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Operationalizing marine spatial planning in the egyptian red sea: implications for climate resilience and sustainable marine resource governance

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Abstract

Marine Spatial Planning has been conducted for the first time in Egypt's Northern Red Sea as a pilot study Advancing Climate Adaptation and Biodiversity Protection through Integrated Marine Governance. Marine Spatial Planning (MSP) is increasingly recognised as a critical tool for addressing the interconnected challenges of climate change and marine resource degradation. This study presents the development of an MSP for the Northern Islands Protected Area (NISPA) in Egypt's Red Sea as a science-based and policy-relevant approach to support climate adaptation and biodiversity conservation. The initiative is aligned with Egypt Vision 2030, the National Biodiversity Strategy and Action Plan, and the Convention on Biological Diversity, while contributing to the national blue economy framework. The MSP functions as a decision-support tool to enhance climate resilience and protect marine ecosystems by applying ecosystem-based management principles. It aims to reduce spatial conflicts among competing uses, minimise cumulative environmental impacts, and safeguard ecologically sensitive habitats, particularly coral reef systems. In doing so, it strengthens the adaptive capacity of both ecosystems and coastal communities to climate-induced stressors such as sea-level rise, ocean warming, and habitat degradation. An iterative and participatory methodology was adopted, integrating multi-source environmental and socio-economic data derived from field surveys, satellite observations, and existing studies. Key parameters included shoreline dynamics, bathymetry, water quality, biodiversity indicators, and the spatial distribution of human activities (e.g., fisheries, tourism, and maritime transport). Stakeholder engagement was ensured through structured consultations and workshops. GIS-based spatial analyses resulted in the production of more than 70 thematic maps and 32 geospatial layers. The MSP generated key outputs, including a sectoral conflict matrix and a spatial zoning framework that prioritises biodiversity protection while enabling sustainable use. Scenario analysis produced two pathways: a conservation-oriented scenario and an integrated development scenario incorporating eco-tourism, aquaculture, and renewable energy. This work demonstrates how MSP can operationalize climate adaptation and resource governance, providing a replicable model for sustainable marine management in data-limited and climate-vulnerable regions.

Keywords: Biodiversity Conservation, Blue Economy, Climate Change Adaptation, Coastal and Marine Governance, Ecosystem-Based Management, marine Spatial Planning (MSP)

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