Synthesizing the Pacific Ocean's remote-sensing environment data indicators to cultivate better socioecological systems and blue transformation governance decisions in Taiwan.

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Abstract

Taiwan's strategic location in the Asia-Pacific region (APR) makes it rank among the globally recognized biodiversity hotspots with extensive marine ecosystems and resources. Yet, marine ecosystem abundance has coincided with increasing coastal megatrends and amplified climate variability to increase marine-coastal vulnerability. Providing practical remedies to Taiwan's dynamic coastal socioecological systems can foster better blue governance solutions. This study synthesizes multi-temporal satellite observations to advance socioecological system resilience and blue transformation governance in Taiwan. Using datasets spanning 2010–2025, we analyze trends in sea surface temperature (SST), sea surface salinity (SSS), sea surface chlorophyll (SSC), and sea surface height (SSH) across the Pacific Ocean to understand their impact on Taiwan's coastal and marine environments. Remote-sensing indicators are integrated to reveal coupled dynamics between oceanographic variability, blue economy sectors, and

socioecological vulnerabilities, including fisheries, aquaculture, marine shipping, renewable energy projects, and coastal community livelihoods. Results highlight significant warming signals in SST, salinity anomalies linked to monsoon variability, and sediment fluxes affecting nearshore ecosystems. Increased SST, averaging 0.15–0.20 °C per year, and sea level rise across coastal urban fishing zones exacerbate livelihood risks, coastal inundation, and habitat loss. This is worsened by increasing SSH patterns associated with climate-driven sea level rise along western plains. Coincidentally, worsening fluxes are observed in the western coastal regions, where massive blue projects exist. These findings provide evidence for adaptive governance pathways that align ecological monitoring with decision-making frameworks for sustainable ocean management. This is because the systemic environmental risks not only threaten ecological integrity but also undermine food security, cultural heritage, and local economies. To build sustainable futures, integrative and transdisciplinary monitoring approaches are needed, where remote sensing data should complement coastal communities' data to provide a powerful and holistic lens for systematic detection, quantification, and communication of multi-faceted coastal risks. This can offer practical insights for policymakers, researchers, and communities to co-develop strategic approaches and initiatives toward sustainable ecosystem-based management and blue governance solutions, potentially contributing to global discussions around urban sustainability that safeguard human health and ecological integrity. Thus, by bridging environmental scientific data with coastal communities' data, we can offer practical policy designs rather than siloed perspectives. Integrated knowledge lenses directly contribute to Taiwan's emerging blue transformation agenda, embedded in the New Southbound Policy. This can strengthen the role of science-based indicators in cultivating better, more resilient and adaptive socioecological systems solutions. To achieve holistic blue transformations, long-term satellite monitoring and sustained marine socioecological systems research are needed to inform sustainable ocean governance solutions.

Keywords: Blue economy and blue governance, Pacific Ocean, Satellite remote sensing, Socioecological systems, Taiwan