Microplastic Contamination in Mangrove Ecosystems in Sri Lanka: Policy Implications and Integration of Global Regulatory Frameworks

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Mangrove ecosystems are vital coastal habitats that deliver critical ecosystem services. However, dense mangrove root systems efficiently entrap and accumulate microplastics (MPs), converting these ecosystems into long-standing sinks for MPs pollution. In Sri Lanka, growing microplastic pollution, linked with the lack of microplastic-specific policy and regulatory framework, inadequate environmental examining, insufficient scientific evidence, institutional fragmentation and poor coordination. These deficiencies have generated major policy and governance gaps, resulting in disintegrated management of MPs contamination across interconnected riverine, estuarine, and coastal ecosystems. This review synthesizes existing knowledge on mangrove microplastic pollution, critically evaluates Sri Lanka's National Environmental Policy and regulatory framework, and reviews the global policy framework on MP pollution control through a comprehensive literature review. The methodology is structured into three sections: (a) study of the plastic lifecycle and microplastic toxic contaminants affecting mangrove ecosystems; (b) an extensive review of microplastic contamination research trends in Sri Lanka, with specific attention on riverine, coastal and estuarine mangrove ecosystems; and (c) an evaluation of global microplastic policy and regulatory frameworks and adaptable policy responses for nationwide mangrove conservation. The review further examines the appropriateness of existing global regulatory mechanisms, including the European Union REACH Synthetic Polymer Microparticles (SPM) Restriction, the EU plastic pellet regulation-2025 on strict rules to prevent pellet losses, and the United Nations Global Plastics Treaty, to create a cohesive policy pathway for Sri Lanka's MP pollution control. By examining these internationally recognized frameworks and mechanisms, this study identifies key policy implications, including the need to regulate globally generated microplastics, prevent industrial pellet loss into the environment, and develop standardized protocols for routine monitoring and assessments. Furthermore, the paper outlines future research and policy directions, emphasizing the importance of scientific monitoring, interdisciplinary research, and integrated river- to -mangrove management approaches. These measures are essential for fostering evidence-based policymaking and achieving effective control of microplastic contamination across interlinked freshwater, estuarine and mangrove ecosystems.

Keywords: *Global microplastic policy and regulatory frameworks, Mangrove, Microplastics, Policy implications*