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Perception of Marine Litter in Goa: Awareness, Attitudes, and Solutions

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Abstract

Marine litter poses a significant threat to marine and coastal ecosystems, impacting wildlife, human health, and local economies. This study examines the public perception of marine litter in Goa, India, focusing on awareness, attitudes, and behaviours. Utilizing a mixed-methods approach, data were collected through structured questionnaires, interviews, and focus group discussions with residents and visitors. The findings highlight gaps in public awareness, varied attitudes towards litter reduction, and the need for targeted educational campaigns and policy interventions. About 65% of respondents were familiar with the term "marine litter," and 78% agreed that it severely impacts beaches and the coastal environment. However, only 60% and 55% of respondents acknowledged severe impacts on tourism and the local economy, respectively. Effective solutions highlighted include education and awareness campaigns (85%), enhanced waste management systems (80%), and promoting sustainable practices (75%). There was strong support (70%) for stricter regulations and penalties. The study recommends innovative solutions such as circular economy initiatives, marine litter monitoring technologies, plastic deposit return schemes, community-based litter banks, public art projects, and eco-tourism programs. These recommendations, if effectively implemented, can foster a more sustainable and engaged community, capable of addressing the multifaceted challenges of marine litter. Collaboration between government authorities, local communities, businesses, and environmental organizations is essential for successful implementation. The study underscores the need for continued research and adaptive management to track progress and refine approaches, ensuring long-term success in combating marine litter in Goa and beyond.

Keywords

Marine litter, public perception, coastal pollution, Goa, environmental awareness, waste management

1. Introduction

Marine litter, characterized by the accumulation of human-produced waste in marine environments, is a critical environmental issue affecting global ecosystems [1]. Plastics, which constitute a major portion of marine debris, pose long-term ecological and health risks [2]. These plastics can persist for centuries, fragmenting into microplastics that further complicate remediation efforts and pose additional hazards to marine organisms [3].

The sources of marine litter are varied, including land-based activities such as tourism, industrial operations, and inadequate waste management practices, as well as ocean-based activities like shipping and fishing [4]. In coastal regions like Goa, the influx of tourism exacerbates the problem, necessitating a thorough understanding of public perception to devise effective mitigation strategies [5].

Marine litter affects marine life through ingestion and entanglement, leading to injuries, starvation, and death [3]. It also degrades the aesthetic value of coastal areas, impacting tourism and recreation industries that are vital to local economies [6]. Additionally, marine litter can facilitate the transport of invasive species and pollutants, further disrupting marine ecosystems [1].

Public perception and awareness play a critical role in the success of marine litter mitigation efforts. Understanding how local communities perceive marine litter, its sources, and its impacts can inform the development of targeted educational campaigns and community engagement strategies [7]. Public participation is essential for effective policy implementation and the promotion of sustainable practices to reduce marine litter [8].

Existing research on public perception of marine litter in coastal regions highlights a general awareness of the issue, but significant knowledge gaps remain regarding the sources and long-term impacts of marine litter. Attitudes towards litter reduction and recycling behaviours vary

among different demographic groups, emphasizing the need for localized studies to understand specific community perspectives and challenges [9].

In Goa, research on public perception of marine litter is limited, with most studies focusing on the ecological and economic impacts [5]. This study aims to fill this gap by exploring the awareness, attitudes, and behaviours of Goa's residents and visitors regarding marine litter. By examining public perception, this research seeks to identify barriers to effective litter management and opportunities for enhancing community involvement in conservation efforts.

Global Perspectives on Marine Litter

Marine litter is a global concern, with plastics being the predominant type of debris [2]. The sources of marine litter include land-based activities such as tourism and inadequate waste management, as well as ocean-based activities like fishing and shipping [4]. The impacts on marine life are severe, including ingestion and entanglement [3]. Studies indicate high public awareness of marine litter, but proactive behaviour remains limited [7].

The prevalence of marine litter is a growing global concern, with significant environmental, economic, and health implications. Studies such as those by Barnes et al. [2] highlight the widespread distribution and persistence of plastic debris, which can fragment into microplastics and pose serious risks to marine life and human health [10][11]. The sources of marine litter are varied, ranging from land-based activities like tourism, industrial operations, and inadequate waste management to ocean-based activities such as fishing and shipping [4]. Marine litter affects marine life through ingestion and entanglement, leading to injuries, starvation, and death [3].

Marine litter's impacts on marine life are manifold. Ingestion of plastic debris by marine organisms can lead to blockages in the digestive system, malnutrition, and even death [10]. Entanglement in plastic debris can cause injuries and hinder mobility, making it difficult for marine animals to find food or escape predators [12]. Moreover, the presence of microplastics in the marine environment poses additional risks, as these small plastic particles can be ingested by a wide range of organisms, entering the food web and potentially affecting human health [11].

Impacts on Coastal Communities and Ecosystems

The impacts of marine litter extend beyond the marine environment, affecting coastal communities and ecosystems. Marine litter degrades the aesthetic value of coastal areas, impacting tourism and recreation industries vital to local economies [6]. Additionally, marine litter can facilitate the transport of invasive species and pollutants, further disrupting marine ecosystems [1]. These impacts underscore the need for comprehensive strategies to address marine litter and protect marine and coastal environments [12][13].

Tourism, a major economic driver for many coastal regions, is significantly affected by marine litter. Beaches littered with plastic waste deter tourists, leading to a decline in tourism revenue and affecting local businesses [6]. Furthermore, the cost of cleaning up marine litter falls on local governments and communities, diverting resources that could be used for other essential services [14]. The ecological impacts of marine litter are equally concerning. Plastic debris can smother coral reefs, reducing their resilience to other stressors such as climate change and overfishing [15]. Mangrove forests, which serve as crucial nurseries for many marine species, can also be damaged by plastic waste accumulating in these habitats [16].

Public Perception and Awareness

Public perception and awareness play a critical role in the success of marine litter mitigation efforts. Understanding how local communities perceive marine litter, its sources, and its impacts can inform the development of targeted educational campaigns and community engagement strategies [7]. Public participation is essential for effective policy implementation and the promotion of sustainable practices to reduce marine litter [8].

Studies on public perception of marine litter have shown that while awareness levels are generally high, there is often a disconnect between awareness and action [7]. This gap can be attributed to various factors, including a lack of understanding of the sources and long-term impacts of marine litter, as well as limited access to facilities and infrastructure for proper waste disposal and recycling [9]. Effective communication strategies that highlight the tangible benefits of reducing marine litter and provide practical solutions for individuals and communities are crucial for bridging this gap [17].

Regional Studies and Contextual Analysis

Research on public perception of marine litter in coastal regions highlights a general awareness of the issue, but significant knowledge gaps remain regarding the sources and long-term impacts of marine litter. Attitudes towards litter reduction and recycling behaviours vary among different demographic groups, emphasizing the need for localized studies to understand specific community perspectives and challenges [9][18].

For example, a study conducted in the Mediterranean region found that younger individuals were more aware of marine litter issues but less likely to participate in beach clean-up activities compared to older age groups [18]. Similarly, research in the Baltic Sea region revealed that while residents were generally aware of the environmental impacts of marine litter, there was limited knowledge about the specific sources and pathways of plastic pollution [19]. These findings underscore the importance of tailored communication and engagement strategies that address the unique characteristics and needs of different demographic groups.

Marine Litter in India

In India, coastal states like Goa face significant challenges related to marine litter. A study by Kumar et al. [5] highlighted that tourism and fisheries are primary contributors to marine litter in Goa. The study emphasized the need for improved waste management practices and stricter enforcement of environmental regulations. Research specific to Goa indicates varying levels of awareness and engagement among different communities. A survey conducted by the National Institute of Oceanography (NIO) in 2018 found that while local fishermen were acutely aware of the impacts of marine litter on their livelihoods, tourists and urban residents showed lower levels of concern and involvement in litter reduction activities [20]. This disparity underscores the need for targeted educational campaigns and community-driven initiatives.

Marine litter in India is further compounded by inadequate waste management infrastructure and regulatory enforcement. Many coastal towns and cities lack sufficient facilities for waste collection, segregation, and recycling, leading to the improper disposal of plastic waste into rivers and the ocean [21]. Moreover, the informal waste sector, which plays a crucial role in waste management in many Indian cities, often lacks the resources and support needed to handle the growing volume of plastic waste effectively [22]. Addressing these challenges

requires a coordinated effort that involves government authorities, local communities, businesses, and non-governmental organizations (NGOs) [23].

Policy and Management Strategies

Effective management of marine litter requires a combination of policy interventions and community engagement. The Indian government has implemented several policies aimed at reducing plastic waste, such as the Plastic Waste Management Rules (2016). However, enforcement remains a challenge [21]. Local initiatives, such as beach clean-up drives and awareness campaigns led by NGOs and community groups, have shown promise in raising awareness and promoting sustainable practices [23].

Internationally, successful marine litter management strategies often involve a multi-faceted approach that includes legislation, education, and community involvement. For instance, the European Union's Marine Strategy Framework Directive (MSFD) sets targets for reducing marine litter and encourages member states to develop national action plans that address both land-based and sea-based sources of litter [4]. Similarly, countries such as Japan and South Korea have implemented extensive public education campaigns and established financial incentives for businesses to reduce plastic waste and invest in recycling infrastructure [24]. These examples highlight the importance of a comprehensive and integrated approach to marine litter management.

The literature highlights the complex and multifaceted nature of marine litter as an environmental issue that requires coordinated efforts at local, national, and international levels. Understanding public perception and behaviour is crucial for developing effective strategies to mitigate the impacts of marine litter and promote sustainable practices. This study aims to contribute to this understanding by exploring the awareness, attitudes, and behaviours of residents and visitors in Goa, India, regarding marine litter.

3. Research Methodology

This study employs a mixed-methods approach, integrating quantitative and qualitative data collection techniques to provide a comprehensive understanding of public perception of marine

litter in Goa. The methodology includes structured questionnaires, semi-structured interviews, and focus group discussions.

Quantitative Approach

A structured questionnaire was administered to a representative sample of 500 residents and visitors in Goa, covering diverse demographic groups. The questionnaire was designed to capture detailed information on public awareness, attitudes, and behaviours related to marine litter. It was divided into seven sections: demographics, awareness, perception of impact, major contributors, effects on the environment, future problems and causes, and suggested solutions.

Qualitative Approach

Complementary semi-structured interviews and focus group discussions were conducted with key stakeholders, including local fishermen, tourism operators, environmental NGOs, and government officials. These qualitative methods provided in-depth insights into individual perceptions and community-level dynamics regarding marine litter.

Data Analysis

Quantitative data from the questionnaires were analysed using statistical software to identify trends and correlations. Qualitative data from interviews and focus groups were analysed using thematic analysis to identify common themes and insights. The combination of these methods allowed for triangulation, enhancing the validity and reliability of the findings.

4. Results

The data collected was analysed to understand the objectives of the study. The detailed results and interpretations from the data collected are given in succeeding paragraphs.

4.1 Demographics

The sample included 52% males and 48% females, with an age range of 18-65 years. The majority (70%) were residents of coastal areas, while 30% were tourists. This distribution ensures a representative sample of the population impacted by marine litter in Goa.

4.2 Awareness about Marine Litter

About 65% of respondents were familiar with the term "marine litter," with higher awareness among residents compared to tourists. Only 40% had encountered information or campaigns

on marine litter. This indicates a significant gap in public awareness initiatives targeting tourists and urban residents. This finding resonates with the study by Hartley et al. [7], which found a high awareness level but low engagement in mitigation activities.

4.3 Perception on Severe Impact of Marine Litter

A significant majority (78%) agreed that marine litter severely impacts beaches and the coastal environment. However, perceptions of its impact on the tourism industry and local economy were less pronounced, with only 60% and 55% of respondents respectively acknowledging severe impacts. This suggests a need for greater emphasis on communicating the economic implications of marine litter, similar to findings by Jambeck et al. (2015) [6], who highlighted the economic burden of marine litter on coastal communities.

4.4 Opinion about Major Contributors to Marine Litter

Plastic waste from individuals (80%) and inadequate waste management systems (75%) were identified as major contributors. Tourism-related activities and commercial fishing were also perceived as significant sources. These findings highlight the need for targeted interventions addressing both individual behaviours and systemic waste management issues. This is consistent with the observations of Ferreira et al. (2021) in Cape Verde [8], where community-based waste management practices were crucial in addressing marine litter.

4.5 Effects of Marine Litter

Respondents largely agreed that marine litter contributes to habitat damage (85%), water pollution (80%), and harm to marine life (90%). There was also concern about its impact on coral reefs (75%) and shoreline pollution (78%). These perceptions align with global studies highlighting the multifaceted impacts of marine litter on the environment, such as the work by Gall & Thompson (2015) [3] and Wright et al. (2013) [11].

4.6 Future Problems and Causes

The primary future concerns included the exacerbation of water pollution and the decline in marine biodiversity. Key causes identified were lack of public awareness, inadequate waste management infrastructure, and insufficient regulations. These findings underscore the need for comprehensive strategies addressing both education and infrastructure, similar to the recommendations by Renzi & Guerranti (2021) [9].

4.7 Suggested Solutions

Effective solutions highlighted included education and awareness campaigns (85%), enhanced waste management systems (80%), and promoting sustainable practices (75%). There was strong support (70%) for stricter regulations and penalties. These responses indicate broad public support for multifaceted approaches to marine litter reduction. This is in line with studies by Renzi & Guerranti (2021) [9] and Veiga et al. (2016) [18], which emphasize the importance of integrated approaches to marine litter management.

4.8 Interpretation of Findings

The findings of this study reflect a significant awareness of marine litter among the residents and tourists of Goa, yet there is a notable gap between awareness and proactive behaviour. This gap is also observed in European contexts, as reported by Hartley et al. [7]. The economic and ecological impacts highlighted by respondents are consistent with global concerns, as articulated by Jambeck et al. [6] and Gall & Thompson [3]. The perceived contributors to marine litter, such as individual plastic waste and inadequate waste management, mirror the findings of Kumar et al. [5] regarding the sources of marine litter in coastal India. The support for educational campaigns and enhanced waste management infrastructure suggests a public readiness to engage in solutions if provided with the necessary resources and support.

5. Discussion

5.1 Comparison with Literature

The findings of this study are consistent with global research indicating that while there is generally high awareness of marine litter, this does not always translate into proactive behaviour. For example, Hartley et al. [7] found that 70% of respondents in European coastal areas were aware of marine litter, but only 30% participated in litter reduction activities. Similarly, in Goa, 65% of respondents were aware of marine litter, yet engagement in mitigation efforts was limited.

Sources and Perceived Impacts

The identification of plastic waste and inadequate waste management systems as major contributors to marine litter in Goa aligns with findings by Ferreira et al. [8] in Cape Verde, where community-based waste management practices were crucial in addressing marine litter.

The perception of severe impacts on marine life (90%) and habitat damage (85%) also mirrors global concerns, as highlighted by Gall & Thompson [3].

Community Engagement and Solutions

The strong support for education and awareness campaigns (85%) and enhanced waste management systems (80%) in this study echoes the recommendations by Renzi & Guerranti [9] for integrated approaches to marine litter management. The findings also underscore the importance of community involvement, similar to the collaborative methodologies emphasized by Ferreira et al. [8].

Economic and Ecological Consequences

The study's findings on the perceived economic impacts of marine litter are significant. A majority of respondents (60%) acknowledged the adverse effects of marine litter on tourism, a critical industry for Goa's economy. This aligns with the research by Jambeck et al. [6], which highlights the economic burden of marine litter on coastal communities. The ecological consequences, including habitat damage (85%) and harm to marine life (90%), are consistent with global studies such as those by Gall & Thompson [3] and Wright et al. [11], which emphasize the extensive ecological disruptions caused by marine litter.

Behavioural Insights and Attitudinal Gaps

The behavioural insights from this study reveal significant attitudinal gaps. While awareness levels are relatively high (65%), proactive behaviour remains limited. This mirrors findings by Hartley et al. [7] and highlights the necessity of bridging the gap between awareness and action. The support for stricter regulations (70%) and enhanced waste management systems (80%) suggests a public willingness to engage in solutions if provided with the appropriate infrastructure and policy support.

5.2 Implications for Policy and Practice

The study underscores the need for targeted educational campaigns to bridge the gap between awareness and action. Improved waste management infrastructure and stricter enforcement of regulations are crucial. Engaging local communities through participatory initiatives can enhance the effectiveness of mitigation efforts. The findings suggest that policies should focus on enhancing public awareness, strengthening waste management systems, and fostering community involvement.

Educational Campaigns

Education is vital in changing behaviours and increasing public participation in marine litter reduction. Campaigns should focus on the impacts of marine litter, proper waste disposal practices, and the importance of reducing plastic use. Educational initiatives can be tailored to different demographic groups to address specific knowledge gaps and cultural contexts [12,13].

Infrastructure and Regulations

Enhancing waste management infrastructure, especially in high-tourism areas, is essential. This includes increasing the availability of recycling facilities and ensuring proper waste disposal. Regulations should be enforced more strictly, with penalties for non-compliance to ensure adherence to waste management practices. Policy interventions should also consider the economic incentives for businesses and individuals to adopt sustainable practices [21].

Community Involvement

Community-driven initiatives, such as beach clean-ups and local awareness programs, can significantly impact marine litter reduction. Engaging local stakeholders, including fishermen, tourism operators, and environmental groups, can foster a sense of ownership and responsibility towards maintaining clean coastal areas. Collaborative efforts can also enhance the resilience of coastal communities to the impacts of marine litter [25].

Technological Innovations

Investing in technological innovations, such as marine litter monitoring systems and advanced waste management technologies, can enhance the effectiveness of litter reduction efforts. Technologies such as drones and underwater robots can be used to identify and map marine litter hotspots, optimizing clean-up operations and targeting sources of litter [26].

5.3 Limitations

The study is limited by its sample size and the geographic concentration within Goa, which may not fully capture the diversity of perceptions and attitudes across different regions. Future research should expand to include broader geographic areas and longitudinal studies to track changes over time, providing a more comprehensive understanding of the issue. Additionally, the reliance on self-reported data may introduce biases that could affect the findings, such as social desirability bias or recall bias. To mitigate these limitations, future studies could

incorporate objective measures and larger, more representative samples, as well as consider the inclusion of more diverse demographic groups.

6. Recommendations

The study highlights the public's considerable awareness of marine litter and its detrimental effects. However, they also reveal a significant gap between this awareness and proactive behaviour. This discrepancy underscores the need for focused educational campaigns, enhanced waste management infrastructure, and stricter regulatory enforcement practices. Therefore, to address the gap identified by the study, following recommendations are proposed:

- **Circular Economy Initiatives:** Promote a circular economy approach by encouraging the development of local businesses that recycle and repurpose marine litter into valuable products, such as furniture, construction materials, and fashion items. This can create economic incentives for litter collection and recycling [21.27].
- **Marine Litter Monitoring Technologies:** Invest in the development and deployment of advanced technologies, such as drones and underwater robots, to monitor and map marine litter hotspots. This data can be used to optimize clean-up efforts and identify sources of litter [26].
- **Plastic Deposit Return Schemes:** Implement deposit return schemes for plastic bottles and containers, offering financial incentives for returning used plastics. This can significantly reduce plastic waste entering the marine environment [28].
- **Community-Based Litter Banks:** Establish community-based litter banks where residents can deposit collected marine litter in exchange for rewards, such as discounts on local goods and services. This can motivate community participation in litter collection [29].
- **Public Art and Awareness Projects:** Use public art installations made from collected marine litter to raise awareness about the issue. These installations can be placed in high-traffic areas to educate the public and encourage behavioural change [30].
- **Eco-Tourism Programs:** Develop eco-tourism programs that involve tourists in beach clean-up activities and environmental education. This can enhance tourists' awareness and engagement while supporting local conservation efforts [25].
- **Policy Integration with Blue Economy Initiatives:** Integrate marine litter management into broader blue economy initiatives, promoting sustainable use of ocean resources and aligning with national and international marine conservation goals [31].

- Awareness Campaigns: Implement targeted educational programs to raise awareness about marine litter and its impacts.
- Community Engagement: Involve local communities in beach clean-up activities and conservation efforts.
- Policy Interventions: Strengthen regulations on waste management and enforce penalties for non-compliance.
- Waste Management Infrastructure: Enhance waste collection and recycling facilities, particularly in high-tourism areas.
- Sustainable Practices: Promote the adoption of sustainable practices among residents, tourists, and businesses.

7. Conclusion

This study provides valuable insights into the public perception of marine litter in Goa, highlighting the need for comprehensive strategies that integrate education, policy, and community engagement. The findings underscore the significant awareness among the public regarding marine litter and its impacts, yet also reveal a substantial gap between awareness and proactive behaviour. This disconnect emphasizes the necessity for targeted educational campaigns, improved waste management infrastructure, and stricter enforcement of regulations.

The support for innovative solutions, such as circular economy initiatives and marine litter monitoring technologies, indicates a public readiness to engage with and support advanced approaches to marine litter management. These recommendations, if effectively implemented, can foster a more sustainable and engaged community, capable of addressing the multifaceted challenges of marine litter.

The study's limitations highlight the need for further research across broader geographic areas and over longer periods to gain a more comprehensive understanding of the evolving perceptions and behaviours related to marine litter. Future studies should also explore the effectiveness of various intervention strategies to identify the most impactful approaches.

By addressing the identified gaps and leveraging community support, it is possible to mitigate the impacts of marine litter and preserve Goa's coastal and marine environments for future generations. The proposed recommendations, including innovative solutions and traditional approaches, offer a practical and holistic pathway to achieve sustainable marine litter management. Effective implementation of these strategies requires collaboration between

government authorities, local communities, businesses, and environmental organizations. Continued research and adaptive management will be crucial to track progress and refine approaches, ensuring long-term success in combating marine litter in Goa and beyond.

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