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EDITORIAL

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Co-Producing Coastal Sustainability Through Higher Education

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Abstract

Coastal regions are undergoing rapid environmental and socio-economic transformations, driven by climate change, demographic shifts, and evolving human–ocean interactions. Despite growing scientific knowledge, significant gaps persist in understanding and governing the complex interdependencies between marine ecosystems and human societies. These gaps reflect a broader disconnect between knowledge production, policy implementation, and community practice. In response, sustainability science has increasingly emphasized knowledge co-production and transdisciplinary approaches, which highlight collaborative, context-sensitive, and action-oriented processes involving scientists, policymakers, and societal actors. Within this evolving landscape, environmental governance is being reconfigured as a dynamic process of social learning, negotiation, and adaptation, rather than a purely technocratic exercise. Higher education institutions are emerging as key intermediary platforms that facilitate such processes by connecting science, policy, and society through community-engaged and real-world learning approaches. This thematic issue brings together six case-based studies that examine how these shifts toward co-production, adaptive governance, and institutional innovation are realized in diverse coastal contexts. Collectively, the contributions demonstrate how universities and multi-stakeholder collaborations help bridge the gap between knowledge and action, supporting more integrated, participatory, and context-responsive approaches to sustainability transitions.

Keywords

coastal sustainability; higher education; knowledge co-production; social-ecological systems; sustainability transitions; transdisciplinary research

1. Introduction

Coastal communities and their environments are undergoing rapid and far-reaching transformations. Global shifts in demographics, climate patterns, hydrological systems, and ocean conditions are increasingly reshaping coastal economies, social structures, and ecosystems (Intergovernmental Oceanographic Commission, 2020; Intergovernmental Panel on Climate Change, 2022). These changes not only intensify environmental pressures—such as ocean warming, biodiversity loss, and coastal degradation—but also expose underlying socio-economic vulnerabilities within coastal regions (Bennett et al., 2021). Addressing these interconnected challenges requires approaches that move beyond sectoral management toward the sustainable use and conservation of marine and coastal resources in ways that support ecological integrity, economic vitality, and social resilience.

Despite growing scientific knowledge, significant gaps remain in understanding and governing the complex interdependencies between marine ecosystems and human societies (Folke et al., 2005; Norström et al., 2020). Even where evidence-based strategies for mitigating ecosystem degradation exist, they are often insufficiently integrated into policy and management frameworks (Cvitanovic et al., 2015). In many cases, existing governance approaches remain fragmented and struggle to foster effective collaboration among diverse stakeholders, often resulting in limited or symbolic outcomes (Bodin, 2017). These limitations reflect a deeper structural challenge: the persistent disconnect between knowledge production, policy implementation, and community practice.

In response, there is increasing recognition that sustainability transitions require not only improved knowledge, but new modes of knowledge production and governance. In particular, knowledge co-production has emerged as a central framework in sustainability science, emphasizing the collaborative generation of knowledge among scientists, policymakers, and societal actors (Norström et al., 2020). Closely related, transdisciplinary research highlights the integration of diverse knowledge systems and the co-design of solutions that are context-sensitive and action-oriented (Mauser et al., 2013). Together, these approaches shift the focus from knowledge as an output to knowledge as a relational and iterative process embedded in governance.

Within this perspective, environmental governance is increasingly understood as a process of social learning, negotiation, and adaptation, rather than a purely technical or institutional exercise (Folke et al., 2005). Effective governance therefore depends not only on formal policies and regulatory frameworks, but also on the capacity to bridge knowledge systems, facilitate stakeholder collaboration, and translate knowledge into practice across scales.

Within this evolving landscape, higher education institutions are emerging as key actors in sustainability transitions. Beyond their traditional roles in teaching and research, universities are increasingly positioned as intermediary platforms for knowledge co-production, connecting science, policy, and society (Benneworth & Nieth, 2018; Trencher et al., 2014). Through community-engaged and real-world learning approaches, including project-based and service learning, universities foster interdisciplinary collaboration and cross-sector partnerships, thereby contributing to the co-creation of knowledge and the development of context-sensitive solutions to complex coastal challenges (Brundiers et al., 2010; Mauser et al., 2013).

This thematic issue brings together a set of case-based studies that examine how these shifts toward co-production, transdisciplinary collaboration, and adaptive governance are being realized in diverse coastal contexts. The contributions collectively illustrate how environmental governance is being reconfigured through the integration of knowledge systems, stakeholder participation, and institutional innovation. By emphasizing practical experiences and social impacts, the issue highlights the critical role of universities and collaborative processes in bridging the gap between knowledge and action in sustainability transitions.

2. This Thematic Issue

The six articles included in this thematic issue collectively address the pressing challenges faced by coastal regions under the impacts of climate change and sustainability transitions.

Taken together, they present a coherent trajectory from macro-level environmental pressures to localized governance practices, and further toward the evolving role of higher education in sustainability. Importantly, this trajectory can be understood through the lens of knowledge co-production and transdisciplinary governance, which highlights how environmental change, governance transformation, and institutional innovation are mutually reinforcing.

The thematic issue begins with a systemic perspective on ocean governance. Shih examines expert perceptions of climate-related impacts on marine ecosystems through a mixed-methods design combining a survey of 70 experts with in-depth semi-structured interviews. The study identifies ocean warming, acidification, and biodiversity loss as the most critical threats, with strong consensus among experts regarding their severity. At the same time, governance frameworks are evaluated as only moderately effective, with respondents pointing to fragmented institutional responsibilities, weak enforcement, and limited adaptive flexibility. Importantly, the study highlights a persistent gap between policy ambition and implementation, particularly in relation to community engagement, financial constraints, and the marginalization of local knowledge. This suggests that governance challenges are not merely technical, but institutional and social, reinforcing the need for more adaptive, coordinated, and participatory governance systems.

Building on this foundation, subsequent studies examine governance in specific coastal contexts. Reyes et al. analyze the Guandu Wetlands in Taiwan through the IUCN Global Standard for Nature-based Solutions, drawing on stakeholder interviews with government agencies, conservation organizations, and site managers. By applying the eight Nature-based Solutions criteria, the study provides a structured evaluation of governance performance, revealing differing stakeholder priorities and trade-offs between ecological conservation, socio-economic demands, and institutional feasibility. While dimensions such as adaptive management and design at scale receive relatively strong evaluations, economic sustainability and long-term monitoring remain weak. The findings illustrate how global governance frameworks are interpreted and negotiated within local contexts, where resource constraints and institutional fragmentation shape implementation. In this process, universities and research institutions emerge as key knowledge intermediaries that support monitoring, coordination, and evidence-based decision-making. This can be understood as part of broader knowledge co-production dynamics, where global frameworks are interpreted and negotiated through local stakeholder interactions (Norström et al., 2020).

Similarly, Yu et al. evaluate governance effectiveness in the Qingluo Wetland in Penghu using the Management Effectiveness Tracking Tool. Based on 30 indicators assessed through focus group discussions with stakeholders from government, NGOs, academia, and local communities, the study finds an overall moderate level of effectiveness. While legal frameworks and conservation objectives are clearly established, implementation is constrained by limited human resources, unstable funding, and insufficient community engagement—challenges that are particularly acute in offshore island settings. The study further highlights tensions between conservation goals and local development needs, reflecting broader structural dilemmas in coastal governance. Importantly, Yu et al. introduce university social responsibility as a complementary mechanism, positioning universities as "knowledge nodes" that facilitate co-learning, student engagement, and cross-sector collaboration. This reframes governance as a more integrated and participatory process that extends beyond top-down regulatory approaches. In this context, university social responsibility initiatives can also be seen as transdisciplinary platforms that facilitate co-learning and bridge institutional and societal knowledge systems (Mauser et al., 2013).

Extending beyond formal governance frameworks, Chang shifts the focus to collaborative governance and knowledge co-production in the Caota Sand Dunes Geopark. Using a qualitative case study approach that combines document analysis, participant observation, and interviews, the study examines how local knowledge is generated, translated, and institutionalized within coastal governance processes. The transformation of the site—from a degraded landscape affected by industrial activity to a geopark shaped by multi-stakeholder collaboration—illustrates how governance emerges through ongoing negotiation and adaptation. A key contribution lies in highlighting the integration of local experiential knowledge, such as observations of environmental change, with scientific data through practices like citizen science and participatory monitoring. In addition, cultural translation—through storytelling, walking-based education, and visual media—plays a crucial role in making the landscape accessible and meaningful to the public. At the same time, the study identifies structural challenges, including fragmented institutions and reliance on short-term project funding, underscoring the difficulty of sustaining participatory governance while preserving the contextual richness of local knowledge. This case exemplifies knowledge co-production in practice, where local experiential knowledge, scientific data, and cultural narratives are continuously integrated through ongoing and participatory processes (Mauser et al., 2013; Norström et al., 2020).

Against this backdrop, the thematic issue also foregrounds the growing role of higher education in sustainability and regional development. Lee et al. examine Taiwan–Japan cross-cultural collaborative workshops as a form of experiential and comparative learning. Using a qualitative-dominant mixed-methods approach—including interviews, participant observation, instructor reflections, and post-program surveys—the study explores how students interpret local issues, collaborate across cultures, and develop action-oriented thinking. The findings show that students deepen their understanding of sustainability by comparing different regional contexts, recognizing how demographic trends, cultural identity, and institutional histories shape development pathways. In addition to cognitive gains, students demonstrate significant growth in intercultural communication competence, the ability to navigate trilingual environments, and increased sensitivity to feasibility and community needs. The study also highlights the importance of pedagogical design, including pre-departure preparation, structured field engagement, and post-program reflection, suggesting that sustainability learning is most effective when embedded in real-world, interactive, and cross-cultural contexts. From this perspective, cross-cultural collaborative learning can be understood as a form of transdisciplinary practice, where students actively engage in

knowledge co-production by integrating diverse cultural perspectives and contextual insights into sustainability problem-solving (Mauser et al., 2013).

Finally, Weiss et al. provide a long-term institutional perspective through the case of the University Centre of the Westfjords in Iceland. Drawing on a 20-year longitudinal case study and an insider research approach, the study examines how a higher education institution contributes to regional development in a remote coastal context. With nearly 300 graduates and a strong tendency for students to remain in the region, the university plays a critical role in addressing demographic challenges such as outmigration and skill shortages. Beyond human capital, the institution contributes to broader forms of community capital, including cultural vitality, entrepreneurship, and social cohesion. Conceptually, the study situates the university within the frameworks of peripheral higher education institutions and neo-endogenous development, emphasizing its role as a locally embedded yet globally connected platform. At the same time, it highlights tensions related to funding, governance, and the balance between academic priorities and regional engagement, offering a nuanced understanding of universities as both enabling and constrained actors in regional transformation. This highlights the institutional dimension of knowledge co-production, where universities serve as long-term platforms for sustaining collaborative knowledge systems and enabling regionally embedded yet globally connected development pathways.

Overall, these contributions collectively reveal a clear trajectory: Under the pressures of climate change, coastal environmental governance is shifting from top-down, technocratic models toward more adaptive, participatory, and knowledge-integrated approaches. Such transformation reflects a broader shift toward knowledge co-production and transdisciplinary governance, where sustainability challenges are addressed through collaborative and context-sensitive processes that bridge science, policy, and society (Mauser et al., 2013; Norström et al., 2020).

Within this transformation, higher education institutions are no longer positioned solely as knowledge providers but as active participants, facilitators, and institutional bridges. By enabling co-learning, supporting stakeholder engagement, and connecting global frameworks with local practices, universities play a crucial role in translating knowledge into action. In doing so, they contribute not only to environmental governance but also to the broader reconfiguration of how knowledge is produced, shared, and applied in sustainability transitions.

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Conflict of Interests

The authors declare no conflict of interests.

Data Availability

The data are not publicly available due to privacy considerations.

LLMs Disclosure

LLM tools (e.g., ChatGPT) were used for language editing and translation support.

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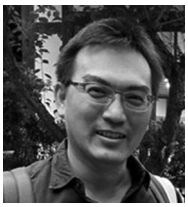

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