangroves have historically been underrepresented in national development narratives. They remain at risk from urban expansion, coastal reclamation, and pollution pressures, even as global evidence highlights their pivotal role in climate adaptation and mitigation. Unlocking the full potential of mangroves therefore requires an integrated approach that combines science, governance, financing, and community engagement, ensuring they are embedded within broader sustainability and diversification agendas.

1.1. Research Aim

The aim of this paper is to examine the ecological, economic, and policy significance of mangroves in the UAE. By situating mangroves at the intersection of

environmental conservation, blue carbon accounting, and sustainable economic growth and explicitly linking them to the UAE Climate Law No. 11/2024, it highlights their role not only as ecosystems of local importance but also as strategic assets in the nation's transition from an oil-based to a blue economy paradigm.

1.2. Historical Reliance of the UAE on Hydrocarbons

Oil demand has historically risen and fallen in cycles, and while a short-term increase is expected in the post-pandemic period, such fluctuations are not unusual. Over the past 150 years, the oil and gas industry has repeatedly experienced periods of boom and bust. However, a structural decline in global demand is inevitable as the world accelerates its transition toward clean energy. If unprepared, the UAE risks being left behind in this shift. To remain competitive, the nation must proactively position itself for a post-oil economy [1] [2].

The 2014 oil price crash illustrated this vulnerability, delivering a significant economic shock to the UAE. Yet, it also served as a wake-up call. Volatility in oil and natural gas markets, combined with the recognition that fossil fuel reserves are finite, spurred a rethinking of long-term economic strategies. For the UAE, sustaining prosperity would require reducing reliance on crude oil revenues and embracing energy efficiency and diversification. A similar realization has guided neighboring Saudi Arabia, which has also embarked on ambitious plans to reduce its dependence on oil and build a more resilient, diversified economy [3].

2. The Blue Economy and Its Relevance to UAE Diversification Strategies

The blue economy refers to the sustainable development of marine and coastal resources to foster economic growth, jobs, and improved well-being, while ensuring ecological integrity [4]. For the UAE, a nation with over 1300 km of coastline along the Arabian Gulf and Gulf of Oman, this concept aligns directly with its diversification agenda. Key blue economy sectors relevant to the UAE include fisheries, aquaculture, maritime transport, port logistics, marine tourism, desalination, and renewable ocean energy [5] [6]. By integrating these sectors, the UAE can strengthen food security, expand employment, and foster innovation without compromising the health of ecosystem [6] [7].

Mangroves, which cover approximately 3000 hectares across Abu Dhabi, Dubai, Umm Al Quwain, Sharjah, Ras Al Khaimah and Ajman are increasingly recognized as a linchpin of this strategy. They deliver ecosystem services valued at billions of dollars annually, including shoreline stabilization, fish nursery functions, and carbon storage. Their restoration is central to initiatives such as the Mangrove Alliance for Climate (MAC), launched by the UAE in 2022, which seeks to plant 100 million mangroves globally by 2030 [8] [9].

2.1. Understanding the Blue Economy

In practice, the UAE's blue economy vision involves balancing industrial growth

with marine conservation. Investments in renewable marine energy, eco-friendly shipping, and biotechnology are paired with ecosystem-based management approaches. This ensures that economic progress complements environmental sustainability, an approach essential for achieving both national development goals and international climate commitments.

2.2. Opportunities for Coastal Communities

Although the UAE's economy is largely urbanized and industrialized, coastal communities, especially in smaller emirates, remain closely linked to marine resources. A sustainable blue economy can unlock significant pathways for inclusive economic growth and job creation, such as:

2.2.1. Economic Growth and Employment

Properly managed marine industries, such as fisheries and aquaculture, can generate new jobs while maintaining long-term resource productivity and resilience [10].

2.2.2. Tourism

Sustainable tourism initiatives can attract visitors while protecting coastal biodiversity and landscapes, providing both income and increased public awareness of marine conservation.

2.2.3. Renewable Energy

Offshore solar, tidal, and wave energy hold promise as the UAE diversifies its clean energy portfolio beyond solar PV and nuclear.

2.2.4. Research and Innovation

Investment in marine research and technological development can lead to innovative solutions, promote sustainable practices, and unlock new economic opportunities.

2.3. Challenges Faced by Coastal Communities

While the blue economy presents significant potential, coastal communities must navigate several challenges.

2.3.1. Environmental Degradation

According to [1], the expansion of urban centers, coastal tourism infrastructure, and port facilities in the UAE has often relied on land reclamation and dredging, leading to the fragmentation and loss of mangrove habitats. Such developments disrupt hydrological cycles, degrade water quality, and eliminate critical carbon sinks. Historically, these pressures, combined with industrial activities, have also resulted in the decline of both mangrove ecosystems and seagrass meadows.

2.3.2. Climate Change

Coastal communities across the UAE increasingly struggle with the impacts of climate change. Rising sea levels threaten to inundate homes and infrastructure,

while intensifying storms damage livelihoods and erode shorelines. Shifting oceanic conditions further disrupt fisheries and weaken natural habitats that communities depend on. In response, mangrove forests provide a critical line of defense. By absorbing wave energy, stabilizing sediments, and buffering storm surges, they reduce the risks that climate change imposes on coastal populations. [11] demonstrates how innovative mangrove cultivation along urban coastlines, particularly in developing nations, strengthens resilience to these growing threats. Similarly, [12] argues that payments for ecosystem services can incentivize mangrove protection, helping communities' lower disaster risks. Without such nature-based solutions, coastal populations will face mounting challenges as climate pressures continue to intensify.

2.3.3. Resource Management

Coastal communities face significant challenges in managing marine and coastal resources sustainably. Overfishing, illegal fishing practices, and destructive harvesting methods threaten fish stocks and coral reef health. Pollution from land-based sources, including plastic waste and untreated sewage, further stresses local ecosystems. Climate change exacerbates these pressures through rising sea levels, ocean acidification, and more frequent extreme weather events. Limited access to scientific data, lack of institutional support, and insufficient enforcement of regulations hinders communities' ability to implement effective resource management strategies, making the balance between livelihoods and conservation an ongoing challenge.

Figure 1. Community members and researchers engaging in mangrove conservation efforts in the UAE. The image highlights the ecological and social importance of mangroves in the region. Source: The National (32).

2.3.4. Community Engagement

Coastal communities often face significant challenges in engaging meaningfully in resource management and blue economy initiatives. Limited access to information, low awareness of sustainable practices, and insufficient technical capacity continue to hinder effective participation. Socioeconomic pressures, such as reli-

ance on fishing or tourism for daily livelihoods, can cause long-term conservation objectives to appear secondary to immediate survival needs. Additionally, institutional barriers and top-down decision-making frequently exclude local populations, reducing policy effectiveness and leading to conflicts over resource use. As illustrated in **Figure 1**, collaborative mangrove conservation projects in the UAE demonstrate the potential of community involvement when supported by inclusive governance and scientific partnerships. These initiatives highlight the importance of empowering local actors through education, co-management frameworks, and shared stewardship of coastal ecosystems.

3. Importance of Mangroves in Global and Regional Sustainability Transitions

As nations across the globe accelerate efforts to align economic growth with climate neutrality, mangroves are increasingly being recognized as cornerstones of sustainable transitions. Their unique ability to provide simultaneous ecological, economic, and social benefits positions them at the nexus of climate mitigation and adaptation strategies. Globally, mangrove forests are among the most carbon-dense ecosystems, capable of storing carbon in both biomass and sediments for centuries. Regionally, in the Arabian Gulf and Red Sea, their resilience in hypersaline and arid conditions demonstrates their capacity to thrive under climate stressors that challenge many other ecosystems. For the UAE, this dual role, as high-value carbon sinks and as natural shields for vulnerable coastlines makes mangroves indispensable to meeting the requirements of the UAE Climate Law No. 11 of 2024 and advancing the Net Zero 2050 agenda. Beyond climate policy, mangroves embody the principles of the blue economy by supporting fisheries, ecotourism, and community livelihoods, thereby linking global sustainability goals with local development priorities.

3.1. Mangrove Bioshields and Their Role in Coastal Resilience

Mangrove forests function as critical "Bioshields", protecting coastlines from erosion, storm surges, and sea-level rise through their unique structural and ecological characteristics. Their dense root systems trap sediments, stabilize shorelines, and attenuate wave energy, thereby reducing the vulnerability of coastal communities and infrastructure [13] [14]. Unlike artificial seawalls, mangroves represent adaptive, self-sustaining defenses that not only mitigate hazards but also regenerate and expand under favorable environmental conditions [15].

Quantitative and qualitative assessments highlight the scale of this ecosystem service. [16] documented that intact mangrove belts can substantially reduce the destructive force of waves, while [17] emphasized the variability of this protection depending on species composition, forest density, and geomorphological context. Recent reviews further demonstrate that mangroves contribute significantly to disaster risk reduction and should be prioritized in ecosystem-based adaptation strategies [18]-[21].

In the Arabian Gulf, where shorelines are highly vulnerable due to hypersaline waters and rapid urban development, mangroves demonstrate exceptional resilience [22]. [2] mapped the spatial coverage of ***Avicennia marina***, showing how even sparse stands contribute to shoreline stabilization. In the UAE, mangrove conservation and restoration projects in Abu Dhabi and Ras Al Khaimah have been strategically integrated into coastal planning, reflecting their value as cost-effective, nature-based infrastructure [23] [24]. These initiatives not only buffer urban coastlines but also provide co-benefits by supporting fisheries and enhancing water quality [25] [26].

Mangroves also provide synergistic protection when considered as part of wider coastal ecosystems. Their interaction with seagrasses and coral reefs strengthens coastal resilience through complementary ecosystem functions [27] [28]. For example, mangroves reduce sediment loads that might otherwise smother coral reefs, while reefs in turn protect mangroves from high-energy wave action, creating a coupled ecological defense system. These interactions are illustrated in **Figure 2**, which highlights the dynamic relationships within tropical seascapes and reinforces the need for integrated ecosystem management approaches.

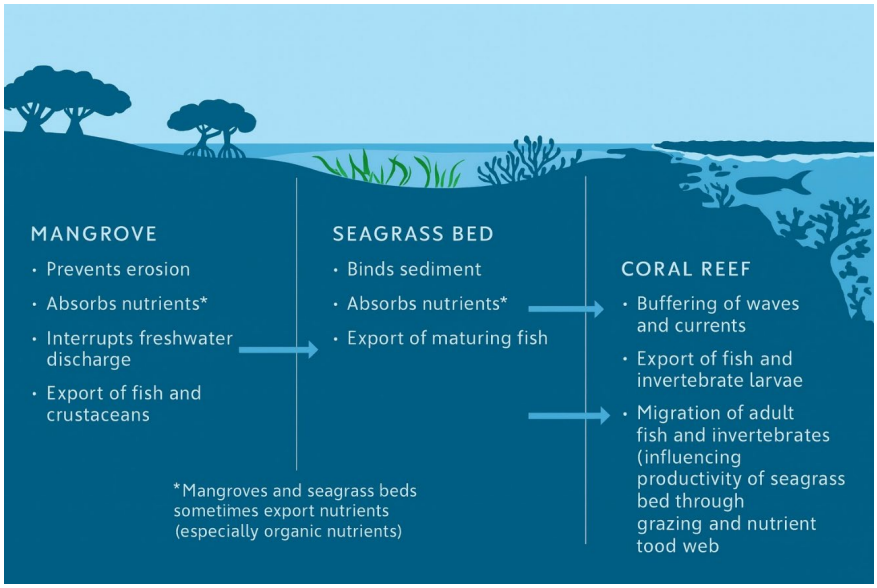

Figure 2. Interactions within the tropical seascape, illustrating the ecological linkages among mangroves, seagrass beds, and coral reefs. Source: adapted from Pramova *et al.*, 2013 (23).

From a policy perspective, their role as Bioshields aligns with national and international sustainability transitions [29] [30]. In the UAE, mangrove conservation supports the country's Net Zero 2050 initiative and its broader strategy to diversify away from oil dependency toward a blue economy. Globally, [31] call for urgent action to integrate mangrove conservation into disaster risk reduction frameworks, recognizing them as living infrastructure that enhances resilience while contributing to biodiversity conservation and carbon sequestration.

Thus, mangroves are not only ecological assets but also strategic natural infrastructures. Their Bioshields function offers the UAE and other coastal nations a cost-effective, multifunctional approach to climate adaptation, disaster risk reduction, and sustainable economic transition.

3.2. Mangrove Fisheries

Mangrove ecosystems along the UAE coastline, dominated by ***Avicennia marina*** (Figure 3), provide critical habitats for fish, crabs, and shrimp species, supporting both biodiversity and the livelihoods of coastal communities (Figure 4). The conversion of mangrove areas for aquaculture or other coastal developments can pose significant ecological risks, including habitat loss, degradation of ecosystem services, water quality deterioration, and heightened susceptibility to disease.

Figure 3. Mangroves of ***Avicennia marina*** at Alzorah Nature Reserve, Ajman, UAE. Source: Authors, 2025(1).

Figure 4. A mud crab in the mangrove habitat, Umm Al Quwain, United Arab Emirates, highlighting the ecological and economic importance of mangrove-associated fisheries in the region. Source: Authors, 2025(1).

At the same time, mangroves present opportunities for nature-positive aquaculture and diversified livelihoods. Sustainable practices can create economic incentives for communities to conserve these habitats while generating income:

1) Mud Crab and Finfish Farming; Local crab species rely on mangroves for shelter, feeding, and breeding. Integrating mud crab and finfish farming with mangrove conservation can provide steady income streams while reinforcing habitat protection.

2) Sustainable Shrimp Cultivation: Low-input shrimp farming compatible with mangrove fringes, including co-culture with seaweed or mollusks, can reduce environmental impacts, recycle nutrients, and diversify income sources, while supporting biodiversity.

3) Mangrove-Derived Products; ***Avicennia marina*** contains bioactive compounds that can be sustainably harvested for nutraceuticals, natural cosmetics, and herbal supplements, offering high-value income opportunities for local communities.

Fisheries inherently associated with mangrove ecosystems, whether conducted directly within mangrove habitats or indirectly benefiting from their ecological functions, remain essential to sustaining local livelihoods. However, such mangrove-linked fisheries are rarely quantified in the literature, making it challenging to fully assess their economic and social importance relative to larger industrial fisheries [32]. The lack of consistent definitions of "mangrove fisheries" across regions and over time further limits the usefulness of broad generalizations [33].

These dynamics reveal a clear tension in the UAE context: while aquaculture and coastal development can enhance food security and economic opportunities, they may also compromise mangrove-dependent fisheries if not carefully managed. Integrated management approaches that combine sustainable aquaculture, ecosystem stewardship, and community engagement are therefore essential. Such strategies aim to balance food production, biodiversity conservation, and socioeconomic well-being, aligning with broader blue economy objectives.

4. Ecosystem Services of Mangroves

Mangroves are among the most productive and ecologically valuable coastal ecosystems [33], providing a wide range of ecosystem services that contribute to climate resilience, biodiversity conservation, and sustainable livelihoods [3] [34]. These services can be broadly categorized into carbon sequestration and storage, coastal protection, biodiversity support, and socioeconomic benefits.

4.1. Carbon Sequestration and Storage

Mangrove forests act as significant carbon sinks, capturing and storing carbon in aboveground biomass (AGB), belowground biomass (BGB), and sediment carbon pools, including soil organic carbon (SOC), dissolved organic carbon (DOC), and dissolved inorganic carbon (DIC) [35]. Globally, mangroves sequester carbon at rates far exceeding most terrestrial forests, with some studies reporting carbon

accumulation of up to 1000 tonnes C per hectare. In the UAE, despite their relatively small extent (approximately 3000 ha), mangroves contribute significantly to coastal carbon stocks, providing a nature-based solution to support national climate mitigation strategies aligned with Net Zero 2050 ambitions.

4.2. Coastal Protection

Mangroves function as natural coastal defenses, attenuating wave energy, reducing shoreline erosion, and stabilizing sediments. Their complex root systems dissipate wave action and buffer storm surges, providing protection against sea-level rise and extreme weather events. Cost-benefit analyses in various regions indicate that mangrove restoration and conservation are far more cost-effective than hard engineering solutions, such as seawalls, for long-term coastal protection [5]. For urbanized coastal areas of the UAE, including Abu Dhabi and Dubai, mangroves could play a pivotal role in safeguarding infrastructure while supporting adaptation to future climate scenarios.

4.3. Biodiversity Hotspots

Mangroves provide critical habitats for a wide array of species, serving as nurseries for commercially important fish and shellfish, and supporting bird populations and other wildlife [6] [7]. These ecosystems sustain fisheries productivity by offering shelter, food, and breeding grounds for juvenile fish, crabs, and shrimp. In the UAE, mangrove-associated fisheries support small-scale coastal livelihoods, contributing to both food security and cultural heritage [7]. Furthermore, mangrove forests enhance marine biodiversity by maintaining ecological connectivity between coastal, estuarine, and nearshore ecosystems [8].

4.4. Socioeconomic Benefits

Beyond ecological functions, mangroves offer significant socioeconomic value. Ecotourism initiatives in mangrove areas, such as guided kayaking and birdwatching tours, illustrate the socioeconomic value of mangroves through ecotourism, generate revenue and raise public awareness of marine conservation [9]. Sustainable harvesting of mangrove resources, such as honey and non-timber products, also supports local livelihoods. Payment for ecosystem services (PES) schemes have been proposed to monetize the benefits provided by mangroves, offering financial incentives for conservation while reducing disaster risk in coastal regions [10].

4.5. Integrating Mangroves into Climate and Development Strategies

The multifunctional services of mangroves make them a cornerstone of the blue economy and national sustainability strategies. By combining carbon sequestration, coastal protection, biodiversity conservation, and socioeconomic benefits, mangroves represent a cost-effective, nature-based solution that addresses multi-

ple Sustainable Development Goals (SDGs), including climate action (SDG 13), life below water (SDG 14), and sustainable communities (SDG 11) [11] [12].

5. Case Studies and Regional Lessons

5.1. Successful Mangrove Conservation and Restoration Initiatives in the UAE and the Arabian Gulf

In recent decades, the United Arab Emirates has made significant progress in mangrove restoration as part of its wider sustainability and climate resilience agenda [13]. Large-scale afforestation initiatives, such as those led by the Environment Agency, Abu Dhabi (**Figure 5**), have increased mangrove coverage through a combination of natural regeneration and advanced planting techniques, including the use of drone-based seeding technologies [14]. Similar efforts in Saudi Arabia and Bahrain have also emphasized the role of mangroves in enhancing coastal protection, biodiversity, and fisheries productivity [15]. These initiatives highlight how Gulf nations are positioning mangroves not only as ecological assets but also as central components of national climate adaptation and blue economy strategies.

Figure 5. Mangrove restoration efforts in the UAE, led by Emirates Nature-WWF. Source: Emirates Nature-WWF (9).

5.2. Lessons from International Experiences (Indonesia, Kenya, Australia)

Globally, mangrove conservation programs provide valuable lessons for the Arabian Gulf. Indonesia, which hosts the largest mangrove area worldwide, has integrated mangrove restoration into its Nationally Determined Contributions (NDCs), recognizing their carbon sequestration potential [16]. In Kenya, community-based conservation models, such as the Mikoko Pamoja project, link mangrove restoration with carbon credit schemes, channeling revenues into local education and health services [17]. Australia, on the other hand, emphasizes rigorous scientific monitoring and adaptive management, ensuring that mangrove pro-

tection is embedded in coastal development planning [18]. These diverse cases demonstrate that while ecological outcomes are essential, the long-term success of mangrove initiatives depends on inclusive governance frameworks and the alignment of conservation goals with socioeconomic incentives.

5.3. Comparative Assessment of Carbon Stock Values and Socioeconomic Benefits

Comparative studies reveal significant differences in carbon storage capacities of mangroves across regions. For instance, [19] note that Indo-Pacific mangroves typically store higher levels of carbon per hectare compared to their Middle Eastern counterparts, largely due to variations in geomorphology and sediment dynamics. However, even relatively smaller mangrove stands in the Arabian Gulf play an outsized role in stabilizing shorelines and providing habitat for commercially important fish species [20]. The socioeconomic benefits, particularly ecotourism in places like the Al Zorah Nature Reserve in Ajman, showcase how mangroves can diversify local economies and foster sustainable livelihoods. When considered alongside global carbon markets, these values underscore the dual role of mangroves as climate mitigation tools and socioeconomic assets, offering compelling justification for their integration into national sustainability frameworks.

6. Policy and Governance Dimensions

Mangrove governance in the UAE intersects coastal management, biodiversity conservation, and climate action, supported by entities such as the Environment Agency - Abu Dhabi (EAD) and the Ministry of Climate Change and Environment (MOCCAE), and guided by national frameworks like the UAE National Biodiversity Strategy as well as international commitments under the Paris Agreement [31] [32]. Despite strong frameworks, mangroves remain underrepresented in blue economy and climate policies, limiting full utilization of their ecosystem services. The Net Zero 2050 Strategy and nature-based solutions, including blue carbon initiatives and restoration programs, offer opportunities to enhance carbon storage, disaster resilience, and socioeconomic benefits. International cooperation with UNFCCC, IUCN, and UNEP, alongside lessons from global mangrove programs, can further strengthen policy integration, ensuring mangroves contribute fully to the UAE's sustainability and blue economy goals [21]-[24].

7. Financing and Innovation for Mangrove Sustainability

Ensuring the long-term conservation and restoration of mangroves in the UAE requires innovative financing mechanisms and technological approaches that link ecological value with economic incentives [25].

7.1. Blue Carbon Markets and Carbon Credits

Mangroves are among the most carbon-dense ecosystems globally, sequestering large amounts of carbon both above ground and in sediments [26]. By participat-

ing in blue carbon markets, the UAE can monetize these ecosystem services through carbon credits, generating revenue that supports restoration and conservation efforts while contributing to national and global climate mitigation targets [27].

7.2. Public-Private Partnerships (PPPs) for Ecotourism and Conservation

Collaborations between government agencies, private enterprises, and non-governmental organizations can enhance both ecological outcomes and socioeconomic benefits. For example, ecotourism initiatives within mangrove reserves can provide sustainable income for local communities, raise public awareness, and fund ongoing habitat restoration [28]. PPPs also create opportunities to integrate conservation goals into urban and coastal development planning.

7.3. Technological Innovations for Monitoring and Management

Advanced tools such as remote sensing, drones, and artificial intelligence (AI) enable real-time monitoring of mangrove health, growth patterns, and carbon sequestration rates. These technologies allow for precise mapping, early detection of threats such as pollution or deforestation, and efficient management of restoration projects at scale [29].

7.4. Innovative Financing Mechanisms

Beyond traditional funding, mechanisms such as green bonds, ESG (Environmental, Social, Governance) investment, and blended finance can mobilize capital from both public and private sources. By linking financial returns to environmental performance, these mechanisms encourage investment in nature-based solutions, ensuring that mangrove conservation contributes both to ecological resilience and to economic sustainability [30].

In summary, the combination of market-based incentives, collaborative partnerships, technological innovation, and creative financing provides a robust framework to sustain and expand mangrove ecosystems in the UAE. Such strategies not only enhance carbon storage and biodiversity but also support livelihoods, ecotourism, and national climate goals, positioning mangroves as a strategic asset within the country's blue economy vision.

8. Challenges and Risks

Mangrove ecosystems in the UAE and the wider Arabian Gulf face multiple anthropogenic and environmental pressures that threaten their sustainability and ecological integrity [31].

8.1. Coastal Development and Urbanization

Rapid urban expansion, industrial projects, and port development have often encroached on mangrove habitats, leading to habitat fragmentation and loss of eco-

logical connectivity. Land reclamation, dredging, and infrastructure projects disrupt tidal flows and sediment deposition, undermining natural regeneration and the capacity of mangroves to provide critical services such as shoreline stabilization and nursery habitats for fish.

8.2. Pollution, Salinity Stress, and Climate Change

Coastal pollution, including industrial effluents, runoff from urban areas, and oil spills, alters water quality, impacting mangrove growth and associated biodiversity. Salinity stress from desalination discharge and reduced freshwater inflows can inhibit seedling survival, particularly in arid regions where mangroves are already under physiological stress [32]. Climate change exacerbates these pressures through rising sea levels, increased storm intensity, and higher sea surface temperatures, which threaten both mangrove survival and the coastal communities dependent on them [33].

8.3. Governance Fragmentation and Limited Community Engagement

While the UAE has established policies for coastal ecosystems and biodiversity, governance remains fragmented across multiple agencies and emirates, which can hinder coordinated mangrove conservation. Moreover, limited community involvement reduces local stewardship and the effectiveness of restoration projects, especially in smaller coastal communities where traditional knowledge and livelihoods are closely tied to mangrove ecosystems [34].

Addressing these challenges requires integrated coastal zone management, stronger regulatory enforcement, pollution mitigation strategies, and the active participation of local communities in mangrove conservation. By combining scientific knowledge, policy coherence, and social engagement, the UAE can strengthen the resilience of its mangroves and the broader coastal environment in the face of increasing anthropogenic and climatic pressures.

9. Pathways to Unlocking the Potential of Mangroves

Maximizing the ecological, economic, and social benefits of mangroves in the UAE requires a multifaceted approach that integrates governance, restoration, community engagement, and strategic positioning within national sustainability agendas.

9.1. Integrated Governance and Cross-Sectoral Collaboration

Effective mangrove management necessitates coordination among federal and emirate-level agencies, private sector stakeholders, and research institutions. Aligning policies across coastal development, fisheries, tourism, and climate strategies ensures that mangroves are protected and leveraged as part of the blue economy.

9.2. Scaling Up Restoration and Nature-Based Solutions

Expanding mangrove restoration projects using advanced techniques, such as

drone-assisted planting, hydrological management, and habitat monitoring, can enhance carbon sequestration, shoreline stabilization, and biodiversity conservation. Integrating mangroves into nature-based solutions supports climate adaptation objectives, including flood mitigation and coastal resilience.

9.3. Community Involvement, Education, and Awareness

Local communities play a crucial role in sustaining mangrove ecosystems. Awareness campaigns, educational programs, and participatory restoration initiatives empower residents, enhance stewardship, and link conservation outcomes to sustainable livelihoods, particularly in fisheries and ecotourism [35].

Positioning Mangroves as a Central Pillar of the UAE's Sustainability Transition Mangroves are increasingly recognized as core assets within the UAE's national blue economy vision, reinforcing their role in climate mitigation, disaster risk reduction, and socioeconomic development. Embedding mangrove conservation into strategic planning, investment frameworks, and carbon credit mechanisms ensures that these ecosystems make tangible contributions to the UAE's Net Zero 2050 agenda and broaden global sustainability commitments.

By combining governance coherence, restoration innovation, community engagement, and strategic policy alignment, the UAE can fully unlock the untapped potential of mangroves as resilient, multifunctional ecosystems at the heart of its sustainable development trajectory.

10. Conclusions

This review paper has synthesized existing global and regional literature on the ecological, economic, and policy significance of mangroves, with a particular focus on their relevance to the UAE's sustainability transition. Evidence consistently demonstrates that mangroves provide multiple ecosystem services, including shoreline stabilization, biodiversity conservation, carbon sequestration, and fisheries support. In global contexts, mangrove-linked fisheries are shown to be essential for sustaining livelihoods and food security, while blue carbon assessments highlight their role in mitigating climate change.

However, despite these global insights, UAE-specific empirical research remains limited. Three critical gaps can be identified. First, the contribution of mangroves to local fisheries productivity has not been quantified with robust field-based evidence, leaving uncertainties about their direct socioeconomic value for coastal communities. Second, there is a lack of systematic socioeconomic valuation of mangrove services in the UAE, including tourism potential, cultural significance, and disaster risk reduction. Third, although the UAE has recognized mangroves as a blue carbon asset, long-term carbon stock monitoring and verification programs are underdeveloped, constraining the integration of mangroves into national and international carbon markets.

Bridging these knowledge gaps requires an integrated research agenda that combines ecological monitoring with participatory socioeconomic studies and ad-

vanced carbon accounting. Establishing long-term monitoring plots, applying standardized blue carbon methodologies (e.g., IPCC, ISO 14064), and engaging local communities in valuation exercises would generate the evidence base necessary for informed decision-making.

From a policy perspective, strengthening UAE-specific empirical data will provide the quantitative foundation for:

1) Integrating mangroves into climate neutrality strategies under the UAE Climate Law (Federal Law No. 11 of 2024).

2) Enhancing fisheries and food security policies through recognition of mangrove-supported productivity.

3) Expanding blue economy opportunities in ecotourism, carbon finance, and conservation-based employment.

4) Informing coastal zone management frameworks that balance development with ecosystem resilience.

In conclusion, authors firmly believe that while global and regional evidence underscores the vital role of mangroves, UAE-specific empirical studies are urgently required to translate these insights into concrete, locally tailored actions. Such efforts will not only reinforce the UAE's leadership in nature-based solutions but also ensure that mangrove ecosystems remain integral to achieving both climate neutrality and socioeconomic resilience in the region.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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