

Advancing Sargassum Management: Puerto Rico's Policies, Research, and Implementation Challenges

Adelantando el Manejo Del Sargazo: Políticas, Investigación y Desafíos en la Implementación en Puerto Rico

Faire Progresser La Gestion Des Sargasses: Politiques, Recherche et Défis de Mise en uvre À Porto Rico

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EXTENDED ABSTRACT

INTRODUCTION

Massive, recurring influxes of floating sargassum seaweed have impacted the Wider Caribbean Region, including Puerto Rico, for over a decade. Although pelagic Sargassum spp. serve as essential habitats for marine organisms in open-ocean ecosystems, their excessive accumulation along shorelines has led to substantial ecological, socio-economic, and public health challenges (UNEP-CEP, 2021). Decomposing sargassum degrades water quality and releases hydrogen sulfide, which produces an unpleasant smell and negatively impacts fisheries, tourism, and coastal ecosystems.

Mitigation efforts across the region include floating boom barriers, manual and mechanical removal, and valorization initiatives, but these strategies pose logistical, legal, and economic challenges. Specialized infrastructure, funding, and expertise are required for containment, removal, and repurposing. With sargassum influxes being relatively new, most Caribbean nations lack sufficient policy frameworks, management plans, and regulations, resulting in fragmented and reactive responses.

This presentation reviews Puerto Rico's policy responses to sargassum, highlighting extensive research into its dynamics, impacts, and potential for valorization. It synthesizes efforts to bridge gaps in governance, foster innovation, and implement sustainable management strategies. By addressing regulatory and logistical barriers, Puerto Rico can enhance its capacity to manage sargassum influxes and contribute valuable knowledge and practices to the region's shared challenges.

METHODOLOGY

This work compiles findings from diverse research studies, including León-Pérez et al. (2024) and IDB Lab (2024), and integrates the author's extensive experience in research and consulting on sargassum management in Puerto Rico. The synthesis includes a review of peer-reviewed literature, technical reports, and policy documents, complemented by insights derived from on-the-ground project implementation and stakeholder engagement. By drawing on a multidisciplinary approach, the study provides an overview of Puerto Rico's policy landscape, scientific advancements, and innovative practices addressing the challenges posed by sargassum influxes.

RESULTS AND DISCUSSION

Policy and Governance Challenges

Puerto Rico, as a U.S. unincorporated territory, faces significant challenges in managing sargassum influxes due to its intricate governance structure, which divides responsibilities between the Commonwealth and U.S. federal agencies. This dual jurisdiction complicates permitting processes, particularly for in-water collection and boom placement, leading to delays, unregulated actions, and increased risks of noncompliance. Although the local government introduced the Protocol for Handling Extreme Accumulations of Sargassum in 2015 and updated it in 2023, its implementation has been minimal and fragmented. These protocols, while serving as a model for regional sargassum management guidelines, have been constrained by local institutional limitations, funding challenges, and unclear legal guidance. A recent analysis of Puerto Rico's legal framework has identified key barriers and recommended streamlining permit processes to improve efficiency and compliance, underscoring the need for a more cohesive approach to sargassum management (León-Pérez et al. 2024).

Research Contributions

Puerto Rico has been at the forefront of sargassum-related research, with key contributions from the University of Puerto Rico (Rio Piedras and Mayagüez campuses), the Polytechnic University, Puerto Rico Sea Grant, and CARICOOS.

Research efforts span sargassum dynamics, ecological impacts, socio-economic implications, and valorization, showcasing the archipelago's scientific expertise and innovation.

In the area of sargassum dynamics and detection, studies have advanced the use of satellite remote sensing with artificial intelligence (AI) and machine learning algorithms to improve detection accuracy. Researchers are developing a remote sensing technique to create a sargassum decay index and explored correlations between Saharan dust and sargassum concentrations. High-resolution forecasting models have been designed to predict coastal inundations, while experimental models investigate biogeochemical impacts, such as hypoxia and ocean acidification caused by sargassum influxes.

Research into ecological impacts includes assessments of nearshore water quality degradation and the accumulation of heavy metals in sargassum. Studies have also documented its effects on mangrove productivity and mortality, changes in seagrass aerial cover, and its impact on habitats essential for juvenile fish of managed species. Additionally, shifts in plankton functional groups and abundance have been identified.

Socio-economic research initiatives have focused on assessing the vulnerability of coastal households to sargassum events and creating an index to prioritize management efforts based on socio-economic, ecological, and shoreline management characteristics. Innovative methods using drones have been developed to measure toxic gases, such as hydrogen sulfide, emitted during sargassum decomposition.

Alternative uses and valorization research has explored applications ranging from biofuel, biocarbon, textiles, and sunblock to advanced materials like remediation membranes, construction materials, solid electrolytes for batteries, and 3D printing filaments. External collaborations with entities such as Invest Puerto Rico, Newlab, Carbonwave, SOS Carbon, and The Ocean Foundation have further driven the development of sustainable sargassum-based products, fostering a circular economy approach.

Strengths and Opportunities

Puerto Rico's small size and robust academic infrastructure, with over 30 universities offering diverse STEM programs, position it as a hub for sargassum-related research and innovation. Accessibility to U.S. federal research funding further bolsters its potential. Potential partnerships with private entities and international organizations provide pathways for developing scalable and market-ready solutions.

Challenges and Limitations

Despite its research strengths, Puerto Rico lags in implementing management strategies compared to other Caribbean nations. Institutional constraints, unclear governance frameworks, and funding gaps remain significant hurdles. Additionally, Puerto Rico's exclusion from some regional initiatives due to its political status limits opportunities for broader collaboration.

CONCLUSIONS AND RECOMMENDATIONS

Puerto Rico has made significant progress in sargassum research and policy development, providing valuable insights and innovations for the Caribbean and beyond. Key recommendations include streamlining permitting processes and improving interagency coordination to enhance sargassum management, leveraging the island's academic and research expertise to strengthen international collaborations, and investing in sustainable valorization projects that promote a circular economy. Additionally, ensuring Puerto Rico's inclusion in regional initiatives can help foster unified responses to shared challenges. By adopting a cohesive approach that emphasizes resource pooling, knowledge sharing, and policy alignment, the Caribbean can accelerate effective sargassum management and build regional resilience.

LITERATURE CITED

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