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Understanding the social–ecological systems of non-state seafood sustainability scheme in the blue economy

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Abstract

Non-state sustainability initiatives, such as eco-certification and voluntary sustainability standards, are eco-friendly, market-driven, and privately managed initiatives that garner support from concerned stakeholders in the blue economy. Consequently, these initiatives play pivotal roles in enhancing resource sustainability within the seafood sector. However, despite their importance, the intricacies of how non-state seafood sustainability schemes operate within the blue economy remain unclear. Therefore, this study examines the interactions of these non-state actors within institutional, social, and ecological contexts to improve common resource management. This study is based on a comprehensive review of secondary data from the literature to delineate its scope. In recent years, there has been an increase in non-state initiatives advocating for sustainable fisheries and the sustainable use of natural blue resources. These initiatives claimed to exhibit established institutional, social, and ecological synergies, yet the foundational principles guiding them remain underexplored. It is essential to note that addressing the long-term sustainability issues in the socioeconomic-ecological systems requires the resilience shift of non-state initiatives. Thus, non-state institutions must strengthen their resilience management capabilities by collaborating with other actors, networks, and institutions to promote sustainable development. This collaboration fosters societal understanding of these resilience factors, which are portrayed in this study. Finally, effective resource management necessitates a delicate balance between economic considerations and environmental preservation, supporting the sustainability of common resources. It is imperative to deepen our understanding of the interplay between the socioeconomic and ecological facets of these systems to ensure that our environmental laws serve as the proper framework for effective resource regulation and management.

Keywords Sustainability scheme · Social–ecological systems · Blue economy · Seafood · Inclusivity · Resilience · Non-state actors

1 Introduction

The oceans and their coastal resources represent one of the six key social–ecological systems central to achieving the United Nations Sustainable Development Goals (Castro-Cadenas et al., 2022; Jones et al., 2022; Olsson et al., 2022). To realize a comprehensive and sustainable blue economy, it is essential for stakeholders from diverse sectors and at different scales to actively integrate into existing social, economic, and ecological systems (Brodie Rudolph et al., 2020; Elegbede, 2023; Kotze, 2019; Lubchenco et al., 2020; Sachs et al., 2019). This integration is aimed at establishing effective governance, coherent rules and policy frameworks which are paramount for managing shared resources (Brodie Rudolph et al., 2020; Ostrom, 2009).

First and foremost, seafood production within the context of blue economy embodies the complexity of intertwined ecological, social, and economic dynamics. These dynamics are collectively assessed to identify gaps so as to devise strategies for sustainable outcomes (Elegbede et al., 2023a; Osuka et al., 2020). The challenges in sustainable fisheries have evolved from conventional obstacles to intricate issues stemming from multifaceted factors, leading to the development of more coherent governance structures that facilitates interactions between human stakeholders and marine resources (Crona et al., 2019; Salinas-Zavala et al., 2022).

Furthermore, a narrow focus on ecological parameters in fisheries management has occasionally overshadowed the broader socioeconomic impacts on ecosystems and communities (Garlock et al., 2022). Such oversight has repercussions for the Sustainable Development Goal (SDG) 14, giving rise to food insecurity and socioeconomic disruptions. Hence, it is imperative to recognize the need for incorporating the socioeconomic dimensions of fisheries (Elegbede et al., 2022b; Garlock et al., 2022).

Another noteworthy aspect is the emergence of non-state actors (NSAs) encompassing civil society organizations, corporations, and research institutions as central players in global natural resource governance (Biermann & Pattberg, 2008). Their increasing involvement in policy formulation and execution aligns with the shift toward “participatory democracy,” advocating for consensus-driven policymaking involving all key stakeholders (Beresford, 2019; Mathur et al., 2008). This inclusive policymaking holds the promise of enhanced ownership, public–private collaborations, democratization, and sustainability (Bäckstrand, 2006).

Several initiatives have been established at both regional and international levels with a primary focus on improving the health of marine ecosystems. Notably initiatives within the European Union (EU) such as Maritime Strategy Framework Directive (MSFD), the Water Framework Directive (WFD), and the EU. These initiatives place strong emphasis on preserving the ecological stability of fish stocks and fisheries. Concurrently, the EU Common Fisheries Policy (CFP) has also intensified regulatory oversight over fisheries, with organizations such as HELCOM (HELCOM, 2022) working to improve conditions in the Baltic Sea (European Commission, 2020).

Despite the existence of such initiatives, biologically viable seafood stocks have experienced a decline of approximately 21% over the past four to five decades, with 31% facing overfishing (Wijen & Chiroleu-Assouline, 2019). However, in the Baltic Sea, an area confronted with the challenges such as eutrophication, contamination by pollutants, and the consequences of climate change, this study has observed positive development in fishing level and the restoration of previously overfished marine resources and the ecosystems. These improvements can be attributed to the implementation of efficient

management measures in specific regions (FAO, 2016; HELCOM, 2022; Pappila & Tynkkynen, 2022).

Nonetheless, numerous governmental and intergovernmental initiatives have proven insufficient in addressing the comprehensive action required (Luo et al., 2010). This gap has prompted non-state interventions aimed at mitigating the unintended consequences of overfishing and bycatch (Oosterveer & Spaargaren, 2011; Wijen & Chiroleu-Assouline, 2019). These intervention employ using market-driven approaches such as ecolabeling to enhance consumer awareness regarding the environmental and social implications of their purchasing choices. These strategies aim to promote a more sustainable industry by influencing consumer behaviors (Bush & Roheim, 2019; Owens, 2008; Pappila & Tynkkynen, 2022).

A salient example of non-state intervention is the Marine Stewardship Council (MSC) certification program (Elegbede et al., 2023c). This non-profit organization recognized globally by its blue label assure consumers of a product's sustainable provenance. Remarkably, in 2020, MSC encompassed approximately 14% of the global seafood capture, establishing itself as a pivotal environmental criterion in terms of seafood volume (Wijen & Chiroleu-Assouline, 2019). Furthermore, the label serves as an informative tool for traders, retailers, marketers, and consumers regarding best practices across the supply chain. While the major participants in this standard predominantly hail from North America and Europe, representation from other regions is gradually increasing (Oosterveer & Spaargaren, 2011).

Secondly, the seafood industry is witnessing a surge in the adoption of Voluntary Sustainability Standards (VSS) and ecolabeling as tools to enhance the status of fisheries (Elegbede et al., 2023c). These standards emphasize the establishing sustainability pillars, such as the chain of custody and certification programs that ensure compliance with various local-to-international regulations and policies (Parlee & Foley, 2022). These non-state mechanisms align specifically with the broader shift toward market-based solutions as alternatives to traditional regulatory structures. Many consider these initiatives as part of a “translational transformation coast,” where change emerges from voluntary private governance systems. The Theory of Change (TOC) maps a pathway from these interventions to both intended and unintended outcomes, aiming to strengthen the resilience of the seafood sector (Arton et al., 2018; Salinas-Zavala et al., 2022).

Past research on marine ecosystem sustainability underscores the crucial role of non-state elements, such as leadership, regulation, and social capital, in fostering collective efforts to manage fishery resources more effectively. However, multiple studies have also underscored the intricate relationship between resource dependence and health. Intense reliance on marine resources can exert undue stress, potentially leading to resource degradation. Conversely, it can also lead to communities' movement toward sustainable long-term management. (Cinner et al., 2012; Duarte et al., 2020).

Despite the recognized significance of non-state actors (NSAs), gaps persist in our comprehension of the social–ecological systems underlying non-state seafood sustainability schemes (NSSS) within the blue economy. Consequently, this study seeks to bridge these gaps by offering a comprehensive understanding of non-state actors' roles and engagements in seafood sustainability, while also examining the broader implications of these initiatives.

Thirdly, through the adopting the socioeconomic–ecological system (SES) framework, this study analyzes non-state sustainability efforts in the seafood industry and their interactions with social, ecological, and institutional factors. Within this framework, this study points out the importance for the collective management of shared resources and advocates for a holistic and inclusive private governance system. In doing so, this study aims

to elucidate the significance of SES in non-state initiatives, underscoring the interconnectivity and dynamism of these systems. Our findings explore potential trajectories for non-governmental actors in their pursuit of fishery sustainability. Additionally, this paper acknowledges the fluid and interconnected nature of these systems are positioning fisheries as pivotal agents of social, economic and ecological transformation. Thus, the next section outlines the approach explored for data collection, the analytical methodology, and the key concerns addressed in this study.

2 Materials and methods

2.1 Data collection

This study used secondary data sources for review, adhering to established protocols (Mensah, 2019; Moher et al., 2009; Tranfield et al., 2003). To conduct this systematic review, this study carefully examined publications, theses, and various online documents to gather the necessary secondary data. Our searches were guided by keywords and terms relevant to socioecological systems associated with non-state seafood initiatives. Key terms included, but were not limited to, social, economic and ecological systems, non-state actors, seafood, sustainable development, governance, blue economy, participation, resilience, and adaptation.

Given the aim of capturing substantial contributions to the discourse, no temporal constraints were applied to the search. However, this study emphasized integrating of as much contemporary literature as possible to reflect the current relevance of the topic (Mensah, 2019). Manuscripts falling outside the scope of the keywords were excluded. Furthermore, the reference sections of selected publications were scanned to ensure that no relevant articles were overlooked. The articles were scrutinized based on predefined criteria related to their significance and contemporariness (Browning & Rigolon, 2019).

2.2 Analytical approach

A comprehensive examination of the entire text facilitated the extraction of salient data. This study employed qualitative assessment methodologies (Vaismoradi et al., 2013; Kibiswa, 2019; Elo & Kyngäs, 2008; Hsieh & Shannon, 2005; Mayring, 2004), complemented by recursive abstraction techniques (Leshan, 2012). This process involved coding information into themes using annotations and continually refining the relevant data within the identified terms and keywords. Through iterative processes, this study developed the key findings, discarding superfluous details or discrepancies. Subsequently, this study formulated summaries and further refined the data collected to ensure cohesiveness, clarity, and succinctness, without compromising the original intent of the source material.

2.3 Key concerns

This review emphasizes the critical facets necessary to understand the socioeconomic and ecological systems inherent to non-state seafood sustainability frameworks in the blue economy. Specifically, this study explored the underpinnings of socioeconomic and ecological systems, their guiding principles, and foundational pillars. Additionally, the study

delves into the common resource pool within non-state initiatives with regard to the development and associated degradation essential for sustainability. The study also examined the essential functionalities of social–ecological systems across various non-state actors and their inclusive practices. Finally, the review concludes with a discussion of a comprehensive framework for systemic resilience in socioeconomic and ecological systems (SES) and the capacities required for managing resilience.

3 The socioeconomic–ecological system

With the surge in economic prosperity, rapid socio-technological evolution, and dissemination of scientific insights, there is growing confidence in societal abilities to manage regional environmental changes (Elegbede et al., 2023b, 2023d; Lebel et al., 2006). Contemporary bureaucratic processes prioritize an approach rooted in standardization, aiming for streamlined social control, operational efficiency, and minimization of variability (Elegbede et al., 2023e; Lebel et al., 2006). However, environmental challenges are often framed solely as technological or administrative. It is crucial to not only educate the public on the sustainable use of ecological systems, but also to instill a sense of accountability. Armed with accurate data and technological expertise, future challenges in the socioeconomic–ecological system can be anticipated and addressed (Lebel et al., 2006).

Previously, SES was first delineated by Cherkasskii (1988) as a composite of two intertwined subsystems: an ecological unit comprising biotic entities and a social unit encompassing both social and economic facets. Here, the ecological unit is the entity being managed, while the social unit governs, monitors, and navigates the relationships within the system (Colding & Barthel, 2019). More than a decade later, Berkes (2012) extended this definition to formulate an analytical framework that bridges ecosystems and their governing institutions. Notably, resilience in local resource management is intrinsically tied to the interplay between these subsystems, underscoring the importance of both dimensions (Colding & Barthel, 2019; Ostrom & Cox, 2010; Partelow, 2016).

Iwanaga et al. (2021) posited that the SES framework facilitates a granular exploration of interconnections across key system segments, especially in contexts like the common pool resource paradigm. Within this scope, resource beneficiaries must exercise holistic resource management while extracting specific resources. This ensures that their actions align with the intended outcomes nested within a governance structure replete with the necessary regulations (McGinnis & Ostrom, 2014). Moreover, the term “socioeconomic–ecological system,” especially in the context of the Nigerian shrimp industry, accentuates the primacy of fishers’ economic conditions over straightforward social elements. This nomenclature implicitly emphasizes the importance of the economic background of fishers in shaping industry dynamics.

Following Ostrom’s (2009) framework, the shrimp fishery is considered a subsystem that includes both shrimp resources and fishers, which is the focal point of the current study. When viewing shrimp as a resource unit, fishermen emerged as their primary users. The governance of this fishery manifests in the interactions between fishers and regulatory or research institutions as well as in the resultant outputs from the shrimp fishery (Ostrom, 2009; Partelow, 2016). Furthermore, recognizing the intricacies of this relationship, the Friend of the Sea (FOS), a non-state sustainability initiative within the fisheries-sectored blue economy, has formulated guiding principles. These principles resonate with the broader agenda of integrating the theory of change (TOC) as a resilience mechanism,

thereby ensuring that activities within the shrimp fishery sector are both responsible and sustainable.

Optimizing the benefits derived from shrimp fisheries necessitates comprehensive management of their social, economic, and ecological aspects. Consequently, a spotlight must be placed on the societal aspects of resource management to elucidate the interplay between the socioeconomic and ecological dimensions of this sector. This must be integrated with environmental policies and biophysical attributes of the system (Bretagnolle et al., 2019; Carruthers et al., 2019).

Of paramount importance is the acknowledgment that socioeconomic systems within the shrimp fisheries realm are swayed by a plethora of factors influencing human resource utilization. These determinants span the gamut of political and economic landscapes as well as diverse, multi-scalar influences permeating the sector (Virapongse et al., 2016). At this time, facilitating unhindered access to crucial social information could significantly refine system analyses and inspire alternative strategies geared toward optimal outcomes (Partelow, 2016). The absence of a holistic, system-centric approach to planning, designing, and managing marine ecosystem resources may hinder the effective and sustainable provision of pivotal ecosystem services. Hence, this paper presents an interdisciplinary socioeconomic-ecological system (SES) framework. This is conceived as a tool to deepen understanding and inform both research and practice on nature-based solutions and marine ecosystem services, with meticulous consideration of the myriad social, economic and ecological variables at play.

4 Common resource pool in non-state initiatives

Following the above, establishing a common resource pool is pivotal for non-state resource management programs. This concept is particularly relevant for typical fishery systems, where securing exclusive access rights to a finite resource can be challenging or even infeasible. As underscored earlier, the exploitation of a common resource relates to the utilization of a finite resource, the exclusivity to which it might be difficult to attain. In essence, the term “common resource” applies when a resource is shared among a collective. Individuals can benefit from their use and exploitation in various ways (Partelow et al., 2019; Schlager, 2016). Therefore, human interaction is imperative for delineating potential resource-usage patterns. Such interactions are non-negotiable. Altogether, common resource theory posits protective measures that prevent overuse by restricting either organizational or individual utilization (Elegbede et al., 2022a; Oakes, 2016).

For the most part, the term “common resources” generally refers to a socioecological scenario operating within a common pool resource system. These resources are often managed through community-oriented behaviors, which can, on occasion, lead to effective privatization. Nevertheless, regulatory oversight and access enforcement typically fall under the jurisdiction of government bodies. Interestingly, these resources can be exploited without any formal guidelines, resulting in a subtraction from the ecosystem (Schlager, 2016). Several studies have depicted the consequences of such unchecked resource extraction as calamitous (Foley & McCay, 2014; Oakes, 2016; Partelow et al., 2019; Schlager, 2016). For example, Nigeria’s fisheries, which are subject to federal regulations, exemplify this common resource pool. Prolonged and unrestricted access to these fisheries has precipitated economic, social, and environmental degradation, mainly due to resource overexploitation (Belton et al., 2020; Nwokike, 2019).

Reversing such misutilization mandates a pragmatic perspective of resource optimization. Collaborative endeavors become paramount for rectifying inappropriate exploitation, ensuring that resource consumption aligns with genuine societal needs or benefits (Foley & McCay, 2014). Adopting this perspective requires the establishment of cost-effective indicators for continuous resource assessment and conservation. This approach compels resource stewards to explore economically viable means of regulating exploitation, even if it entails extending tenure rights to individual beneficiaries (Costello & Grainger, 2018).

Users of a common resource pool should strategize collectively, forming governance structures to secure the sustainability of the resource (Oakes, 2016; Schlager, 2016). Essential tactics aligned with the institutional fabric are indispensable for curbing economic value reductions and fostering mutual trust and transparency. Additionally, enhanced institutional prowess in fisheries management facilitates multi-stakeholder engagement, in accordance with theories advocating uniform environmental considerations (Aguilar-Rivera, 2019).

Overall, the blue economic sector has witnessed significant growth in recent years. However, this expansion, often achieved without due consideration of socioeconomic and ecological sustainability, has resulted in employment opportunities with substandard wages and pronounced environmental ramifications. This scenario is particularly pronounced in developing nations (Elegbede et al., 2023a, 2023b, 2023c, 2023d, 2023e). Many intertwined and mutually reinforcing oceanic pressures, such as marine litter pollution, overfishing, ocean warming, acidification, oxygen loss, rising sea levels, and heightened extreme weather events, are affecting coastal regions and the broader economies of developing countries. These pressures not only jeopardize the marine resources upon which these sectors depend, but also threaten the future socioeconomic benefits that could be derived from them (Mejjad et al., 2022).

The ongoing debate surrounding “depletion” versus “sustainability” in the context of sustainable development, particularly concerning the management of common ocean resources for a more resilient blue economy, inherently involves the social, economic, and ecological dimensions (Elegbede et al., 2023e), as delineated in Table 1. Notably, the term “depletion” holds both a direct and inverse relationship with sustainability. This intricate relationship is further elaborated within the sustainable development framework as illustrated in Fig. 1.

From the above, the trajectory of development science appears to be grounded in a fundamental premise, that the most effective solutions are those which comprehensively address societal needs, guaranteeing economic viability, environmental sustainability, and social equity (Mensah, 2019; Porter & van der Linde, 1995). This principle as depicted in Fig. 1, profoundly influences the interconnected realms of sustainable development, illuminating the intricate relationships between collective human efforts and the depletion of communal resources, encompassing ecological, economic, and social aspects.

By interpreting the visual narrative in Fig. 1, one can deduce the utmost importance of revitalizing the depleted ocean ecosystem and its resources. This revitalization serves as a cornerstone for achieving a resilient blue economy and consequently ensuring the well-being and prosperity of humanity.

Similarly, Wanamaker (2018) asserts that these domains represents a collection of interconnected concepts that profoundly influence human decision-making, efforts, and actions aimed at the judicious management of shared resources. Moreover, Yang (2019) reinforces this perspective by indicating that Fig. 1 emphasizes the necessity of aligning human initiatives in sustainable resource stewardship to counteract the erosion of socioeconomic and ecological structures, thereby promoting sustainable societal advancement.

Table 1 Categories, objectives and indicators of socioeconomic and ecological systems for a sustainable blue economy

System category	Sustainable objectives	Interrelated indicators
Social-economic	<p>Health and well-being</p> <p>Sustainable communities</p> <p>Employment and livelihoods</p> <p>Income distribution</p> <p>Engagement</p> <p>Distribution of access and benefits</p> <p>Gross domestic product (GDP)</p> <p>Trade balance:</p> <p>Investment in research and innovation</p> <p>Cultural preservation</p> <p>Tourism impact</p>	<p>Estimates the job opportunities created by blue economy sectors and the positive influence of these jobs on local livelihoods</p> <p>Examine the way at which the valuable resources generated from the blue economy are being shared while putting into consideration the vulnerable localities</p> <p>Examine the rate at which the local communities participate and involve in the decision-making in correspondence with the blue economy</p> <p>Measure improvements in the quality-of-life indicators and other essential services in coastal communities</p> <p>Assess how the cultural heritage and values with respect to the marine environment are being preserved</p> <p>Examine the environmental, socioeconomic and cultural impacts of coastal and marine tourism, with focus on carrying capacity, modernization, local engagement, financial empowerment, availability of education and training opportunities in marine-related sectors</p> <p>Measure balance between the exportation and importation of marine resource</p>
Ecological (biophysical)	<p>Productivity and trophic structure</p> <p>Blue biodiversity</p> <p>Habitat and ecosystem integrity</p> <p>Fisheries stock status</p> <p>Habitat health</p> <p>Marine pollution</p> <p>Ocean acidification</p> <p>Coastal erosion and sea level rise</p>	<p>Examine the ecological condition of the marine environment via diversity of species and the ecosystems, stock assessments, rate of degradation and adherence to sustainable fishing quotas</p> <p>Critical monitoring of the contaminants such as heavy metals and microplastics present in the marine ecosystem in order to minimize the degree of pollution</p> <p>Determine how much the ocean's pH and carbonate composition have changed as a result of rising carbon dioxide levels, which can be harmful to marine life, especially that with calcium carbonate shells</p> <p>Analyze how quickly the shore is eroding and how much the sea is rising, as both of these factors might affect coastal ecosystems and habitats</p>
Integrated (governance, institutional and management)	<p>Legal and policy support</p> <p>Governance structure</p> <p>Cooperation and accountability in decision process</p> <p>Ecosystem services valuation</p> <p>Integrated ocean management</p> <p>Resilience and adaptation</p> <p>Carbon footprint</p> <p>Innovation and technology</p> <p>Stakeholder collaboration</p> <p>Policy coherence</p> <p>Regulatory compliance</p>	<p>Assign economic values to the services provided by marine ecosystems, such as carbon sequestration, nutrient cycling, and storm protection, to better inform decision-making</p> <p>Measure the ability of socioecological systems to withstand and recover from disturbances, such as climate events or market fluctuations, while maintaining their functionality</p> <p>Calculate the carbon emissions associated with various blue economy activities and explore strategies to reduce their carbon footprint</p> <p>Monitor the development and adoption of sustainable technologies, such as aquaculture practices that minimize environmental impact or renewable energy solutions for offshore platforms</p> <p>Evaluate the extent to which diverse stakeholders collaborate, including governments, industries, academia, NGOs, and local communities, to develop and implement sustainable blue economy strategies</p>

In practical terms, this collaborative approach extends to various areas such as land use, freshwater management, agricultural practices, architectural design and development, energy conservation, education, equal opportunity, and legislative formulation and implementation, amongst others (Kay & Alder, 2017; Mensah, 2019). The overarching principle suggests that by thoughtfully integrating principles from these three sustainability spheres into practical scenarios, collective benefits are achieved: the preservation of natural resources, ecological protection, economic prosperity, and sociocultural progress anchored in peace and the observation of human rights (DESA-UN, 2018; Kaivo-oja et al., 2014).

Building on this foundation, Basiago (1999) contends that the intermeshing of these three domains is a *sine qua non* for genuine sustainability, offering a persuasive exposition of the interconnections among economic, social, and ecological sustainability.

In the context of economic benefits in multiuser scenarios, these advantages become evident through effective fishing strategies aimed at generating returns that surpass the initial investments made by participants. Consequently, these advantages exert a significant influence on global fishing practices, reshaping the fishing industry (Arlinghaus et al., 2017; Foley & McCay, 2014; Horowitz et al., 2018; Oakes, 2016). However, in multifaceted scenarios, adopting a strategy of limited exploitation can lead to social discord due to competition for scarce resources (Fig. 1). Therefore, interventions are often hindered by ensuing social conflicts (Villamayor-Tomas et al., 2016).

When considering fisheries, embracing self-governance may offer more benefits compared to relying on conventional oversight. In this context, each fishery's socioeconomic–ecological unit voluntarily establishes an exploitation strategy, guided by regulated institutional guidance rather than adhering to orthodox governance frameworks (Ostrom, 2009; Elegbede et al., 2022a). This approach empowers fishers to manage their fisheries autonomously while aligning with market-driven enforcement, meeting consumer's optimum expectations for their catch. Moreover, as custodians of a shared resource pool, market entrants with their self-organization and governance mechanisms can enforce sustainability norms (Villamayor-Tomas et al., 2016).

However, it is crucial to recognize that the fishing community holds the responsibility for resource stewardship. Yet, external interventions in resources like shrimp often face constraints due to unpredictable external factors. Therefore, it is paramount for the fishing community not only to lead resource management but also to offer effective strategies. In this context, transparent and collaborative external interventions are crucial for ensuring long-term sustainability (Foley & Havice, 2016; Roheim & Zhang, 2018).

For example, in Tanzania, fisheries resource stakeholders willingly relinquish state regulations and were eventually legally empowered to enforce universally accepted standards (Allison, 2004). In this case, the community introduced a local management framework termed "coastal management policies" (CMPs). Among these, the largest is the coastal zone conservation and development program based in Tanga, which operates both regionally and locally, addressing pivotal coastal concerns such as destructive fishing practices, mangrove preservation, and fostering alternative livelihoods (Benjaminsen & Bryceson, 2012; Samoilys & Kanyange, 2008). Furthermore, Faivre et al. (2017) noted that this program has addressed myriad challenges, spanning resource conservation to socioeconomic and ecological services. Overall, the decentralized approach streamlines regional resource management, and by bolstering institutional and human capacities, such strategies underpin concerted efforts to conserve, protect, and enhance coastal assets, which are essential for a nation's economic bedrock (Bennett & Dearden, 2014; Olsen, 2003).

Not only has this CMP framework fostered symbiotic relationships between resource users and government entities, it has also provided a holistic management blueprint that

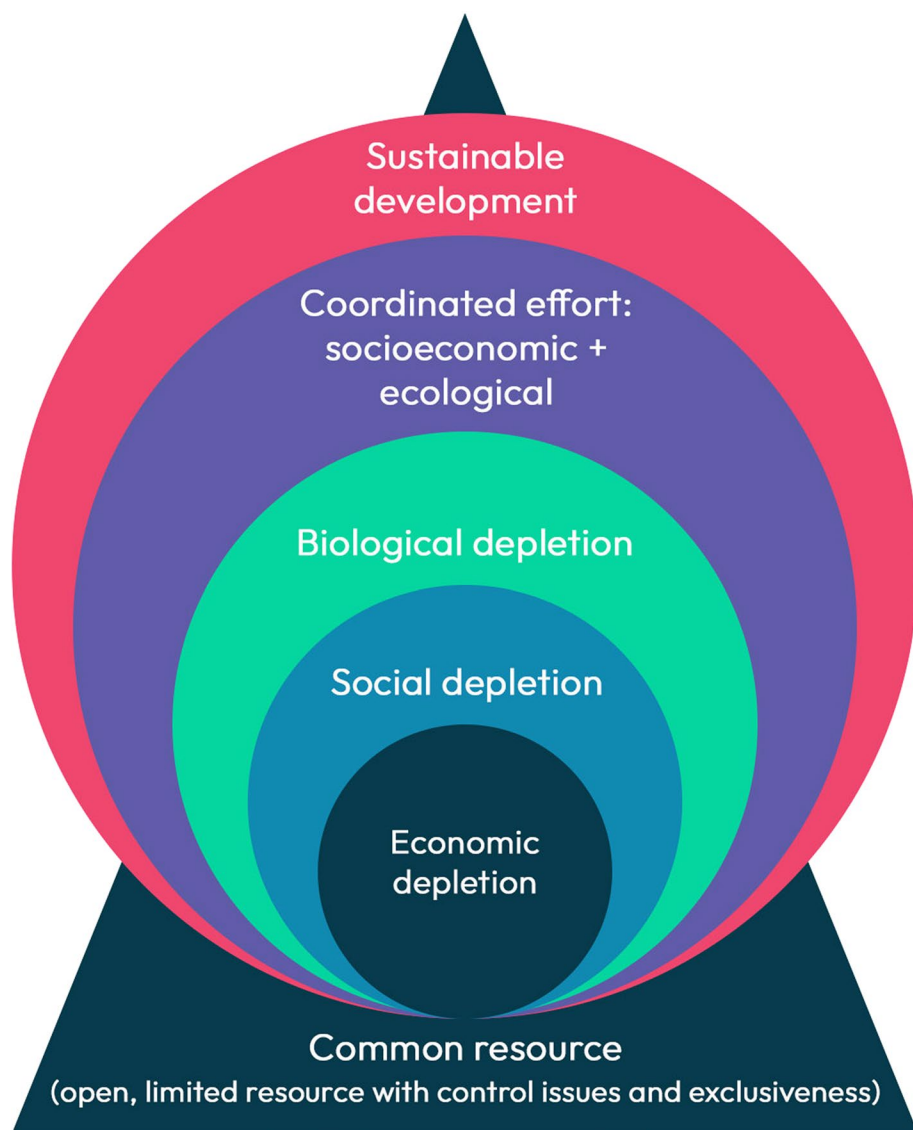


Fig. 1 Common resource pool with corresponding depletions. Source: Arlinghaus et al., (2017), Foley and McCay (2014), Horowitz et al. (2018), Oakes (2016), Ostrom (2009), Partelow (2018), Schlager (2016) and Villamayor-Tomas et al. (2016)

recognizes the interconnectedness of stakeholders and their cumulative impact. As a result, this interconnected approach overcomes the disjointed nature of single-sector management, encompassing activities such as fishing, mining, coastal agriculture, conservation, and tourism.

On the whole, the overarching goal is to facilitate judicious cross-sectoral decision-making, prioritizing the preservation and sustainable utilization of coastal and marine resources (Pomeroy et al., 2014). Consequently, this cohesive approach fortified the coastal

resource foundation, which is vital for the nation's economic health. Furthermore, communities reliant on coastal resources have seen marked enhancements in their living standards and overall well-being.

To sum up, coastal communities in Tanzania have been proactive in formulating and enforcing comprehensive policies since the early days of planning. As outlined by Wells et al. (2007) and Pomeroy et al. (2014), these local endeavors encompass the creation and implementation of by-laws, patrols to combat illegal fishing and mangrove destruction, regulations for fishing gear, and efforts to replant mangroves in ecologically compromised areas. Notably, at both local and regional scales, there has been a substantial improvement in capacity and awareness. This transformation includes a noticeable shift in attitudes and responsibilities toward coastal resource preservation among locals and government representatives (Wells et al., 2010).

This evolving relationship has evolved into a structured project that received positive feedback from the community. Furthermore, collaborative management efforts have streamlined organizational structures, thereby reducing the burden on state regulatory entities. This communal approach to sustainable management not only holds promise for the long term, but also aims to restore ecological and biotic balance across the ecosystem's units. Currently, sector-specific regulations guide bodies responsible for managing coastal resources, leading to fragmented decisions concerning marine resources by disparate industries (Panigrahi & Mohanty, 2012). These considerations also extend to societal factors, such as inequality, intra-governance dynamics, economic yield, and production media (Agarwal, 2018; Ostrom, 2009).

Nonetheless, the concept “tragedy of the common” remains a pressing challenge in the fishing sector (Cuervo-Sánchez et al., 2018). Cultivating a sense of voluntary, self-governed resource use without the harsh imposition of regulations may prove intricate, at least in the foreseeable future (Foley & McCay, 2014). In response to this challenge, the World Wildlife Fund posits that sustainable fishery certification could be an alternative to prevailing fisheries management and conservation mechanisms (Ovitz & Johnson, 2019). Under such a system, a deep-seated sense of stewardship is promoted among the stakeholders. They are granted privileged access to fish, contingent on adherence to sustainable practices, ensuring the resource's long-term viability (Pomeroy et al., 2015).

In scenarios where governmental engagement is minimal, communities can benefit from a shared resource pool since the regulatory and administrative duties are communally borne (Stratoudakis et al., 2016). Additionally, VSS promote stakeholder participation in decisions about fisheries resources, grounded in the socioeconomic–ecological nexus each entity shares with the fisheries (Foley & McCay, 2014; McLain et al., 2018; Roheim & Zhang, 2018). Consequently, fishers participating in VSS schemes do not possess unilateral rights over fisheries. Instead, the shared resource pool pivots toward private rather than public benefits (McLain et al., 2018). However, this approach may spark disputes over property demarcations. Some fishermen, wary of these delineations, might become reticent to join non-state private resource management programs (Roheim & Zhang, 2018). Therefore, certification processes should contemplate efficient resource allocation strategies tied to the shared resource pool, holistically addressing sustainable development challenges (Elegbede et al., 2023c; Foley & McCay, 2014; McLain et al., 2018).

5 Inclusivity of non-state actors in the decision-making process

The role of non-state actors, including individuals, groups, social networks, and organizations, in the policymaking process has gained widespread recognition because of their inclusiveness and effectiveness. Their involvement can be classified into two contexts: socioeconomic and ecological (Fig. 2). The levels of engagement vary, encompassing consultation, collaboration, and empowerment in activities, such as implementation, monitoring, sanctioning, and information dissemination (Danielsen et al., 2022). As elaborated in the subsequent subsection and illustrated in Table 2, the engagement of diverse non-state actors, in most cases, encompasses wide range of scenarios and activities that are of high interests. This could be attributed to the fact that several stakeholders of different importance and attributes are assigned to varying tasks that are specific to ecosystem benefits and risks.

First, deliberation is an open dialogue process that fosters reflection among participants with differing political and philosophical perspectives (Ison et al., 2007; Leeuwis, 2000). Even when perspectives are entrenched, effective deliberation can reveal underlying motivations and views (Schusler et al., 2003). This process can transpire in both formal and informal settings and even across expansive networks (Clarke et al., 2013). Thus, deliberative methods can strengthen communication between the public and experts (Pearse, 2020). Ahiaga-Dagbui and Smith (2014) proposed that cognitive authenticity may complement or even replace traditional parliamentary democracy in certain contexts.

Second, Tengö et al. (2014) posit that multiple structures in non-state actors can cater to diverse needs across geographical areas. Often, these structures known as polycentric entities contain multiple centers or authorities (Stephan et al., 2019) with layered components, such as federal systems serving as the prime examples. However, polycentric, multilayered systems do not always exhibit rigid organization. As noted by Berkes (2002) and Tai (2015), layered governance structures can be pivotal in tackling governance issues that vary by scale and addressing cross-scale interactions. Additionally, multilayered governance enables the regulation of vertical institutional interactions. A recurring criticism is that these polycentric and layered structures sometimes lead to inefficient and overlapping collaboration and management (Berkes, 2002; Wang, 2014).

Third, as highlighted by Bovens et al. (2008), accountability is another factor in the inclusion of non-state actors. This refers to the responsibility of higher administrators to provide information, justify decisions, act or abstain, and face consequences if their rationales fall short. While local governments often respond to central authority, they frequently neglect downward accountability, particularly in natural resource management (Ribot, 2003). Accountability also extends to lateral relationships, such as interactions between state resource agencies and specialized advisory groups (Lockwood et al., 2010). Instruments to ensure accountability include transparency, impartial oversight, polycentricity, separation of powers, legal avenues for redress, financial management, and a robust press (Ribot, 2003).

Ultimately, the principal aim of effective governance is social justice. Environmental changes that lead to an uneven distribution of benefits and inherent risks typically require interventions to rectify these disparities (Busscher et al., 2020; Forsyth, 2004; Low & Gleeson, 1998). Such inequalities stem from oppressive governance or subtler disparities in power dynamics and conditions (Swyngedouw & Heynen, 2003).

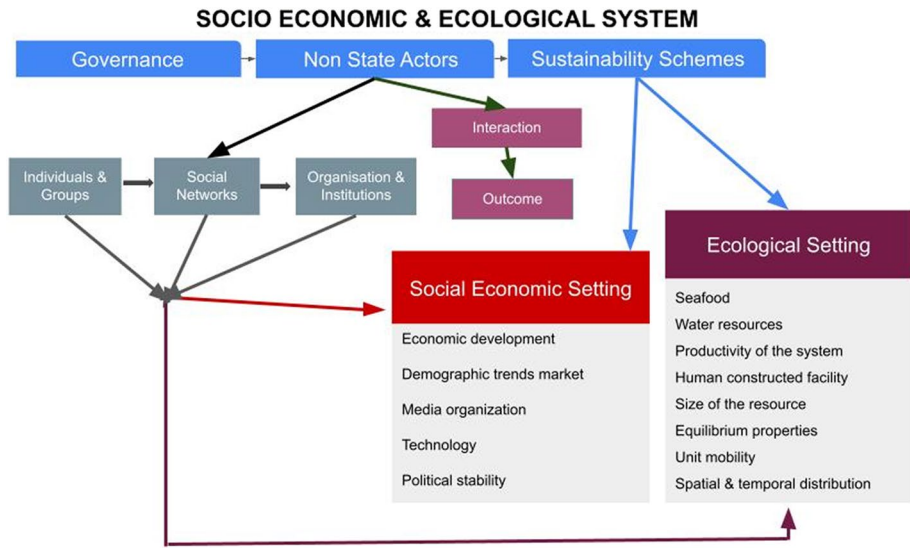


Fig. 2 Inclusiveness of non-state actors in socioeconomic and ecological settings

6 Understanding the essentiality of the social–ecological systems of non-state actors as change mechanism for seafood production

This section elucidates the multifaceted roles and contributions of non-state actors, including individuals, social networks, organizations, and institutions, in fostering sustainable governance. Instead of focusing solely on individuals or institutions, it is pivotal to consider evolving processes to ensure that no critical details are overlooked. The discourse highlights how individuals can foster dynamic governance structures adept at intricate problem solving by harnessing social networks, establishing cooperative frameworks, and integrating both formal and informal rules. To categorize non-state actors involvement (Table 2), this study obtained data from some selected Regional Fisheries Management Organizations (RFMOs). This categorization encompasses individuals attending RFMOs meetings as accredited observers and those serving as expert advisors for member states or collaborative non-member state delegations. This approach ensures the comprehensive inclusion of non-state actor participants (Petersson et al., 2019).

Global seafood management encompasses numerous organizations, each specializing in a distinct domain, ranging from single-to multispecies perspectives. In our discussion, the engagement of non-state actors has emerged as a significant catalyst for change. International entities with vast territorial influence, such as the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR, 2018), now include non-state actors as meeting observers. Recognizing their valuable contributions, these organizations often invite scientific advisors and grant participatory rights to those possessing niche expertise.

In the Pacific Ocean region, both single and multispecies governing bodies coexist. For instance, the Pacific Salmon Commission (PSC) and Inter-American Tropical Tuna Commission (IATTC, 2003) often welcome non-state entities with unique knowledge about specific species or the wider tuna industry as observers during their deliberations. Similarly, the Indian Ocean Tuna Commission (IOTC, 2014) facilitates observer participation for

Table 2 Non-state user inclusivity in regional seafood management organizations. Adapted from Dellmuth et al. (2021) and FAO (2016)

Oceanic and continental regions	Organization name	Area of competence	Type of mandate	Non-state intervention mechanism
Global and trans-ocean	CCAMLR	HS, NW	MS	Participation as short/long-term observer. Scientific advisers can give advice
	IWC	ABNJ-HS	MS	Scientific advisers can give advice
	CCSBT	Every water bodies where southern bluefin tuna can be observed	Single species (Southern bluefin tuna (<i>Thunnus maccoyii</i>))	Specialized organizations can attend as observers. Long-term observer status available
	IATTC	HS, NW	MS	Recognized that the non-state institutions may participate as observers
	PSC	NW	Five Pacific Salmon stocks (<i>Oncorhynchus kisutch</i> , <i>O. ishawytscha</i> , <i>O. nerka</i> , <i>O. gorbuscha</i> , and <i>O. keta</i>)	Organizations with salmon knowledge can attend the thrice-yearly commission
	IOTC	HS, NW	MS (tuna and tuna-like species)	Experienced non-state organizations may participate as observers
	SEAFDEC	HS, NW	MS	Organizations that support SEAFDEC's objectives may participate as observers
	WCPFC	HS, NW	MS	Organizations can get long-term observer status
	PICES	HS, NW	MS	Organizations that support PICES's objectives may participate as observers
	FFA	HS, NW	MS, including big eye tuna, yellowfin tuna, skipjack tuna	Observers with recognized experience are welcome
Indian Ocean	Pacific Community	HS, NW	MS	Recognized organizations can participate in the biannual commission
	SPRFMO	HS	All species except highly migratory species	Organizations with relevant concerns may participate as observers (open to 15 non-state entities)
	IOTC	HS, NW	Tuna and tuna-like species	Specialized organizations may attend as observers. Two-thirds majority required for binding measures
	STOFA	HS	Fish, mollusca, crustaceans, and other sedentary species	Scientific observers are welcome; promotes cooperation and provides scientific advice
	RECOFI	NW	MS	Non-state organizations can attend as observers
Atlantic Ocean	CECAF	HS, NW	MS	Organizations with relevant concerns may participate as observers
	CRFM	NW	MS	Non-state organizations are welcome; promotes cooperation and provides scientific advice

Table 2 (continued)

Oceanic and continental regions	Organization name	Area of competence	Type of mandate	Non-state intervention mechanism
	COREP	HS, NW	MS	Short/long-term observer participation in meetings and engagements
	NASCO	HS, NW	<i>Salmo salar</i>	Scientific observers are welcome; promotes cooperation and provides scientific advice
	FCWC	NW	MS	Short/long-term observer participation in meetings and engagements
	ICCAT	HS, NW	Tuna, tuna-like species, and pelagic sharks	Observers admitted under specific guidelines and criteria
	NAFO	HS, NW	Aside from salmon, tuna, marlin, whales, and quiescent species, all marine fisheries resources	Organizations supporting NAFO objectives may participate as observers
	NEAFC	HS, NW	Fish, molluscs, crustaceans, including sedentary species	Organizations with relevant concerns may participate as observers
Mediterranean and Black Sea	GFCM	HS, NW	MS	Non-member UN or its specialized agency members are welcome

ABNJ—High Seas (HS), National waters (NW); Caribbean Regional Fisheries Mechanism (CRFM); Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR); Commission for the Conservation of Southern Bluefin Tuna (CCSBT); Fisheries Committee for the West Central Gulf of Guinea (FCWC); Fishery Committee for the Eastern Central Atlantic (CECAF); Forum Fisheries Agency (FFA); General Fisheries Commission (GFCM); Indian Ocean Tuna Commission (IOTC); Inter-American Tropical Tuna Commission (IATTC); International Commission for the Conservation of Atlantic Tunas (ICCAT); International Whaling Commission (IWC); Multiple species (MS); North Atlantic Salmon Conservation Organization (NASCO); North Pacific Marine Science Organization (PICES); North-East Atlantic Fisheries Commission (NEAFC); Northwest Atlantic Fisheries Organization (NAFO); Pacific Salmon Commission (PSC); Regional Commission for Fisheries (RECOFI); Regional Fisheries Commission for the Gulf of Guinea (COREP); South Indian Ocean Fisheries Agreement (SIOFA); South Pacific Regional Fisheries Management Organization (SPRFMO); South-east Asian Fisheries Development Center (SEAFDEC); Western and Central Pacific Fisheries Commission (WCPFC)

non-state entities with specialized knowledge about tuna. Conservation and management decisions within these bodies usually necessitate a robust consensus among their members.

Shifting our attention to the Atlantic, organizations such as the North Atlantic Salmon Conservation Organization (NASCO) and Fishery Committee for the Eastern Central Atlantic (CECAF) actively promote the participation of non-state actors. Observers, particularly those endowed with relevant expertise or agendas that align with the commission's mission, are invited to sessions to enhance cooperation and offer scientific perspectives. Representing the Mediterranean, the General Fisheries Commission (GFCM) is open to non-member states associated with the United Nations or its specialized agencies. Across all oceanic regions, the recurring theme is the pronounced emphasis on integrating non-state actors into the decision-making processes of seafood management organizations (refer to Table 2). The subsequent section provides key insights from the table.

In summary, entities globally recognize the indispensable role of diverse expertise in advancing sustainable seafood production. This expertise can be channeled through various roles, including observer roles, scientific advisory positions, or direct participatory rights. Nanz and Steffek (2004) offer detailed insight into the responsibilities of various stakeholders, ranging from organizational representatives to policymakers. These individuals play a central role in governance, driving policy innovation, shaping agendas, and illustrating potential strategies (Morgan et al., 2021). For instance, individual policymakers exhibit the ability to craft effective policy alternatives and select suitable venues for change, as evidenced in a study analyzing change processes within water management systems (Meijerink & Huitema, 2010). These policymakers bolster social capital by nurturing trust and partnerships, rallying support, and mediating disputes among water management systems. Their dedication is commendable (Meijerink & Huitema, 2010; Ostrom, 2009). Consequently, their leadership is instrumental in articulating a collective vision that resonates with stakeholders. Policy entrepreneurs frequently use narratives to present specific perspectives (Meijerink & Huitema, 2010). Recognizing the centrality of robust leadership is crucial for the success of governance endeavors (Beer et al., 2023; Gutierrez et al., 2011).

Individuals endowed with the capability to generate social capital often lead the creation and sustenance of social networks, which are crucial for resource management. These networks comprised of diverse actors, fostering “collective entrepreneurship” and operating across various geographical scales (Doh et al., 2019; Meijerink & Huitema, 2010). Furthermore, these networks bring together actors with shared objectives, beliefs, and values, fostering collaboration even among those with distinct ideologies (Meijerink & Huitema, 2010).

Scholars stress the importance of social networks, referred to as policy networks, in policy formulation and execution for successful management of natural resources (Li et al., 2021; Rist et al., 2007). Dormant or “shadow” networks perceived as reservoirs of innovation, complement the functions of established organizations, especially during swift transformations (Gunderson et al., 1995; Kettl, 2000). These networks have the potential to bridge or delineate boundaries in resource management, enhancing adaptive capacities to address emerging challenges. Over time, some of these networks may form structured adaptable organizations (Christensen et al., 2016; Ford et al., 2018), with the need to manage intricate social–ecological systems (Akamani et al., 2016; Orach & Schlüter, 2016). Insights from local management initiatives reveal the capability of key actors to quickly form ad hoc entities, capitalizing on their social networks, to address emergent challenges (Nazir et al., 2022; Santo & Moragues-Faus, 2019). These bodies can bridge or delineate boundaries; bridging entities connect local actors to higher governance tiers, whereas boundary organizations play vital roles in delineating knowledge from action (Apetrei

et al., 2021; Davis et al., 2021; White et al., 2022). Thus, knowledge and idea dissemination can manifest in both horizontal and vertical dimensions, paralleling the dissemination of worldviews and collective vision at the individual actor level.

Furthermore, studies have highlighted the significance of organizational adaptations in the context of adaptive ecosystem-based governance, stemming from altered perceptions or mandates (Nalau et al., 2018; Pasquini & Cowling, 2015; Ziervogel et al., 2017). Organizations can either function autonomously or integrate into preexisting governance frameworks. Additionally, venue manipulation, as posited by Meijerink and Huitema (2010), involves integrating novel groups into pre-established institutions and creating new policy change conditions.

Likewise, organizational design principles pertaining to social–ecological systems and resource management have been pioneered by numerous scholars, including Ostrom and colleagues in regional and multi-tiered management systems. Certain design traits correlate with successful outcomes such as information provision, dispute resolution, and readiness for alteration (Breitmeier et al., 2006). However, it is worth noting that although ecological institutional change has been under-researched, the burgeoning influence of non-state entities in instigating institutional evolution is unmistakable and gaining scientific traction.

7 Framework for systemic resilience of socioeconomic and ecological systems (SES) for blue economy

This section offers insights into the varying perspectives on the role of systems within the fishing industry, and the criteria and indicators of socioeconomic–ecological system (SES) resilience used to evaluate shifts in resilience (Table 3). First, Arnold and Wade (2017) describe systems as a cohesive assembly of interconnected components that synergistically form a unified entity, ensuring performance standards are met to achieve the intended outcome. Essentially, the foundational operations of a system should align with the values of its constituent components to realize the desired results.

Table 3 illustrates the significant role of a system's attributes when its components work in harmony towards a common objective, thereby influencing the system's overarching functionality (Arnold & Wade, 2017; Meadows, 2008). Szymczycha et al. (2019) emphasize that once a system is integrated into a complex entity, its component cannot be easily disassembled and reconstituted as standalone elements. Detaching or isolating any of these components can compromise the integrity of the system. It is important to note that the perceived complexity of a system does not always accurately reflect reality. Rather, it often arises as a conceptual construct as the system progresses from a simpler state to a multifaceted holistic one (Scollick, 2016). Similarly, comprehending the intricacies of socioeconomic and ecological systems requires an understanding of their interrelationships and the challenges they encounter. For a system to maintain its effectiveness over time, it must demonstrate adaptability in response to changing circumstances. Indeed, the resilience and longevity of a system are inherently linked to its flexibility (Ackefors, 2009; Scollick, 2016). To ensure the sustainable and appropriate operation of fisheries systems in the long term, there must be a harmonious interplay among their components, supported by the implementation of a collective resource strategy (Barrett et al., 2019; Hand et al., 2018; Symes, 2006).

This "Framework for systemic resilience of socioeconomic and ecological Systems (SES) for the blue economy," as outlined in Table 3, promotes a comprehensive strategy to

achieve sustainability and resilience in fisheries. In essence, the framework underscores the intricate interplay between ecological and socioeconomic elements, emphasizing the complexities and interconnections within these systems. At its core, this framework emphasizes the importance for adaptability and flexibility to ensure lasting operational success.

SES for the blue economy highlights the necessity for fisheries management strategies to incorporate sustainable harvest thresholds, ecosystem-centric approaches, adaptive management tactics, and technological innovations. It also calls for the industry to diversify its market to reduce dependency on specific fish species, underscoring the importance of fostering collaboration among diverse stakeholders, including fishermen, scientists, policymakers, and conservationists. An efficacious SES is cognizant of potential disruptions that could upset its equilibrium, emphasizing the primacy of resilience, both ecologically (in relation to fish stocks) and socially (related to cultural and community frameworks). Beyond everything, it recognizes that external stressors, such as economic shifts and unsustainable technology integration, may hinder resilience. As a result, a proficient SES demands a holistic approach, accommodating all stakeholders, integrating adaptability, and recognizing the intricate nexus of interactions that characterize the fisheries domain.

The interwoven structure of the socioeconomic–ecological system (SES) is influenced by geographic constraints, which impact the patterns of interaction across networks (Dahdouh-Guebas et al., 2021; Palomo & Hernandez-Flores, 2019). Notably, distinct boundaries between the social subsystems (comprising fishers, consumers, actors, or government entities) and the natural components only become apparent when new relationships form, well before any alterations to the natural components occur. It is important to emphasize that these natural components persist until such changes occur (McGinnis & Ostrom, 2014; Ostrom, 2009).

In a similar vein, interactions of SESs (non-state users) with public institutional governance structures often influence other common users, such as fishers and consumers, as well as external factors. These interactions occur not only through governance structures but also among the SESs themselves (Colding & Barthel, 2019). To establish an adaptable framework, it is imperative to consider the complexity and interdependencies of the system components. This framework necessitates timely feedback to facilitate behavioral changes, while leveraging self-organizing biophysical processes in unpredictable contexts to manage outcomes and relationships (Delgado-Serrano et al., 2015).

Despite governing bodies emphasizing sustainable and conservative ecological measures, yet it remains crucial to provide foundational training and orientation regarding these measures for participants within SESs (Colding & Barthel, 2019). Blythe et al. (2014) highlight the evolved architecture of maritime systems, emphasizing human influences on vital aspects like buoyancy. The authors further assert that modern practices, including intensive agriculture, extractive industries, and unsustainable consumer behaviors, can lead to resource depletion, adversely affecting fishers and their families.

To achieve long-term sustainability in the fishing industry diversifying resource exploitation objectives is essential. Emphasizing sustainable harvest limits can help prevent overfishing and allow rejuvenation of fish populations. Such sustainable harvest goals balance fishing efforts with the reproductive capacity of fish stocks, ensuring prolonged sustainability (Elegbede et al., 2023b, 2023d; Lowerre-Barbieri et al., 2017). In addition, the fishing industry focuses on conserving favorable habitats for sustainable fishing. An ecosystem-based approach considers the relationships between fish populations, habitats, and other ecosystem species. Goals aimed at conserving critical habitats, minimizing bycatch, and preserving biodiversity reinforce a resilient ecosystem and robust fishing industry (Elegbede et al., 2023e; Okubo & Ishii, 2023).

Table 3 Framework for systemic resilience of socioeconomic and ecological systems (SES) for blue economy

System components	Interactions and relationships	Challenges and disturbances	Resilience strategies
System foundations	Synergistic collection of components to achieve results	System's inferred complexity might not align with reality	Recognizing and embracing system complexity. Adaptable framework considering interdependencies
Social components	Interaction between fishers, consumers, actors, and governmental bodies	Potential for disruption, uncertainty, unpredictability. Cultural and communal breakdown	Adaptive management solutions: monitoring, flexible decision-making, collaborative approaches
Ecological components	Interaction of fish populations, their habitats, and biodiversity	Biodiversity loss, ecological breakdown, entire fishing system collapse	Ecosystem-based approach: preserving habitats, reducing bycatch, maintaining biodiversity
Economic dimensions	Market diversification, reducing reliance on specific species	Economic resilience reduced by adoption of unsustainable technologies, mismanagement of natural resources	Investment in R&D for sustainable technology, considering future ecosystem stocks, promote market diversification
Governance and institutional structures	Governance structures affecting interactions between SES components	Unsustainable fisheries management strategies affecting SES resilience	Integrate knowledge systems among stakeholders, form robust institutional structures
External pressures and influences	SES's systemic structure, stages influencing patterns of interaction across networks	External pressures altering resilience activities, leading to reduced economic resilience	Foster more effective institutional structures and integrated knowledge systems
Long-term sustainability	Sustainable harvest goals balancing fishing efforts and fish stock reproduction	Resource depletion impacting livelihoods, modernity causing overexploitation	Set sustainable harvest limits, preserve habitats, use adaptive management solutions, technological advancements for sustainability

Furthermore, adaptive management facilitates nimble decision-making, calling for continuous monitoring of fish populations, habitats, and market dynamics to form strategies (Hasselman, 2017; Silva et al., 2018).

In the realm of modern sustainability, various advancement in technology have emerged as essential components. These include superior data collection methods, real-time monitoring systems, and improvement in fishing gear aimed at mitigating bycatch and reducing environmental impacts (Elegbede et al., 2023b, 2023e; Poisson et al., 2022). Considerable investments in research and development (R&D) have led to the development of more effective and environmentally friendly fishing methods (Elegbede et al., 2023b, 2023d; Ikram et al., 2021).

Of equal importance, the fishing industry has embraced market diversification as a strategy to reduce dependence on specific species or markets. This strategy involves diversifying target species, exploring new markets, and promoting value-added products. By doing so, the industry becomes more resilient to demand fluctuations and potential stock depletion (Bjørndal et al., 2015; Elegbede et al., 2023b, 2023d, 2023e; Gabellini & Scaramuzzi, 2022). Furthermore, recognizing the significance of stakeholder inclusion in decision-making processes, the fishing sector advocates for collaborative approaches. By fostering partnerships among fishermen, scientists, policymakers, and conservationists, integrated input ensures that management decisions are well-rounded and adaptive (Christie et al., 2017).

While a well-functioning system is marked by stability and effective task execution, all systems are susceptible to disruptions, uncertainties, and unpredictability, whether intentional or not. Therefore, it is essential to assess the individual component elements to gauge the overall resilience of a system. Resilience, in this context, reflects a system's capacity to withstand additional stress and maintain stability (Hodbod & Eakin, 2015).

Hodbod and Eakin (2015) posit that resilience can also be defined based on speed at which a system becomes self-sufficient and its environment's adaptability to challenges. Resilience is thus crucial when analyzing socioeconomic–ecological systems (SES) and addressing long-term sustainability issues. Effective management strategies for fisheries, which promote both the environmental preservation and economic viability are instrumental in enhancing SES resilience (Gerhardinger et al., 2014).

In the context of fisheries, "environmental resilience" refers to the ability of fish populations to withstand and recover from various disturbances, whether human-induced or natural. Resilience can be quantified by evaluating the number of fish that can thrive and reproduce in a given environment (Mason et al., 2022). Furthermore, social resilience is intricately linked to cultural and community dynamics, governance structures, and fish populations, especially in developing nations (Blythe et al., 2014; Colding & Barthel, 2019; Gerhardinger et al., 2014; Hodbod & Eakin, 2015; Ojea et al., 2017). Historically, the interdependence of socioeconomic and ecological systems has been evident. Consequently, changes in social resilience often correlate with shifts in ecological resilience and vice versa (Ojea et al., 2017). These interactions can lead to various outcomes, including the progression of a system from vulnerability to ecological breakdown before total collapse, a reduction in biodiversity that subsequently diminishes ecological resilience and vice versa, or a decrease in ecological resilience, further diminishing biodiversity (Farley & Smith, 2020; Macleod et al., 2022). Understanding resilience within SES is important for supporting future sustainable development efforts (Noulèkoun et al., 2021; Yang et al., 2020).

However, despite these critical insights, there exists a demand for greater confidence in the efficacy of resilience mechanisms concerning stewardship and conservation. Gutiérrez and Morgan (2017) have argued that certain fisheries management approaches can have

adverse effect on the resilience of socioeconomic-ecological systems (SES). This is particularly evident in their impacts on exploitation areas and the economic benefits derived from catches. Such considerations extend to both the sustenance and ecological aspects of fish resources, which are integral to the sustainability of the fisheries sector (Farley & Smith, 2020; Delgado-Serrano et al., 2015).

External pressures can significantly influence resilience efforts of fisheries within the SES framework either by amplifying or reducing these efforts (Sterling et al., 2017). Also economic transformation can weaken economic resilience and affect fishing activities (Whitney & Ban, 2019). This effect is partly attributed to the adoption of unsustainable technologies that disregard the future stocks of ecosystems, thereby exacerbating the challenge of natural resource management (Whitney et al., 2017). Therefore, the implementation of an enhanced institutional framework that anticipates stakeholder interests and incorporates integrated knowledge from all parties involved is important for strengthening systemic resilience (Gerhardinger et al., 2014; Yuan et al., 2022). An ideal SES comprises of a complex network that can adapt and respond to changes, fostering self-organization. Effective fisheries management necessitates a comprehensive understanding of all the systems at play (Arlinghaus et al., 2017; Cumming & Allen, 2017).

7.1 Managing resilience for sustainable development

Generally, in the pursuit of resilience for sustainable development, societies must enhance their resilience management capabilities (Bryan et al., 2023; Lebel et al., 2006). These capabilities revolve around three fundamental pillars: actors, social networks, and institutions. The ease or difficulty of managing the ecosystems essential for human well-being depends on their current state and unique characteristics (Barnes et al., 2017; Lebel et al., 2006).

These capability can initially be categorized into three core components, as illustrated in Fig. 2: self-organization, adaptability, and learning. A system's capacity for self-organization reflects its ability to maintain and redefine its identity. These internal system possess the inherent mechanisms required to counter external influences (Arthur, 2018; Carpenter et al., 2001; Holling, 2001). This enables systems to sustain themselves without continuous external assistance, financing, or resources. The ability of a system to adapt and learn signifies its proficiency in refining its pursuit of specific management goals and adjusting to new objectives as circumstances change (Adger et al., 2005; Folke et al., 2004). This capability merits further investigation.

Effectively handling uncertainties or nonlinearities requires a willingness to learn, an acknowledgment of the inevitability of change, and the perception of interventions as adaptive management or experimental endeavors (Adger & Vincent, 2005; Fougères et al., 2022; Maani, 2013). Moreover, the capacity to integrate insights from various sources and types of data, including implicit and explicit knowledge, increases the likelihood of identifying critical thresholds and elements of diversity (Berkes et al., 2000). Detecting thresholds that are difficult to reverse at an early stage is crucial, as it may enable societies to intervene and prevent ecosystems from entering unfavorable condition (Carpenter et al., 2001; Standish et al., 2014). Following major disruptions, nurturing, and maintaining socioecological diversity become imperative for rejuvenation and recovery (Maassen, 2020; Maikhuri et al., 2017). Additionally, integrating ecological process understanding into institutional frameworks is expected to optimize the alignment between regulations and ecosystems, even in the face of their dynamism (Aarikka-Stenroos & Ritala, 2017; Folke

et al., 2004; Tsujimoto et al., 2018). Given that regional systems are constantly exposed to potent external influences such as legal modifications, financial shifts, and environmental changes, it is essential for them to navigate interactions across varying scales (Meissner & Jacobs, 2016).

8 Conclusions

This study provides clear reflections on the significance of SES in non-state initiatives within the context of sustainability schemes for a more sustainable, circular blue economy. It underpins the essentiality of collaborative management of the available blue resources and the inclusiveness of these initiatives and their institutions in decision-making. This study shed light on the complexities and interdependencies within the seafood industry, emphasizing the need for effective management practices. While this research provides valuable insights, it is important to acknowledge the limitation of not following a systematic review method of sourcing secondary data, without proper inclusion of all expected literature. Our findings underscore the significance of inclusive social and ecological systems within the framework of a blue economy, with the ultimate purpose of successfully administering and managing common resources. The blue economy, driven by the seafood industry, stands at the crossroads of sustainability and development and is greatly influenced by non-state sustainability initiatives such as eco-certification and labels, which play pivotal roles in shaping the sustainability landscape. However, these initiatives, though pivotal, remain inadequately understood, particularly within the nuanced framework of socioeconomic–ecological systems (SES) that underpin non-state seafood sustainability schemes (NSSS). A deeper investigation into the synergies of the institutional, social, and ecological interactions among non-state actors provide a roadmap for enhancing the management of common resources. This study witnessed a noticeable increase in non-state efforts aimed at championing sustainable fisheries. Nevertheless, for these endeavors to translate into tangible sustainable outcomes, resilience has emerged as a cornerstone.

As non-state institutions embark on the journey toward sustainable fisheries, societal elements, such as actors, networks, and institutions are instrumental in navigating the challenges that lie ahead. Striking the right balance between economic growth and environmental preservation, especially within the fisheries sector, depends on the development of comprehensive management strategies that take into account both human-induced ecosystem conditions and intrinsic qualities. The social dimensions of resource management supported by environmental laws and biophysical frameworks are of paramount importance. It is the harmonious integration of socioeconomic and ecological facets that will determine the future trajectory of the seafood industry. As we move forward, understanding and managing the interplay between these dimensions, coupled with economically viable measures and policy implementations in resource management, will be the keystone of sustainability in the seafood industry.

8.1 Contributions

While many authors have provided conceptual frameworks that decipher the concept of the blue economy as well as the opportunities for transformation and the challenges facing the governance of the blue economy, this study provides a rationale framework (socioeconomic and ecological systems) that critically highlights the transnational contributions, the

interlinkage, and how numerous non-state actors could be prominently incorporated in the governance of the blue economy. Likewise, the study elucidates the substantial variabilities of the NSAs participation in the Regional Fisheries Management Organizations, albeit, the NSAs have common long-term goals. Similarly, this study provides a clear grasp on the criteria and indicators of socioeconomic–ecological system (SES) resilience used for evaluating the technical and economic shifts for a more sustainable and equitable blue economy, coupled with quantification of how these multi-dynamic systems could be feasibly managed by the collaboration of the NSAs and government entities. It is critical that states cannot effectively and independently manage the global blue resources. The intervention of non-state initiatives and institutions is highly important to synergize with existing structures at the communal, local, national, regional and global level to sustainably manage the these resources. Thus, this paper serves as a tool for stakeholders and other relevant players to see how inclusiveness in managing the resources can be maintained especially in this present ocean decade of action and beyond.

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Author contributions The authors contributed to the study conception and design and performed material preparation, data collection, and analysis. The first draft of the manuscript has been written and edited by the authors.

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Data availability The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Conflict of interest The authors declare that there is no conflict of interest regarding this study.

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