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Unveiling the hidden treasures: the vital contributions of Bhitarkanika mangrove in supporting local communities

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Abstract

Mangroves are salt-resistant vegetation that inhibit the muddy intertidal region of tropical and sub-tropical countries. Bhitarkanika Mangrove Sanctuary is one of the hotspots of Odisha state due to its wide range of biodiversity. Mangroves are always integral to the coastal livelihood by providing goods and services to the communities. The importance of mangroves gets neglected by sideling its provision of valuable resources and protection services against cyclones and storms. The present article studied the benefits provided by the Bhitarkanika Mangroves forests to the local communities and focuses on the sustainable conservation of resources for the future. Evidence-based suggestions are suitable for achieving the sustainability of local communities by adopting conservation measures.

Keywords biodiversity, conservation, mangroves, sustainability

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Introduction

Mangroves are well-known diversified vegetation ranging from large trees to small shrubs with highly specialized morphological and physiological adaptations to thrive in flooded and saline habitats [1-2]. Mangroves, often known as "bio-shields" or "natural sea defense," serve as nutrient sinks and safeguard offshore habitats [3]. Mangroves constitute the symbiotic link between the terrestrial and marine ecosystems. It provides ideal environments for many ecologically and commercially significant fish and shellfish species to breed, feed, and raise their young [4]. Apart from this, local and migratory waterbirds utilize these areas as feeding grounds [5]. Coastal ecosystems provide numerous benefits to humans such as stabilizing coastal land, nutrient cycling, mitigating natural calamities, and supporting diverse products of plants and animals [5-6].

India covers 4921 sq. km (0.15%) of its total land area with mangroves, accounting for 3% of the world's total and 8% of Asia's [7]. The Indian maritime states are covered with sparsely distributed mangrove forests along their coastal stretch. According to Nayak and Bahuguna [8], mangroves are divided into two groups based on their geomorphic location: 'Onshore areas' and 'Offshore areas (Islands). The Sundarbans have grown to be the single biggest chunk of mangroves on the earth and are sited in the deltaic region of the Ganga-Brahmhaputra River basin. The onshore geomorphic areas along the Odisha coast are classified as beach, estuary, and deltaic mangroves. Three zones make up

the mangroves along the Odisha coast: the deltaic section of Mahanadi, the deltaic part of Brahmani and Baitarani (also known as the mangrove sector of Bhitarkanika), and the Balasore shore. Bhitarkanika is the most important of the three mangrove zones becauseof its length and unique biodiversity. On the Odisha coast, many researchers have intensively investigated the mangrove region of the deltaic sector of Mahanadi, Chilika Lake, and the Bhitarkanika Wildlife Sanctuary. Nevertheless, the mangrove flora of different estuaries, such as Subarnarekha, Budha Balanga, Devi, Rushikulya, etc., has not yet been investigated by others [9].

Bhitarkanika mangroves and its rich biodiversity

The Bhitarkanika mangrove ecosystem was India's mainland's second-largest single-block-formed mangrove forest. These ecosystems were formed in the Brahmani-Baitrani deltaic region and were designated a wildlife sanctuary in 1975. The Bhitarkanika Wildlife Sanctuary encompassing an area of 672 sq. km, constitutes the mangrove forests. The land adjacent to the area, spanning 145 sq. km, was declared a national park in 1998. Along the sanctuary's eastern side, 35 km of coastline stretches constitute the Gahirmatha Marine Sanctuary, stated in 1998 [5]. Many authors have identified the different numbers of mangrove species [2, 5, 8, 10-13] during their subsequent study period, as listed in Table 1.

Table 1. Lists of identified number of mangrove and true mangrove species of Bhitarkanika

SN.	Authors	No. of mangrove species	No. of true mangrove species	References
1	Panda et al.,	101	29	[2]
2	Hussain and Badola	64	28	[6]
3	Nayak and Bahuguna	62-67	-	[8]
4	Banerjee and Rao	55	-	[10]
5	Pattanaik et al.,	51	-	[11]
6	Mandal and Naskar	57	32	[12]
7	Raghavan et al.,	-	35	[13]

The Bhitarkanika has a wide range of biodiversity, constituting around 285 bird species (including migratory ducks and geese), twenty-six mammal species, five amphibian species, and forty-four reptile species. It also provides shelter to countless species of fish, and a broad variety of invertebrates in these mangroves. The mangroves are home to several notable carnivorous animals, including the threatened leopard cat (*Felis bengalensis*) and fishing cat (*Felis viverrina*). Furthermore, these mangroves serve as the ideal environment for a wide variety of endangered reptiles, such as the Indian Python (*Python molurus*) and saltwater crocodile (*Crocodylus porosus*). Other unique creatures that can be found in this area include the Olive ridley (*Lepidochelys olivacea*), the water monitor (*Varanus salvator*), and the King cobra (*Ophiophagus hannah*) [14].

Benefits gained by the coastal community from the mangrove forests of Bhitarkanika

Mangrove ecosystems are extensively documented as providers of many goods and services to individuals and sustain their livelihood by protecting them from natural calamities [15]. The residents living near the vicinity of mangroves benefit from valuable sources such as fuelwood, fodder, timber, tannin, and other natural products. These forests have characteristics of protecting the mainland by minimizing natural phenomena such as saltwater intrusion towards freshwater resources, erosion of land from waves and winds, encouraging sediment to settle, and coastal land stabilization. It acts as a natural barrier to protect coastal communities' life and property from storms and cyclones [15-17]. Various studies have monetized the benefits realized by the local communities as an outcome of the existence of mangrove forests. Few studies related to Bhitarkanika mangrove

forests have found that according to Hussain and Badola [6], a value of US$ 107 household^{-1} annum^{-1} was generated from the utilization of forestry and fishery resources. In the twenty-first century, scientists considered the mangrove forest a rich carbon reservoir that may trap up to four times more carbon than other kinds of forests worldwide. As per Bal and Banerjee's [18] studies, the mangrove expanse of Bhitarkanika, the collective biomass averages 866.67 ± 166.10 t ha^{-1}, with an overall carbon measurement of 444.68 ± 83.70 t ha^{-1}. The soil organic carbon registers at an average of 3.73 ± 2.10 t ha^{-1}, while the mean clutter carbon amounts to 0.59 ± 0.20 t ha^{-1}. According to the research conducted by Badola and Hussain [5], the loss incurred by the village, which gets protection from mangroves (US$ 33.31), is lesser than the village having no shelter of mangroves but had an embankment (US$ 153.74) due to cyclones or storms.

The problem encompasses the mangrove of Bhitarkanika

The mangrove forest of Bhitarkanika faces several significant challenges and problems that threaten its health and sustainability. These issues have important implications for both the ecosystem itself and the well-being of the coastal communities that depend on it. Due to the high dependency and ignorance of the local community, the major problems include; Habitat Destruction: One of the primary problems faced by the Bhitarkanika mangrove forest is deforestation and habitat loss due to various human activities. Illegal logging, clearing of mangroves for agriculture and aquaculture, and infrastructure development are contributing to the destruction of mangrove habitats, leading to a loss of biodiversity and degradation of the ecosystem [19-21]. This destruction disrupts the meticulous equilibrium of the ecosystem and threatens the endurance of numerous plant and animal species.

Poaching and illegal fishing: Poaching of endangered species and illegal fishing activities pose a significant threat to the biodiversity of the Bhitarkanika mangroves [22]. The mangrove ecosystem is home to various species, such as the saltwater crocodile, the Indian python, and the Olive Ridley turtle are particularly vulnerable to illegal wildlife trade, which poses a significant threat to the species. The demand for crocodile skin, turtle eggs, and python meat drives illegal activities, disrupting the ecosystem's delicate balance and hampering conservation efforts.

Pollution and water quality: The mangrove forest of Bhitarkanika is threatened by pollution from multiple sources, including industrial operations, agricultural, and residential waste, which ultimately deteriorates the water quality. Elevated levels of pollutants can harm mangrove vegetation and negatively impact the health and existence of various plants and animals, including fish and other marine species [19]. It also disrupts the nutrient cycles and overall ecosystem functioning.

Climate change and rising sea level: Two of the important pervasive effects of climate change that represent a danger to the Bhitarkanika mangrove forest are the rising sea levels and an upsurge in the occurrence of extreme weather phenomena [23]. These changes can result in saltwater intrusion, increased erosion, and habitat loss. Changes in rainfall patterns and temperature can also affect the growth and dispersion of mangrove species. The mangroves' ability to adapt to these changes may be limited, putting the ecosystem at risk.

Lack of awareness and sustainable practices: Limited awareness about the importance of mangroves and sustainable resource management practices among the local communities can contribute to the problems faced by the Bhitarkanika mangrove forest [24]. Unregulated fishing practices, unsustainable harvesting of mangrove resources, and inadequate waste management can exacerbate the degradation of the ecosystem. The long-term sustainability of the mangroves depends on effective conservation efforts, including community engagement and educational initiatives.

Conservation strategies for mangrove forests of Bhitarkanika

In accordance with the Ramsar Convention, the Bhitarkanika mangrove is also nominated as a Ramsar Site, a globally recognized wetland. This designation is based on the significance of the Bhitarkanika mangroves as a habitat for migratory birds and the conservation of biodiversity [25]. Conservation strategies are crucial to ensuring ecologically responsible stewardship and

safeguarding the Bhitarkanika mangrove forests (Figure 1). Some key strategies that can help to preserve and restore these critical resources. Strengthening legal protection: Enforce and strengthen existing laws and regulations on mangrove protection and conservation. Legal protection includes strict enforcement against illegal logging, encroachment, and poaching. Collaborate with local law enforcement agencies, forest departments, and community organizations to monitor and prevent illicit activities [26].

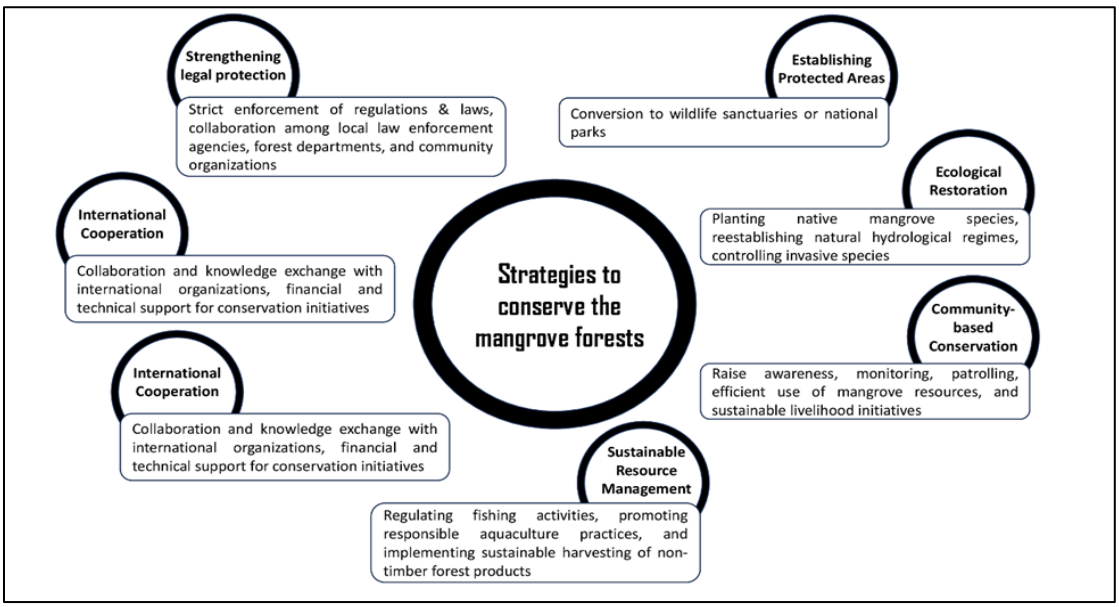

Figure 1. Components promoting the conservation strategies of mangroves

Establishing Protected Areas: Designate and manage protected areas within the Bhitarkanika mangrove forest, such as wildlife sanctuaries or national parks. These areas can serve as safe havens for vulnerable species and contribute to the overall conservation of the ecosystem. Implement effective management plans and enforcement measures to ensure the integrity of protected areas [26]. Ecological restoration: Implement mangrove restoration programs to rehabilitate degraded areas within the Bhitarkanika mangrove forest. Restoration of mangroves can involve planting native mangrove species, reestablishing natural hydrological regimes, and controlling invasive species. Collaborate with scientific institutions and experts to develop restoration plans based on ecological principles and local knowledge. Natural restoration and hydrological restoration are preferable over artificial restoration because of their high success rate in the growth of mangrove forests [27].

Community-based Conservation: Engage local communities in conservation efforts and promote their active participation in sustainable resource management practices. Raise awareness about mangroves' importance, benefits, and ecological value. This need for conservation can help foster a sense of ownership and responsibility among community members. Encouraging community-led initiatives for monitoring, patrolling, efficient use of mangrove resources, and sustainable livelihood initiatives can empower local communities to participate in conservation activities actively. Community-based participatory management is found to be the best practice for mangrove conservation [27].

Sustainable Resource Management: Promoting sustainable practices for resource use within and around the mangrove forest is essential. Sustainable resource management includes regulating fishing activities, promoting responsible aquaculture practices, and implementing sustainable harvesting of non-timber forest products. Encouraging alternative livelihood options compatible with

mangrove conservation, such as eco-tourism or agroforestry, can help reduce dependency on destructive activities [26]. Climate Change Adaptation: Develop strategies to adapt and alleviate the effects of climate change on the mangrove ecosystem. The adaptation may entail constructing infrastructure that is climate resilient, encouraging sustainable land-use techniques, and employing coastal zone management plans into action. Climate change mitigation can be achieved by fostering research and monitoring programs to understand the specific vulnerabilities of the Bhitarkanika mangroves to climate change and inform adaptive management strategies [28]. International Cooperation: Foster collaboration and knowledge exchange with international organizations, research institutions, and other countries with mangrove conservation experience. Learn from successful case studies and best practices in mangrove conservation worldwide. Seek financial and technical support for conservation initiatives through partnerships and funding opportunities [29].

Evidence-based strategies for the sustainability of mangrove ecosystems

In order to preserve the sustainability of the local agro-ecosystems and livelihoods, which at the moment lack resilience and are vulnerable to several factors like cyclones, floods, and rising sea levels, it is crucial that the ecological services offered by the Bhitarkanika ecosystem remain sustainable [5]. The mangrove forests have a substantial economic impact because they improve the local economy's sustainability and capacity to withstand the adverse consequences of climate change. While in the current scenario, the mitigation of atmospheric carbon is of utmost importance, carbon reduction is possible through proper preservation and management of mangroves. Concerning the situation, the United Nations Framework Convention on Climate Change (UNFCCC) has a strategy for mitigating global warming and environmental shifts that aims to lower greenhouse gas emissions via REDD+ (Reducing Emissions from Deforestation and Forest Degradation) programs and manage mangroves by keeping an eye on biomass and carbon storage in the mangrove. Explicit information on the composition, biomass, and carbon content of forests can effectively demonstrate the significance and need for conservation [15]. To ensure the importance and longevity of local communities, it's crucial to conduct thorough research on the production efficiency of mangrove-dependent ecosystems. This includes examining the influence of steady alteration in ecosystems, reducing production efficiency due to human actions, and understanding how they contribute to the local economy [6]. Implementing sustainable tourism development approaches improves the stakeholder's livelihood through mangrove forests' economic, social, and environmental benefits [24-25]. The awareness among the local communities will help policymakers build a policy that considers stakeholder consultation and agreement for cautious planning, management, guidelines, or even limits of specific activities for developing better conservation strategies for the Bhitarkanika Mangrove forests.

Conclusion

The current study has illuminated the invaluable role played by the Bhitarkanika Mangrove in bolstering local communities. These coastal ecosystems, often hidden treasures, are essential for supporting livelihoods and ensuring community sustainability. They act as a natural shield, against the devastating impacts of natural and man-made disasters, safeguarding the lives and livelihoods of those residing in their vicinity. Moreover, they enhance local economic resilience, particularly in the face of mounting challenges posed by climate change. Research into mangrove-dependent systems, responses to environmental changes, and human impact is essential for understanding their contributions to local economies and sustainability. However, sustainable tourism development offers an encouraging avenue for harnessing the multifaceted economic, social, and environmental benefits of these ecosystems. It is crucial to elevate awareness within local communities and actively involve them in the policymaking process, ensuring the perpetual support and preservation of these hidden treasures for the benefit of present and future generations.

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