Triple Exposure: Reducing negative impacts of climate change, blue growth, and conservation on coastal communities

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Summary: Coastal communities are on the frontlines of three accelerating global change drivers: climate change, blue growth, and the expansion of area-based conservation, leading to a 'triple exposure' scenario. Despite efforts to maximize social benefits from climate, development, and conservation, externally-driven processes can converge to amplify vulnerabilities and inequalities. Pre-existing social injustices increase the sensitivity of affected individuals to change and limit their capacity to adapt or benefit from the interacting impacts of triple exposure. We argue that external implementors cannot effectively and equitably achieve climate, economic, and conservation goals without prioritizing social justice and building general resilience. We therefore recommend that implementors: 1) address root causes of vulnerability, namely pre-existing social injustices; 2) use participatory systems approaches to improve understanding of local contexts and potential consequences of proposed initiatives, and; 3) leverage inclusive partnerships to facilitate collaborative design and implementation. These strategies—applied together and adapted to local contexts—can support wellbeing, justice, and resilience within coastal communities experiencing rapid change.

Keywords: vulnerability, climate change, blue growth, blue economy, conservation, equity, justice, transformation, social-ecological system, sustainability

Introduction

Twenty years ago, O'Brien and Leichenko [1] challenged us to consider the impacts of climate change and globalization simultaneously rather than in isolation. In their influential paper, they introduced the concept of 'double exposure' as a framework for examining the cumulative impacts of the two exposures. Critically, they argued that the complex interactions between climate change and globalization would create new, and uneven, vulnerabilities across regions, sectors, ecosystems, and social groups. Their 'double exposure' framework highlighted the need to examine how these interacting exposures produce novel sets of impacts, often exacerbating marginalization and inequality. Today, the 'double exposure' framework remains highly relevant, particularly for people whose way of life, cultural identity, livelihoods, and food security are inextricably connected to the ocean (hereafter coastal communities).

Both climate change and globalization continue to accelerate in marine and coastal systems. Unprecedented changes in the physical and chemical properties of the ocean are changing seasonality and abundance of oceanic and coastal organisms [2]. For example, marine heat waves have doubled in frequency over the 20th century, leading to more extreme storms and recurrent mass coral bleaching events, threatening sensitive marine ecosystems and the lives and livelihoods of billions of people [3]. Similarly, increased economic development in the oceans from increased international trade, foreign investment, and interest from transnational corporations (termed 'blue growth') is re-shaping local marine resource extraction and consumption, biodiversity loss, and patterns of inequality globally [4,5] with revenues increasingly concentrated in the hands of a few corporate actors [6].

Since the publication of the 'double exposure' framework, a third significant global driver of change has emerged for coastal communities. In response to biodiversity loss, the rapid expansion of area-based marine conservation is producing radical policy change in biodiverse locations, especially in less economically-developed regions. In particular, the global coverage of marine protected areas (MPAs) has increased 15-fold within the last two decades [7,8]. This rapid expansion is likely to continue into the future given the recent adoption of the target to increase coverage to 30% by the year 2030 ('30 x 30 target') by the 196 Parties to the Convention on Biological Diversity within the Kunming-Montreal Global Biodiversity Framework [9]. While several marine conservation initiatives have slowed biodiversity loss and improved the wellbeing of many [10–12], others are ineffectively and inequitably managed [13–15] and have harmed local people through displacement, increased inequality, and human rights abuses [16–18]. Regardless of impact, the adoption and implementation of the 30 x 30 target will transform marine resource access and use on a staggering scale.

In this paper, we build on O'Brien and Leichenko [1] to include externally-driven area-based marine conservation as a third exposure that is interacting with climate change and blue growth to produce novel impacts in coastal communities. In doing so, we propose 'triple exposure' as a framework to examine the cumulative and differential impacts - both positive and negative - of these three global exposures. We identify climate change, blue growth, and area-based conservation as 'exposures' based on their shared characteristics. We argue that in most cases they represent rapidly advancing, high impact, externally-driven, global change processes over which many communities have limited influence. This also encompasses the increasing number of externally-driven climate initiatives that seek to achieve climate adaptation and mitigation through biodiversity conservation or economic development (e.g., blue carbon initiatives). Although these exposures can and have produced tangible benefits for coastal communities (e.g., increased resilience, poverty reduction, species recovery), many cases exist where they have unintentionally increased, rather than reduced, inequality and vulnerabilities [4,16,19,20]. Yet,

research on the differential and novel impacts of these interacting exposures on coastal communities is limited [5,12,21].

Recognising the significant knowledge gaps and implications for those on the frontlines of these three accelerating exposures [2,22], this paper examines the cumulative and differential impacts of triple exposure on coastal communities, and the implications of these positive and negative impacts for the design and implementation of climate, development, and area-based conservation initiatives (hereafter termed coastal initiatives). We first describe the 'triple exposure' framework in more detail to justify our focus on these three exposures within a suite of multiple interacting exposures. We then examine factors that shape differential vulnerability to triple exposure, demonstrating how current and historical inequalities can undermine the successful and equitable implementation of coastal initiatives. Finally, we propose promoting social justice and building general resilience as two mutually-reinforcing principles to minimize the negative impacts of 'triple exposure' in coastal populations, and provide tangible, transformational strategies to advance them.

Coastal communities at the 'triple exposure' frontier

Climate change is recognized as a key and growing driver of vulnerability in coastal communities [2], disproportionately impacting marine ecosystems and resource-dependent populations in less economically-developed regions [2,3,23]. For example, ocean warming is predicted to result in severe food and nutritional security consequences in the tropics, with potential losses of up to 40% in marine capture fisheries and over 80% of sensitive ecosystems such as coral reefs [24–26]. At the same time, climate adaptation and mitigation initiatives can also exacerbate vulnerability and inequality within coastal communities [19,20]. For example, cases exist where coastal infrastructure aimed at protecting against sea-level rise and coastal storms impeded important hydrological processes, resulting in increased vulnerability to flooding, environmental damage, and sanitation risk [19,21]. Elsewhere, externally-driven "blue carbon" initiatives have also been said to undermine local rights and livelihoods [27].

Many coastal areas are being framed as "prime for development" or "uncommodified spaces" by national and foreign actors seeking to advance their economic interests under the emerging "blue economy" or "blue growth" agendas [4,21,28]. Blue growth can result in powerful economic actors controlling where and how marine resources are used, conserved, and managed (WFFP 2014, p. 3 as cited in Barbesgaard [22]). These actors are seeking to capitalize on an ocean economy that is expected to grow to $3 trillion per annum by 2030 [5,29]. Focal areas then become hubs for externally-driven investment, including investment in industrial fisheries, aquaculture, shipping, tourism, and renewable energy. In some cases, external economic investment is contributing to lost access due to appropriation of coastal resources by foreign actors, as well as extensive resource extraction and associated environmental degradation [4,30,31]. For example, technological advances and national "investments" in marine capture fisheries in the form of over $25 billion in annual subsidies have led many wealthy countries to exploit fishing areas in less wealthy nations, further depleting dwindling, often climate-sensitive, fish stocks important to small-scale fisheries [21,32].

The global expansion of externally-driven area-based conservation is a third exposure, which restructures how people around the world can access, interact with, and benefit from the ocean. With over 27 million km^2 or 7.8% of the ocean currently within MPAs, area-based conservation is arguably the most prolific biodiversity conservation tool used in the ocean today, and its application is accelerating [33]. Notably, many coastal areas, particularly a in the Global South, are major conservation priorities given their high biodiversity value [34,35], with the majority of

the world's 16,500 MPAs located within nearshore waters [33]. With effective and equitable implementation, area-based conservation that employs rights-based approaches can help protect marine biodiversity from anthropogenic threats (including climate change and unsustainable blue growth), safeguard social benefits from healthy marine ecosystems, as well as strengthen local rights and livelihoods [36,37]. Nonetheless, numerous cases exist where externally conceived and poorly implemented conservation initiatives have failed to recognize local rights, needs, and voices, leading to increased vulnerability and inequality through conflict, disenfranchisement, and lost access to key resources (e.g.,[17,18,38]).

Based on current climate, conservation, and development projections, targets, and discourses, the expected impacts (whether positive or negative) of externally-driven climate change, blue growth, and area-based conservation will likely be immense, global in extent, and continue to rapidly accelerate [2,5,9]. While these three exposures are not the only change drivers affecting coastal communities, they are three of the most significant externally-driven and interacting global change processes transforming ocean environments, economies, and governance at an unprecedented scale. They are also producing large and varied impacts on groups and communities that are already dealing with other exposures and inequitable social structures [39]. Importantly, these three exposures do not operate in isolation, but interact to create novel and differential impacts. For example, in the Sundarban Biosphere Reserve in India, efforts to conserve critical species and habitats in light of climate impacts and local threats include restricting access to large areas within the wetland [40]. However, for fisheries-dependent groups subject to historical and ongoing marginalization and repeated climate shocks, the seizure of assets, restricted fishing access based on ethnicity, and abuse from enforcement staff, have severely compromised their wellbeing, increasing their vulnerability to economic exploitation and future climate shocks (See other examples in Box 1).

Differential vulnerabilities to 'triple exposure'

Differences in vulnerabilities to, and impacts of, interacting exposures often result from inequitable institutional structures, policies, and cultural norms [41]. Triple exposure can reinforce these entrenched inequalities, exacerbate vulnerability, and undermine the success of coastal initiatives.

Current and historical injustices and inequalities, including colonialism, power imbalances, inequitable policies, corruption, and gender norms, create and reinforce social structures and hierarchies that marginalize select coastal communities and individuals within them [42,43]. For example, gendered processes or roles can often explain why women are more likely to be impacted by disasters [44], excluded from decision-making [45], or restricted in accessing marine resources after project implementation [19,46,47]. As the Sundarban case illustrates, individual sensitivity to triple exposure is not only shaped by factors such as resource dependency but also by inequalities associated with gender, race, education level, economic status, and religious or ethnic identity [39,46,48–50].

For groups subject to marginalization, historical injustices and contextual inequalities can also hinder their ability to adapt to negative shocks from triple exposure and related coastal initiatives (Box 1). In many coastal communities, access to resources or services (e.g., credit, healthcare, infrastructure, insurance), capabilities (e.g., education, language, occupational diversity, capacity to self-organize), power, institutions, and learning mechanisms are often limited and highly variable [51]. This severely limits people's ability to prepare for, adapt to, or recover from stressors or shocks (i.e., adaptive capacity) [50,52–54]. This limited access is often a product of long-standing social or economic policies of marginalization, or social or cultural

norms that accept and reinforce inequalities and injustice. Triple exposure can interact with these reinforced structures and norms to further increase susceptibility of groups subject to marginalization to future shocks, exacerbating existing inequalities and vulnerabilities (Box 1). For example, in Aboadze, Ghana, increased coastal development associated with blue growth forced poorer individuals to live in exposed low-lying areas vulnerable to sea-level rise and reduced the farmland available to adapt to drought conditions [21] (Box 1 – Ghana case). In the same case, competition with foreign industrial fishing fleets led many to resort to unsustainable fishing practices to make up for lost catch (e.g., dynamite fishing), compromising the integrity of the ecosystems they rely on.

Box 1 here

Social and economic marginalization can also limit one's ability to benefit from coastal initiatives. Differences in access and power between implementers and affected individuals can result in policies and initiatives that are designed by, and deliver disproportionate benefits to, external actors or local elites, further disenfranchising communities and individuals subject to marginalization (Box 1) [19,28,51]. For example, while conservation and related economic opportunities can benefit local resource users through improved marine ecosystem health, those benefits only accrue to those with the ability to use or access them [12]. Thus, benefits often flow to select actors (e.g., local elites, large commercial operators) with greater influence in conservation design and rule-making or the capacity to capitalize on benefits (e.g., [17,45,47]). Gustavsson et al. [46] describe how a conservation and tourism development project in Zanzibar resulted in increased economic activity, yet local people were relegated to low-paying jobs due to language and cultural barriers, with higher-paying jobs going to non-locals. Further, female seaweed farmers, who lacked a voice in decision-making fora, were displaced from their farms.

Transformational strategies

To meaningfully mitigate negative impacts from triple exposure, particularly those stemming from maladaptive and inequitable responses to climate change, development interests, and biodiversity loss, we argue that a radical reorientation of climate, blue economy, and area-based conservation policy and practice is required. The cases above and other research show that efforts to make coastal initiatives more effective and equitable through integrative approaches (e.g., integrated conservation and development, nature-based solutions to climate change, integrated ocean management, etc.) and attempts to mitigate social costs (e.g., "do no harm" policies, alternative livelihood programs, etc.), may be inadequate or inappropriate in practice [17,19,27,55]. To address this gap, we argue two principles are key. First, prioritizing social justice needs to be a foundational principle through which these initiatives are designed and implemented. Second, implementers should prioritize building general resilience given the uncertainty surrounding triple exposure as it interacts with other endogenous and exogenous drivers of change. Here general resilience is defined as the capacity of a social-ecological system to adapt or transform in response to a range of disturbances [56]. It contrasts with specific resilience as the capacity to respond to a particular type of disturbance, such as sea-level rise or protected area access restrictions.

In this section, we outline what social justice and general resilience offer as foundational principles. We then propose three key strategies that implementors of coastal initiatives can use to operationalise these principles: 1) identifying and addressing root causes of vulnerability; 2) using participatory systems approaches to identify these root causes and pathways towards building general resilience; and 3) developing and leveraging community-centred, cross-scale and cross-sectoral partnerships between diverse actors to facilitate the

collaborative design and implementation of identified solutions (Fig 1). These strategies are not exhaustive or mutually exclusive. They are also not intended to be prescriptive, acknowledging the agency and diversity of worldviews, knowledge systems, values, and priorities within coastal communities [57]. Nonetheless, these principles and strategies (outlined below) — applied together and adapted to the local context — offer an opportunity to advance current practice and research at the nexus of climate, development, and conservation sectors towards more just and effective solutions.

Figure 1 here

Principle 1: Prioritizing social justice

Prioritizing social justice— the right or fair treatment of all people—requires attention to three of its key dimensions: recognition, procedure, and distribution [30,58,59]. Recognitional justice involves identifying, recognizing, and acknowledging the rights, needs, livelihoods, knowledge systems, worldviews, and values of different societal groups [60]. For example, this means properly considering the nutritional, economic, and cultural dependence on aquatic foods of current and future generations in coastal areas when proposing conservation activities that restrict access to marine resources [63]. Recognitional justice is especially important for groups that are marginalized within dominant governance systems and management processes. Recognition is increasing acknowledged as underpinning the other two key justice dimensions [61], where the recognition of all rights-holders and stakeholders and their diverse identities and values is a key first step to prioritizing procedural and distributional justice [62].

Second, prioritizing procedural justice involves the active participation and leadership of all relevant coastal rights-holders and stakeholders in decision-making to identify local people's preferences and goals, key risks for various groups, and context-appropriate solutions that do not exacerbate existing vulnerability and inequalities [50,57]. Procedural justice requires recognition of relevant decision-making participants, and proactive steps to address barriers to meaningful participation and local leadership in decision-making [64]. For example, while "stakeholder participation" is a common refrain, effective engagement and collaboration must go beyond extending invitations to fostering key procedural justice criteria. This includes transparency and neutrality in decision-making processes, adequate voice, decision control, accessible conflict resolution mechanisms, and other elements of agency, respect, and politeness in interpersonal treatment [61,65]. Some cases require supporting disenfranchised groups and local leaders for them to meaningfully engage and/or lead decision-making processes without exacerbating their capacity constraints for local issues or personal needs (e.g., considering the financial or time poverty of women) [28,42]. In all cases it should involve supporting local leadership, which sometimes might involve establishing shared governance structures between local rights-holders, stakeholders, and other actors (e.g., Box 2).

Third, prioritizing distributional justice involves working with rights-holders and stakeholders to identify, monitor, and manage the realized (or potential) impacts of interventions and the distribution of those impacts among different societal groups [66]. This includes, for example, considering the differential impacts of initiatives on women, who are often overlooked in impact assessments and yet comprise around 47% of the workforce engaged in fishing and post-harvest operations [42,47,54,67]. Developing or adopting contextually-appropriate guidelines, social safeguards, and justice principles for recognizing and engaging with groups subject to marginalization (e.g., FAO Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries [68], Blue Economy Finance Principles [69]) can help facilitate more equitable benefit and cost sharing, mitigation actions, and compensatory mechanisms. Importantly,

distributional equity is plural and situated in time, place, and in terms of what is being distributed among whom [48,62]. Thus, distributional justice requires going beyond "net benefit" and "do no harm" policies towards identification of local conceptions of what constitutes a fair distribution of costs and benefits. It also requires assessing the (mis)alignment of local conceptions with those embedded in coastal policy and tools, which are often developed in the Global North [62].

Principle 2: Building general resilience

While many coastal communities are accustomed to change, their resilience has been undermined by exogenous and endogenous drivers of inequality and vulnerability [28,70]. Moreover, their specific resilience is potentially insufficient to respond to one exposure (e.g. climate change) while dealing with negative impacts from maladaptive and inequitable coastal initiatives (i.e., triple exposure) [40,71]. There are many examples where coastal initiatives were successful in building specific resilience to a particular stressor, but compromised long-term, general resilience and increased inequality (e.g., Box 1 – Ghana case) [19,56,72]. Prioritising general resilience as a goal in coastal initiatives can better capture the need for increasing the capacity of diverse actors to respond to the myriad of environmental, political, economic, and socio-cultural changes and uncertainties catalysed by triple exposure and other shocks [73]. This can include developing initiatives that facilitate increasing the agency, flexibility, learning, collective action, and access to key resources, services, power, and institutions of various individuals and groups [52,73].

Strategy 1: Identify and address root causes of vulnerability

Transformational solutions aiming to prioritize social justice and build general resilience must identify and seek to dismantle the root causes of vulnerability and inequality, both those external to, and embedded within, the local socio-environmental context [41,55,74,75]. Many root causes of vulnerability and inequality represent "slow variables", fundamental and long-term structures or processes that underpin or undermine desirable outcomes and change [76,77]. Slow variables often explain how and why triple exposure and other drivers of change disproportionately affect some individuals and/or locations and not others. Root causes of vulnerability can be: social (e.g., social marginalization, systemic racism, unequal access to resources), economic (e.g., unjust neoliberal trade policies, privatization of coastal commons, aid conditionality), political (e.g., colonial legacies, political exclusion, disproportionate corporate lobbying power), or environmental (e.g., non-point sources of pollution) [55,78–81]. From tourism development initiatives that result in elite capital accumulation and marginalize disadvantaged groups [82], to well-intentioned conservation enforcement strategies that exacerbate social vulnerabilities (e.g., poverty) that drive non-compliance [18,40,83], failure to address root causes can lead to ineffective policies and unjust outcomes [19,55].

Root causes of coastal vulnerability and inequality are often interconnected, remote, and multi-scalar, and thus must be addressed at the appropriate spatial and temporal scale(s) [84–86]. For instance, some climate programs have been critiqued for missing opportunities to mitigate climate risk by focusing solely on adaptation [41,74,87,88]. Morrison et al. [84] showed how conservation of the Great Barrier Reef focuses on regulating the behaviour of local reef users rather than addressing the practices of multinational corporations that drive reef degradation through investment in fossil fuels. Root causes can also stem from legacies of unjust state institutions and policies, which hinder the success of coastal initiatives. In Mnazi Bay, Tanzania (Box 1), recent MPA and development initiatives were seen as a continuation of the state's efforts to exert control and further disempower and disenfranchise local communities

[18,38]. These initiatives resulted in increased conflict, food insecurity, and worsening wellbeing outcomes [18].

In these and other cases, addressing root causes requires accurate problem definition, shifting focus away from the symptoms of climate change, unsustainable development, and poorly implemented conservation (e.g., habitat loss, poor compliance), towards the deeper, root causes of vulnerability to these global change processes. These include systemic issues at the local (e.g., inequitable distribution of social services or power to influence decision-making), national (e.g., weak environmental regulations, poor inter-agency coordination, exclusion of local rights holders in governance, tax systems that support economic leakages), and global (e.g., carbon emissions, exploitative North-South trade and tax systems) levels [80,84,89–91]. In many cases, addressing the root causes of vulnerability will require interrogating the capitalist, gendered, and colonial underpinnings that lead to disproportionate vulnerability and outcomes in coastal communities [44,92–96]. An effective approach can be to start from examining the outcomes we wish to address or avoid, and work backward towards identifying the causal drivers. Carefully tailored social-ecological vulnerability assessments can help uncover relevant drivers of vulnerability and inequality and help shape contextually appropriate interventions at the right scale [97–100]. Such interventions could then be tailored to address the specific vulnerabilities of groups and sub-groups. This might include combining familiar interventions in new ways. For example, pairing local conservation or restoration efforts with stronger national climate mitigation policies (e.g., decarbonization) [84,101,102], revising existing economic policies that promote leakages or marginalization as part of national blue growth strategies, and more. Acknowledging root causes of vulnerability can point to levers of change that when addressed intentionally, can advance recognitional, procedural, and distributional dimensions of justice.

Strategy 2: Use participatory systems approaches for planning and decision making

Approaches to designing, implementing, and evaluating coastal interventions that draw on systems thinking (hereafter, 'systems approaches') are well positioned to identify root causes of vulnerability and inequality, avoid maladaptive and inequitable outcomes from coastal initiatives, and identify pathways towards building general resilience [76,103]. Coastal communities are embedded within complex social-ecological systems, each influenced by unique endogenous and exogenous processes, interactions, and feedbacks, including past and present drivers of change. The complexity of coastal systems means that root causes of vulnerability and inequality are often “hidden” and difficult to isolate within other interacting social and ecological processes. This is especially true for root causes that are deeply embedded within the social system (e.g., cultural norms) or those that are distal and remote (e.g., non-point sources of pollution). This complexity also adds to the challenge of predicting the potential impacts of new coastal initiatives, as these initiatives might interact with other drivers to produce a novel set of disparate outcomes. Failure to consider the system interactions between triple exposure and the social-ecological context can therefore lead to misdiagnoses and maladaptive responses that fail to address root causes, resulting in unintended feedbacks, ineffective policies, and social-ecological traps [57,84,104–106].

Participatory systems approaches can help identify how root causes and planned initiatives intersect with change processes to affect distinct groups or different aspects of wellbeing [57,107]. Participatory approaches can provide a forum for disenfranchised individuals and groups to communicate their perspectives and experiences regarding current or historical factors that drive local inequality and vulnerability, and to co-develop inclusive strategies to address these issues (e.g., Box 2 - Madagascar case). Thus, participatory approaches can foster recognitional

and procedural justice in decision-making, and thus, distributive justice (Figure 1). Such approaches can also highlight potential unintended socioecological feedbacks, inequitable impacts and trade-offs, thresholds, and processes that exacerbate vulnerability from planned initiatives [74,108,109]. For example, participatory model building and scenario exercises can be used to identify how a proposed development might interact with a current climate adaptation project, and/or conflict with the goals and aspirations of local and external actors. Implementors can also gain insight on how climate shocks and current initiatives are jointly affecting important nursery habitats, or what might happen to resource-dependent individuals if an area is closed for conservation purposes and a major storm or economic shock were to subsequently affect alternative income streams. They can also highlight opportunities, such as conservation initiatives for mitigating the spread of zoonotic disease and future pandemics, or applying rights-based approaches within planned cross-sectoral initiatives (Box 2). In addition to strategy development, implementers can collectively identify appropriate indicators for monitoring root causes and evaluating progress in addressing them. Combining the rich knowledge bases of local actors with emerging technologies and data (e.g., remote sensing products, long-term monitoring datasets, predictive modelling) can inform such systems model and scenario building processes to identify viable paths towards building general resilience [98,103,110,111].

Strategy 3: Leverage cross-scale and cross-sectoral partnerships

Addressing the complexity of challenges presented by triple exposure and other change drivers is beyond the scope of a single actor or work at a single scale [112]. Developing strategies to address triple exposure requires proactive efforts to improve integration, coordination, and recognition through cross-sectoral and cross-scale collaborations, often between unlikely partners. Partnerships with those most affected by, and responsible for, change, can support effective solutions through: 1) better identification of appropriate and equitable strategies and; 2) providing the capacity to implement them.

Inclusive collaborations that bring together affected groups with decision-makers foster recognition and procedural justice and greater integration. Such collaborations also can generate innovative and context-specific solutions that are more likely to be considered legitimate by local actors. Bringing together diverse ways of knowing can improve participatory planning processes (e.g., systems approaches and scenario building) through improved problem definition, better identification of root causes, key system interactions and processes, and facilitate more plausible assessments of potential trade-offs from future policies or disturbances [73,109,113]. For example, the Watershed Interventions for Systems Health in Fiji (WISH Fiji) project is a cross-scale, multi-actor initiative that uses a participatory systems approach to identify culturally appropriate interventions to address social-ecological impacts from climate, development, and poorly planned conservation within Fijian watersheds (Box 2). Including "non-traditional" actors that are responsible for, or have the power to influence, exogenous root causes also increases the likelihood of developing solutions that address processes driving vulnerability and inequality. Coordinated multi-sectoral and cross-scale planning involving the "traditional" marine sectors (e.g., shipping, tourism, fisheries) and other sectors such as finance, business, education, public health, disaster management, and insurance) can help facilitate better coordination in planning across sectors and governance levels [114]. Such collaborations can also help identify (mis)alignments between planned initiatives and current and future activities.

Cross-scale and cross-sectoral partnerships can also provide the capacity, coordination, and mechanisms needed for implementation. By pooling technical and financial capacity between

partners and leveraging their influence, agency, authority, and networks, coastal initiatives are more likely to address root causes and promote justice at the appropriate scale. In Eastern Indonesia, collaborations between local communities, provincial and national governments, and international NGOs, created a network of MPAs to improve coral reef resilience and protect local rights by building on, and reinforcing, local customary tenure rules with provincial regulations and national level support [115]. Cross-scale partnerships may also be necessary to effectively respond to shocks. In Mauritius, a local NGO leveraged its pre-existing local and regional networks and infrastructure to serve as a hub for the volunteer response to a major oil spill that severely impacted sensitive coastal habitats [116]. However, community members lacked the necessary training and protective equipment to safely address the spill immediately following the disaster. In this case, stronger cross-scale partnerships between local actors and those at higher levels of governance could have ensured that adequate resources were available to avoid unnecessary health risks. To effectively address root drivers in other contexts partnerships may require national actors to address unsustainable or inequitable national economic policies, producers in the agricultural sector to address upstream watershed pollution (Box 2 - Fiji case), or local community leaders to address unjust practices regarding groups subject to marginalization. At a global scale, leveraging existing cross-sectoral initiatives, such as the UN Decade on Ocean Sciences, UN Global Compact, and the United Nations' Sustainable Development Goals (SDGs), can take advantage of the multiple intersections between global targets and agendas, and provide a supportive platform or starting point to advance synergistic policy development [114,117,118].

Overcoming barriers to transformation

Implementing the three strategies we outline above is not without significant challenges given that trade-offs can exist between the climate, development, and conservation agendas, particularly across geographic and temporal scales [119,120]. Such partnerships will require going beyond "do no harm" polices and "stakeholder participation" practices that commonly do not constitute meaningful engagement [61] towards taking proactive steps to address power imbalances, pre-existing injustices, and conflicts that prevent broad and equitable participation and local leadership in integrated planning.

Leveraging and learning from existing partnerships and approaches that forefront justice and equity issues can be a useful strategy to achieve more just outcomes. For example, the Indigenous and Community Conserved Areas Consortium [ICCAs] and the Conservation through Reconciliation Partnership are taking steps to address prior injustices and empower disenfranchised groups who might be disadvantaged by large-scale initiatives. Formalizing shared and locally-led resource governance arrangements, rights-based approaches, collaborations with human rights organisations, or the use of national or international courts can also empower local actors to address historical marginalization [121]. Such mechanisms have been successfully used to challenge powerful forces. For example, Viglione [122] reports an increase in litigious responses to climate change, documenting the example of a Peruvian farmer who has brought a legal case against the largest emitter of CO_2 in the European Union. In some cases, restorative justice could be warranted to address historical injustices, as demonstrated by the fisheries and forestry reparations for Maori populations in New Zealand [123] and ongoing efforts in British Columbia, Canada to foster reconciliation with Indigenous peoples through collaborative fisheries governance [121] (Box 2 -Canada case). In other cases, it will require significant transformation of current structures and mechanisms. For example, current funding mechanisms are biased towards organizations who can navigate the bureaucratic complexities of funding bodies. Making these funding mechanisms more

accessible to local rights-holders can facilitate greater self-determination by allowing them to develop and implement initiatives themselves.

Box 2 here

The approaches recommended here will require long-term investment of time, energy, and resources to ensure sustained effectiveness in addressing triple exposure. Efforts to address pre-existing power imbalances, historical injustices, conflict, limited capacity, and siloed governance that hinder effective collaboration require long-term investment beyond traditional donor cycles. Similarly, developing local capacity for increased local leadership and ongoing participation in partnerships also requires sustained investment. As such, addressing triple exposure requires advancing beyond the one-off or sporadic multi-stakeholder interventions that are currently employed, towards creating mechanisms that enable and sustain broad participation in decision-making, ongoing dialogue, trust-building, conflict resolution, and difficult conversations surrounding historical injustices [124] (e.g. Box 2 – Madagascar case). The rapidly accelerating changes brought about by triple exposure also necessitate enduring and adaptive governance and monitoring systems. With ongoing investment in collaboration, partners can continuously share insights on emerging drivers of vulnerability and inequality, novel trade-offs and impacts generated by recent policies or disturbances, and co-develop or adaptively manage strategies to appropriately respond [125].

Conclusion

While coastal societies stand to benefit the most from resilient coastal ecosystems and strong local economies, they are also the most highly susceptible to increased vulnerability stemming from triple exposure, particularly in cases where externally-driven coastal initiatives fail to adequately consider local rights, livelihoods, and needs. With the current momentum behind expanding climate adaptation, blue growth, and area-based conservation efforts globally, implementors have an opportunity to proactively develop initiatives that prioritize social justice and build general resilience by employing systems-based planning approaches to identify and address root causes of vulnerability and inequality, and developing novel partnerships for collective action. Doing this likely requires rethinking existing operating and funding structures, which will entail strong leadership, sustained support, and carefully facilitated organizational change processes. By leveraging and advancing beyond existing integrated management initiatives and approaches, climate, development, and conservation actors can proactively address systemic injustices, power imbalances, and other factors that undermine the effectiveness and fairness of current initiatives. The strategies we recommend here may be resisted or intractable in some contexts. Nonetheless, compared to the potential negative impacts from triple exposure, even small steps towards promoting social justice and resilience within coastal communities are a worthwhile investment.

References

1. O'Brien, K.L., and Leichenko, R.M. (2000). Double exposure: assessing the impacts of climate change within the context of economic globalization. Glob. Environ. Change *10*, 221–232. 10.1021/acs.est.7b05861.

2. Cooley, S., and Schoeman, D. (2022). Oceans and Coastal Ecosystems and their Services. In Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contributions of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (Cambridge University Press), pp. 1–236.

3. Lam, V.W.Y., Allison, E.H., Bell, J.D., Blythe, J., Cheung, W.W.L., Frölicher, T.L., Gasalla, M.A., and Sumaila, U.R. (2020). Climate change, tropical fisheries and prospects for sustainable development. Nat. Rev. Earth Environ. *1*, 440–454. 10.1038/s43017-020-0071-9.

4. Bennett, N.J. (2021). Blue growth and blue justice: Ten risks and solutions for the ocean economy. Mar. Policy *125*, 104387.

5. Jouffray, J.-B., Blasiak, R., Norström, A.V., Österblom, H., and Nyström, M. (2020). The Blue Acceleration: The Trajectory of Human Expansion into the Ocean. One Earth *2*, 43–54. 10.1016/j.oneear.2019.12.016.

6. Virdin, J., Vegh, T., Jouffray, J.-B., Blasiak, R., Mason, S., Österblom, H., Vermeer, D., Wachtmeister, H., and N. Werner (2021). The Ocean 100: Transnational corporations in the ocean economy. Sci. Adv. *7*, eabc8041. 10.1126/sciadv.abc8041.

7. UNEP-WCMC, IUCN, and NGS (2018). Protected Planet Report 2018 (United Nations Environment Programme (UNEP) World Conservation Monitoring Centre (UNEP-WCMC), International Union for Conservation of Nature (IUCN), and National Geographic Society (NGS)).

8. Berger, M.F., Caruso, V., and Peterson, E. (2019). An updated orientation to marine conservation funding flows. Mar. Policy *107*, 103497. 10.1016/j.marpol.2019.04.001.

9. CBD (2022). Kunming-Montreal Global Biodiversity Framework (Convention on Biological Diversity).

10. Mizrahi, M., Diedrich, A., Weeks, R., and Pressey, R.L. (2018). A Systematic Review of the Socioeconomic Factors that Influence How Marine Protected Areas Impact on Ecosystems and Livelihoods. Soc. Nat. Resour. *32*, 4–20. 10.1080/08941920.2018.1489568.

11. Ban, N.C., Gurney, G.G., Marshall, N.A., Whitney, C.K., Mills, M., Gelcich, S., Bennett, N.J., Meehan, M.C., Butler, C., Ban, S., et al. (2019). Well-being outcomes of marine protected areas. Nat. Sustain. *2*. 10.1038/s41893-019-0306-2.

12. Gill, D.A., Cheng, S.H., Glew, L., Aigner, E., Bennett, N.J., and Mascia, M.B. (2019). Social Synergies, Tradeoffs, and Equity in Marine Conservation Impacts. Annu. Rev. Environ. Resour. *44*, 1–26. 10.1146/annurev-environ-110718.

13. Agardy, T., di Sciara, G.N., and Christie, P. (2011). Mind the gap: Addressing the shortcomings of marine protected areas through large scale marine spatial planning. Mar. Policy *35*, 226–232. 10.1016/j.marpol.2010.10.006.

14. Gill, D.A., Mascia, M.B., Ahmadia, G.N., Glew, L., Lester, S.E., Barnes, M., Craigie, I., Darling, E.S., Free, C.M., Geldmann, J., et al. (2017). Capacity shortfalls hinder the performance of marine protected areas globally. Nature *543*, 665–669. 10.1038/nature21708.

15. Zafra-Calvo, N., Garmendia, E., Pascual, U., Palomo, I., Gross-Camp, N., Brockington, D., Cortes-Vazquez, J.-A., Coolsaet, B., and Burgess, N.D. (2019). Progress toward Equitably Managed Protected Areas in Aichi Target 11: A Global Survey. BioScience *69*, 191–197. 10.1093/biosci/biy143.

16. Agrawal, A., and Redford, K. (2009). Conservation and Displacement: An Overview. Conserv. Soc. *7*, 1. 10.4103/0972-4923.54790.

17. Brondo, K., and Bown, N. (2011). Neoliberal conservation, garifuna territorial rights and resource management in the Cayos Cochinos marine protected area. Conserv. Soc. *9*, 91–105. 10.4103/0972-4923.83720.

18. Kamat, V.R. (2018). Dispossession and disenchantment: The micropolitics of marine conservation in southeastern Tanzania. Mar. Policy *88*, 261–268. 10.1016/j.marpol.2017.12.002.

19. Sovacool, B.K., Linnér, B.-O., and Goodsite, M.E. (2015). The political economy of climate adaptation. Nat. Clim. Change *5*, 616–618. 10.1038/nclimate2665.

20. Eriksen, S., Schipper, E.L.F., Scoville-Simonds, M., Vincent, K., Adam, H.N., Brooks, N., Harding, B., Khatri, D., Lenaerts, L., Liverman, D., et al. (2021). Adaptation interventions and their effect on vulnerability in developing countries: Help, hindrance or irrelevance? World Dev. *141*, 105383. 10.1016/j.worlddev.2020.105383.

21. Nolan, C., Delabre, I., Menga, F., and Goodman, M. (2022). Double exposure to capitalist expansion and climatic change: a study of vulnerability on the Ghanaian coastal commodity frontier. Ecol. Soc. *27*, 1. 10.5751/ES-12815-270101.

22. Barbesgaard, M. (2018). Blue growth: savior or ocean grabbing? J. Peasant Stud. *45*, 130–149. 10.1080/03066150.2017.1377186.

23. Wolff, N.H., Donner, S.D., Cao, L., Iglesias-Prieto, R., Sale, P.F., and Mumby, P.J. (2015). Global inequities between polluters and the polluted: climate change impacts on coral reefs. Glob. Change Biol. *21*, 3982–3994. 10.1111/gcb.13015.

24. Cheung, W.W.L., Lam, V.W.Y., Sarmiento, J.L., Kearney, K., Watson, R., Zeller, D., and Pauly, D. (2010). Large-scale redistribution of maximum fisheries catch potential in the global ocean under climate change. Glob. Change Biol. *16*, 24–35. 10.1111/j.1365-2486.2009.01995.x.

25. Golden, C. (2016). Fall in fish catch threatens human health. Nat. Hist. *534*, 317–320.

26. Frieler, K., Meinshausen, M., Golly, A., Mengel, M., Lebek, K., Donner, S.D., and Hoegh-Guldberg, O. (2013). Limiting global warming to 2 °C is unlikely to save most coral reefs. Nat. Clim. Change *3*, 165–170. 10.1038/nclimate1674.

27. WFFP (2015). World Fisheries Day: WFFP denounces 'false solutions' to climate change. World Forum of Fisher People (WFFP). http://worldfishers.org/2015/11/20/world-fisheries-day-wffp-denounces-false-solutions-to-climate-change/.

28. Cohen, P.J., Allison, E.H., Andrew, N.L., Cinner, J., Evans, L.S., Fabinyi, M., Garces, L.R., Hall, S.J., Hicks, C.C., Hughes, T.P., et al. (2019). Securing a Just Space for Small-Scale Fisheries in the Blue Economy. Front. Mar. Sci. *6*, 171. 10.3389/fmars.2019.00171.

29. OECD (2016). The Ocean Economy in 2030 (Organisation for Economic Co-operation and Development (OECD)).

30. Bennett, N.J., Cisneros-Montemayor, A.M., Blythe, J., Silver, J.J., Singh, G., Andrews, N., Calò, A., Christie, P., Di Franco, A., Finkbeiner, E.M., et al. (2019). Towards a sustainable and equitable blue economy. Nat. Sustain. *2*, 991–993. 10.1038/s41893-019-0404-1.

31. OECD (2020). Sustainable Ocean for All: Harnessing the Benefits of Sustainable Ocean Economies for Developing Countries (Organisation for Economic Co-operation and Development (OECD)).

32. Schuhbauer, A., Skerritt, D.J., Ebrahim, N., Le Manach, F., and Sumaila, U.R. (2020). The Global Fisheries Subsidies Divide Between Small- and Large-Scale Fisheries. Front. Mar. Sci. *7*, 539214. 10.3389/fmars.2020.539214.

33. UNEP-WCMC, IUCN, and NGS (2021). Protected Planet Live Report 2021 (UN Environment World Conservation Monitoring Centre (UNEP-WCMC) WCMC, International Union for Conservation of Nature (IUCN) and National Geographic Society (NGS)).

34. Secretariat of the CBD (2011). Aichi Target 11. Decision X/2.

35. Woodley, S., Locke, H., Laffoley, D., MacKinnon, K., Sandwith, T., and Smart, J. (2019). A review of evidence for area-based conservation targets for the post-2020 global biodiversity framework. PARKS, 31–46. 10.2305/IUCN.CH.2019.PARKS-25-2SW2.en.

36. Gurney, G.G., Darling, E.S., Ahmadia, G.N., Agostini, V.N., Ban, N.C., Blythe, J., Claudet, J., Epstein, G., Estradivari, Himes-Cornell, A., et al. (2021). Biodiversity needs every tool in the box: use OECMs. Nature *595*, 646–649. 10.1038/d41586-021-02041-4.

37. Grorud-Colvert, K., Sullivan-Stack, J., Roberts, C., Constant, V., Horta e Costa, B., Pike, E.P., Kingston, N., Laffoley, D., Sala, E., Claudet, J., et al. (2021). The MPA Guide: A framework to achieve global goals for the ocean. Science *373*, eabf0861. 10.1126/science.abf0861.

38. Baker, D., Murray, G., Kaijage, J., Levine, A., Gill, D., and Makupa, E. (2021). Relationships Matter: Assessing the Impacts of a Marine Protected Area on Human Wellbeing and Relational Values in Southern Tanzania. Front. Mar. Sci. *8*. 10.3389/fmars.2021.673045.

39. Bennett, N.J., Blythe, J., Tyler, S., and Ban, N.C. (2016). Communities and change in the anthropocene: understanding social-ecological vulnerability and planning adaptations to multiple interacting exposures. Reg. Environ. Change *16*, 907–926. 10.1007/s10113-015-0839-5.

40. Ghosh, P. (2015). Conservation And Conflicts In The Sundarban Biosphere Reserve, India. Geogr. Rev. *105*, 429–440. 10.1111/j.1931-0846.2015.12101.x.

41. Barnett, J. (2020). Global environmental change II: Political economies of vulnerability to climate change. Prog. Hum. Geogr. *44*, 1–13. 10.1177/0309132519898254.

42. Matsue, N., Daw, T., and Garrett, L. (2014). Women Fish Traders on the Kenyan Coast: Livelihoods, Bargaining Power, and Participation in Management. Coast. Manag. *42*, 531–554. 10.1080/08920753.2014.964819.

43. Barclay, J., Wilkinson, E., White, C.S., Shelton, C., Forster, J., Few, R., Lorenzoni, I., Woolhouse, G., Jowitt, C., Stone, H., et al. (2019). Historical Trajectories of Disaster Risk in Dominica. Int. J. Disaster Risk Sci. *10*, 149–165. 10.1007/s13753-019-0215-z.

44. Ajibade, I., McBean, G., and Bezner-Kerr, R. (2013). Urban flooding in Lagos, Nigeria: Patterns of vulnerability and resilience among women. Glob. Environ. Change *23*, 1714–1725. 10.1016/j.gloenvcha.2013.08.009.

45. Mahajan, S.L., and Daw, T. (2016). Perceptions of ecosystem services and benefits to human well-being from community-based marine protected areas in Kenya. Mar. Policy *74*, 108–119. 10.1016/j.marpol.2016.09.005.

46. Gustavsson, M., Lindström, L., Jiddawi, N.S., and de la Torre-Castro, M. (2014). Procedural and distributive justice in a community-based managed Marine Protected Area in Zanzibar, Tanzania. Mar. Policy *46*, 91–100. 10.1016/j.marpol.2014.01.005.

47. Rohe, J., Schlüter, A., and Ferse, S.C.A. (2018). A gender lens on women's harvesting activities and interactions with local marine governance in a South Pacific fishing community. Marit. Stud. *17*, 155–162. 10.1007/s40152-018-0106-8.

48. McDermott, M., Mahanty, S., and Schreckenberg, K. (2013). Examining equity: A multidimensional framework for assessing equity in payments for ecosystem services. Environ. Sci. Policy *33*, 416–427. 10.1016/j.envsci.2012.10.006.

49. Blythe, J., Flaherty, M., and Murray, G. (2015). Vulnerability of coastal livelihoods to shrimp farming: Insights from Mozambique. AMBIO *44*, 275–284. 10.1007/s13280-014-0574-z.

50. Thomas, K., Hardy, R.D., Lazrus, H., Mendez, M., Orlove, B., Rivera-Collazo, I., Roberts, J.T., Rockman, M., Warner, B.P., and Winthrop, R. (2019). Explaining differential vulnerability to climate change: A social science review. Wiley Interdiscip. Rev. Clim. Change *10*, 1–18. 10.1002/wcc.565.

645 51. Menezes, A., Eide, A., and Raakjær, J. (2011). Moving Out of Poverty: Conditions for
646 Wealth Creation in Small-Scale Fisheries in Mozambique. In Poverty Mosaics: Realities
647 and Prospects in Small-Scale Fisheries, S. Jentoft and A. Eide, eds. (Springer
648 Netherlands), pp. 407–426.

649 52. Cinner, J.E., Adger, W.N., Allison, E.H., Barnes, M.L., Brown, K., Cohen, P.J.,
650 Gelcich, S., Hicks, C.C., Hughes, T.P., Lau, J., et al. (2018). Building adaptive capacity
651 to climate change in tropical coastal communities. Nat. Clim. Change *8*, 117–123.
652 10.1038/s41558-017-0065-x.

653 53. D'agata, S., Darling, E.S., Gurney, G.G., McClanahan, T.R., Muthiga, N.A.,
654 Rabearisoa, A., and Maina, J.M. (2020). Multiscale determinants of social adaptive
655 capacity in small-scale fishing communities. Environ. Sci. Policy *108*, 56–66.
656 10.1016/j.envsci.2020.03.006.

657 54. Green, K.M., Selgrath, J.C., Frawley, T.H., Oestreich, W.K., Mansfield, E.J., Urteaga,
658 J., Swanson, S.S., Santana, F.N., Green, S.J., Naggea, J., et al. (2021). How adaptive
659 capacity shapes the Adapt, React, Cope response to climate impacts: insights from
660 small-scale fisheries. Clim. Change *164*, 15. 10.1007/s10584-021-02965-w.

661 55. Piggott-McKellar, A.E., McNamara, K.E., and Nunn, P.D. (2020). Who defines "good"
662 climate change adaptation and why it matters: a case study from Abaiang Island,
663 Kiribati. Reg. Environ. Change *20*, 43. 10.1007/s10113-020-01614-9.

664 56. Carpenter, S.R., Arrow, K.J., Barrett, S., Biggs, R., Brock, W.A., Crépin, A.-S.,
665 Engström, G., Folke, C., Hughes, T.P., Kautsky, N., et al. (2012). General Resilience to
666 Cope with Extreme Events. Sustainability *4*, 3248–3259. 10.3390/su4123248.

667 57. Sterling, E.J., Pascua, P., Sigouin, A., Gazit, N., Mandle, L., Betley, E., Aini, J., Albert,
668 S., Caillon, S., Caselle, J.E., et al. (2020). Creating a space for place and
669 multidimensional well-being: lessons learned from localizing the SDGs. Sustain. Sci.
670 10.1007/s11625-020-00822-w.

671 58. Fraser, N. (2009). Scales of Justice: Reimagining Political Space in a Globalizing World
672 (Columbia University Press).

673 59. Sikor, T. (2013). The Justices and Injustices of Ecosystem Services (Routledge).

674 60. Martin, A., Coolsaet, B., Corbera, E., Dawson, N.M., Fraser, J.A., Lehmann, I., and
675 Rodriguez, I. (2016). Justice and conservation: The need to incorporate recognition.
676 Biol. Conserv. *197*, 254–261. 10.1016/j.biocon.2016.03.021.

677 61. Ruano-Chamorro, C., Gurney, G.G., and Cinner, J.E. (2022). Advancing procedural
678 justice in conservation. Conserv. Lett. *15*, e12861. 10.1111/conl.12861.

679 62. Gurney, G.G., Mangubhai, S., Fox, M., Kiatkoski Kim, M., and Agrawal, A. (2021).
680 Equity in environmental governance: perceived fairness of distributional justice
681 principles in marine co-management. Environ. Sci. Policy *124*, 23–32.
682 10.1016/j.envsci.2021.05.022.

683 63. Short, R.E., Gelcich, S., Little, D.C., Micheli, F., Allison, E.H., Basurto, X., Belton, B.,
684 Brugere, C., Bush, S.R., Cao, L., et al. (2021). Harnessing the diversity of small-scale

685 actors is key to the future of aquatic food systems. Nat. Food *2*, 733–741.
686 10.1038/s43016-021-00363-0.

687 64. Turner, R.A., Addison, J., Arias, A., Bergseth, B.J., Marshall, N.A., Morrison, T.H., and
688 Tobin, R.C. (2016). Trust, confidence, and equity affect the legitimacy of natural
689 resource governance. Ecol. Soc. *21*. 10.5751/ES-08542-210318.

690 65. Mascia, M.B. (2017). A novel framework for analyzing conservation impacts:
691 evaluation, theory, and marine protected areas. Ann. N. Y. Acad. Sci. *1399*, 93–115.
692 10.1111/nyas.13428.

693 66. Kaplan-Hallam, M., and Bennett, N.J. (2018). Adaptive social impact management for
694 conservation and environmental management. Conserv. Biol. *32*, 304–314.
695 10.1111/cobi.12985.

696 67. Monfort, M.C. (2015). The role of women in the seafood industry (Food & Agriculture
697 Organisation (FAO)).

698 68. FAO (2018). Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in
699 the Context of Food Security and Poverty Eradication (Food and Agriculture
700 Organization of the United Nations (FAO)).

701 69. UNEPFI (2022). The Sustainable Blue Economy Finance Principles. UN Environment
702 Programme Finance Initiative (UNEPFI). https://www.unepfi.org/blue-finance/the-
703 principles/.

704 70. Blythe, J.L. (2015). Resilience and social thresholds in small-scale fishing communities.
705 Sustain. Sci. *10*, 157–165. 10.1007/s11625-014-0253-9.

706 71. Thiault, L., Gelcich, S., Cinner, J.E., Tapia-Lewin, S., Chlous, F., and Claudet, J.
707 (2019). Generic and specific facets of vulnerability for analysing trade-offs and
708 synergies in natural resource management. People Nat. *1*, 573–589.
709 10.1002/pan3.10056.

710 72. Walker, B., and Westley, F. (2011). Perspectives on Resilience to Disasters across
711 Sectors and Cultures. Ecol. Soc. *16*, 4.

712 73. McConney, P., Cox, S.-A., and Parsram, K. (2015). Building food security and
713 resilience into fisheries governance in the Eastern Caribbean. Reg. Environ. Change *15*,
714 1355–1365. 10.1007/s10113-014-0703-z.

715 74. Blythe, J., Silver, J., Evans, L., Armitage, D., Bennett, N.J., Moore, M.-L., Morrison,
716 T.H., and Brown, K. (2018). The Dark Side of Transformation: Latent Risks in
717 Contemporary Sustainability Discourse. Antipode *50*, 1206–1223.
718 https://doi.org/10.1111/anti.12405.

719 75. Thiault, L., Gelcich, S., Marshall, N., Marshall, P., Chlous, F., and Claudet, J. (2019).
720 Operationalizing vulnerability for social–ecological integration in conservation and
721 natural resource management. Conserv. Lett. 10.1111/conl.12677.

722 76. Biggs, R., Schlüter, M., Biggs, D., Bohensky, E.L., BurnSilver, S., Cundill, G., Dakos,
723 V., Daw, T.M., Evans, L.S., Kotschy, K., et al. (2012). Toward Principles for Enhancing

724 the Resilience of Ecosystem Services. Annu. Rev. Environ. Resour. *37*, 421–448.
725 10.1146/annurev-environ-051211-123836.

726 77. Walker, B.H., Carpenter, S.R., Rockstrom, J., Crépin, A.-S., and Peterson, G.D. (2012).
727 Drivers, "Slow" Variables, "Fast" Variables, Shocks, and Resilience. Ecol. Soc. *17*, 30.

728 78. Büscher, B., Sullivan, S., Neves, K., Igoe, J., and Brockington, D. (2012). Towards a
729 Synthesized Critique of Neoliberal Biodiversity Conservation. Capital. Nat. Social. *23*,
730 4–30. 10.1080/10455752.2012.674149.

731 79. Forster, J., Turner, R.A., Fitzsimmons, C., Peterson, A.M., Mahon, R., and Stead, S.M.
732 (2017). Evidence of a common understanding of proximate and distal drivers of reef
733 health. Mar. Policy *84*, 263–272. 10.1016/j.marpol.2017.07.017.

734 80. Hickel, J. (2017). The Divide: A Brief Guide to Global Inequality and its Solutions
735 (Penguin Random House UK).

736 81. Jenkins, A., Jupiter, S.D., Capon, A., Horwitz, P., and Negin, J. (2020). Nested ecology
737 and emergence in pandemics. Lancet Planet. Health *4*, e302–e303. 10.1016/S2542-
738 5196(20)30165-0.

739 82. MacNeill, T. (2015). Development as Imperialism: Power and the Perpetuation of
740 Poverty in Afro-Indigenous Communities of Coastal Honduras. Humanity Soc. *41*, 1–
741 31. 10.1177/0160597615603748.

742 83. Raycraft, J. (2019). Conserving Poverty: Destructive Fishing Gear Use in a Tanzanian
743 Marine Protected Area. Conserv. Soc. *17*, 297–309. 10.4103/cs.cs_18_53.

744 84. Morrison, T.H., Adger, N., Barnett, J., Brown, K., Possingham, H., and Hughes, T.
745 (2020). Advancing Coral Reef Governance into the Anthropocene. One Earth *2*, 64–74.
746 10.1016/j.oneear.2019.12.014.

747 85. Hull, V., and Liu, J. (2018). Telecoupling: A new frontier for global sustainability. Ecol.
748 Soc. *23*, 41. 10.5751/ES-10494-230441.

749 86. Brodie Rudolph, T., Ruckelshaus, M., Swilling, M., Allison, E.H., Österblom, H.,
750 Gelcich, S., and Mbatha, P. (2020). A transition to sustainable ocean governance. Nat.
751 Commun. *11*, 3600. 10.1038/s41467-020-17410-2.

752 87. Beymer-Farris, B., Bassett, T., and Bryceson, I. (2012). Resilience in the Cultural
753 Landscape (Cambridge University Press Cambridge).

754 88. Brown, K., and Westaway, E. (2011). Agency, Capacity, and Resilience to
755 Environmental Change: Lessons from Human Development, Well-Being, and Disasters.
756 Annu. Rev. Environ. Resour. *36*, 321–342. 10.1146/annurev-environ-052610-092905.

757 89. Clifton, J., and Foale, S. (2017). Extracting ideology from policy: Analysing the social
758 construction of conservation priorities in the Coral Triangle region. Mar. Policy *82*,
759 189–196. 10.1016/j.marpol.2017.03.018.

90. Galaz, V., Crona, B., Dauriach, A., Jouffray, J.-B., Österblom, H., and Fichtner, J. (2018). Tax havens and global environmental degradation. Nat. Ecol. Evol. *2*, 1352–1357. 10.1038/s41559-018-0497-3.

91. UNDP (2017). Institutional and Coordination Mechanisms: Guidance Note on Facilitating Integration and Coherence for SDG Implementation (United Nations Development Programme (UNDP)).

92. Andres, L., and Round, J. (2015). The Role of 'Persistent Resilience' within Everyday Life and Polity: Households Coping with Marginality within the 'Big Society.' Environ. Plan. Econ. Space *47*, 676–690. 10.1068/a46299.

93. Cameron, E.S. (2012). Securing Indigenous politics: A critique of the vulnerability and adaptation approach to the human dimensions of climate change in the Canadian Arctic. Glob. Environ. Change *22*, 103–114. 10.1016/j.gloenvcha.2011.11.004.

94. Cretney, R., and Bond, S. (2014). 'Bouncing back' to capitalism? Grass-roots autonomous activism in shaping discourses of resilience and transformation following disaster. Resilience *2*, 18–31. 10.1080/21693293.2013.872449.

95. Klein, N. (2015). This changes everything: Capitalism vs. the climate (Simon and Schuster).

96. Walker, B.L.E., López-Carr, D., Chen, C., and Currier, K. (2014). Perceptions of environmental change in Moorea, French Polynesia: the importance of temporal, spatial, and scalar contexts. GeoJournal *79*, 705–719. 10.1007/s10708-014-9548-8.

97. Cumberbatch, J., Drakes, C., Mackey, T., Nagdee, M., Wood, J., Degia, A.K., and Hinds, C. (2020). Social Vulnerability Index: Barbados – A Case Study. Coast. Manag. *48*, 505–526. 10.1080/08920753.2020.1796193.

98. Gray, S.R.J., Gagnon, A.S., Gray, S.A., O'Dwyer, B., O'Mahony, C., Muir, D., Devoy, R.J.N., Falaleeva, M., and Gault, J. (2014). Are coastal managers detecting the problem? Assessing stakeholder perception of climate vulnerability using Fuzzy Cognitive Mapping. Ocean Coast. Manag. *94*, 74–89. 10.1016/j.ocecoaman.2013.11.008.

99. Thiault, L., Marshall, P., Gelcich, S., Collin, A., Chlous, F., and Claudet, J. (2018). Space and time matter in social-ecological vulnerability assessments. Mar. Policy *88*, 213–221. 10.1016/j.marpol.2017.11.027.

100. Thiault, L., Jupiter, S.D., Johnson, J.E., Cinner, J.E., Jarvis, R.M., Heron, S.F., Maina, J.M., Marshall, N.A., Marshall, P.A., and Claudet, J. (2021). Harnessing the potential of vulnerability assessments for managing social-ecological systems. Ecol. Soc. *26*, 1. https://doi.org/10.5751/ES-12167-260201.

101. Anthony, K.R.N., Helmstedt, K.J., Bay, L.K., Fidelman, P., Hussey, K.E., Lundgren, P., Mead, D., McLeod, I.M., Mumby, P.J., Newlands, M., et al. (2020). Interventions to help coral reefs under global change—A complex decision challenge. PLOS ONE *15*, e0236399. 10.1371/journal.pone.0236399.

102. Whitney, C., Frid, A., Edgar, B., Walkus, J., Siwallace, P., Siwallace, I., and Ban, N. (2020). “Like the plains people losing the buffalo”: perceptions of climate change impacts, fisheries management, and adaptation actions by Indigenous peoples in coastal British Columbia, Canada. Ecol. Soc. *25*. 10.5751/ES-12027-250433.

103. Mahajan, S.L., Glew, L., Ryan, M., Griffin, J., Murphy, R., Petersen de Villiers, S., and Rieder, E. (2022). The Craft of Systems Change: Practical Tools for a Complex World (World Wildlife Fund).

104. Barnett, J., and O’Neill, S. (2010). Maladaptation. Glob. Environ. Change *20*, 211–213. https://doi.org/10.1016/j.gloenvcha.2009.11.004.

105. Eriksson, H., Blythe, J., Österblom, H., and Olsson, P. (2021). Beyond social-ecological traps: fostering transformations towards sustainability. Ecol. Soc. *26*. 10.5751/ES-12198-260113.

106. Baker, D., Murray, G., and Agyare, A.K. (2018). Governance and the making and breaking of social-ecological traps. Ecol. Soc. *23*. 10.5751/ES-09992-230138.

107. Naylor, A., Ford, J., Pearce, T., and Van Alstine, J. (2020). Conceptualizing Climate Vulnerability in Complex Adaptive Systems. One Earth *2*, 444–454. 10.1016/j.oneear.2020.04.011.

108. Fabinyi, M., Evans, L., and Foale, S.J. (2014). Social-ecological systems, social diversity, and power: insights from anthropology and political ecology. Ecol. Soc. *19*, 28. 10.5751/ES-07029-190428.

109. Mahajan, S.L., Glew, L., Rieder, E., Ahmadia, G., Darling, E., Fox, H.E., Mascia, M.B., and McKinnon, M. (2019). Systems thinking for planning and evaluating conservation interventions. Conserv. Sci. Pract., e44. 10.1111/csp2.44.

110. Kelly, R.A., Jakeman, A.J., Barreteau, O., Borsuk, M.E., ElSawah, S., Hamilton, S.H., Henriksen, H.J., Kuikka, S., Maier, H.R., Rizzoli, A.E., et al. (2013). Selecting among five common modelling approaches for integrated environmental assessment and management. Environ. Model. Softw. *47*, 159–181.

111. Hovmand, P.S. (2014). Group Model Building and Community-Based System Dynamics Process. In Community Based System Dynamics, P. S. Hovmand, ed. (Springer), pp. 17–30. 10.1007/978-1-4614-8763-0_2.

112. Barbier, E.B., and Burgess, J.C. (2020). Sustainability and development after COVID-19. World Dev. *135*, 105082. 10.1016/j.worlddev.2020.105082.

113. Daw, T.M., Coulthard, S., Cheung, W.W.L., Brown, K., Abunge, C., Galafassi, D., Peterson, G.D., McClanahan, T.R., Omukoto, J.O., and Munyi, L. (2015). Evaluating taboo trade-offs in ecosystems services and human well-being. Proc. Natl. Acad. Sci. *112*, 6949–6954. 10.1073/pnas.1414900112.

114. Claudet, J., Bopp, L., Cheung, W.W.L., Devillers, R., Escobar-Briones, E., Haugan, P., Heymans, J.J., Masson-Delmotte, V., Matz-Lück, N., Miloslavich, P., et al. (2020). A Roadmap for Using the UN Decade of Ocean Science for Sustainable Development in

Support of Science, Policy, and Action. One Earth *2*, 34–42. 10.1016/j.oneear.2019.10.012.

115. Purwanto, Andradi-Brown, D.A., Matualage, D., Rumengan, I., Awaludinnoer, Pada, D., Hidayat, N.I., Amkieltiela, Fox, H.E., Fox, M., et al. (2021). The Bird's Head Seascape Marine Protected Area network—Preventing biodiversity and ecosystem service loss amidst rapid change in Papua, Indonesia. Conserv. Sci. Pract. *3*, e393. https://doi.org/10.1111/csp2.393.

116. Naggea, J., and Miller, R.M. (in press). A comparative case study of multistakeholder responses following oil spills in Pointe d'Esny, Mauritius, and Huntington Beach, California. Ecol. Soc.

117. Reyers, B., and Selig, E.R. (2020). Global targets that reveal the social–ecological interdependencies of sustainable development. Nat. Ecol. Evol. *4*, 1011–1019. 10.1038/s41559-020-1230-6.

118. Stafford-Smith, M., Griggs, D., Gaffney, O., Ullah, F., Reyers, B., Kanie, N., Stigson, B., Shrivastava, P., Leach, M., and O'Connell, D. (2017). Integration: the key to implementing the Sustainable Development Goals. Sustain. Sci. *12*, 911–919. 10.1007/s11625-016-0383-3.

119. McShane, T.O., Hirsch, P.D., Trung, T.C., Songorwa, A.N., Kinzig, A., Monteferri, B., Mutekanga, D., Thang, H.V., Dammert, J.L., Pulgar-Vidal, M., et al. (2011). Hard choices: Making trade-offs between biodiversity conservation and human well-being. Biol. Conserv. *144*, 966–972. 10.1016/j.biocon.2010.04.038.

120. Morrison, T.H., Adger, W.N., Brown, K., Hettiarachchi, M., Huchery, C., Lemos, M.C., and Hughes, T.P. (2020). Political dynamics and governance of World Heritage ecosystems. Nat. Sustain. *3*, 947–955. 10.1038/s41893-020-0568-8.

121. DFO (2019). Government of Canada signs historic reconciliation agreement with B.C. Coastal First Nations. Dep. Fish. Oceans DFO Can. https://www.canada.ca/en/fisheries-oceans/news/2019/07/government-of-canada-signs-historic-reconciliation-agreement-with-bc-coastal-first-nations.html.

122. Viglione, G. (2020). Climate lawsuits are breaking new legal ground to protect the planet. Nature *579*, 184–185. 10.1038/d41586-020-00175-5.

123. Iorns Magallanes, C.J. (2008). Reparations for Maori Grievances in Aotearoa/New Zealand. In Reparations for Indigenous Peoples: International and Comparative Perspectives, F. Lenzerini, ed. (Oxford University Press), pp. 523–566.

124. Dietsch, A.M., Wald, D.M., Stern, M.J., and Tully, B. (2021). An understanding of trust, identity, and power can enhance equitable and resilient conservation partnerships and processes. Conserv. Sci. Pract. *3*, e421. 10.1111/csp2.421.

125. Berkley, J., and Beratan, K. (2021). Capturing practitioners' "how-to" knowledge in the form of recommendations for more effective planning of collaborative adaptive management projects. Ecol. Soc. *26*. 10.5751/ES-12840-260424.

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Figure Legends

Figure 1 title: Figure 1. Transformative strategies to reduce negative triple exposure impacts by prioritizing social justice and building general resilience.

Figure 1 caption: Strategies can be jointly applied to reduce triple exposure. For example, implementors can employ participatory systems approaches to identify root causes of vulnerability and inequality, potential impacts of future initiatives, and identify appropriate solutions to address root causes and avoid maladaptive/inequitable outcomes. Developing and leveraging inclusive cross-scale and cross-sectoral partnerships can facilitate implementing these participatory approaches by improving diversity, recognition, and integration in planning, and increasing capacity and coordination for implementation. See Figure S1 for additional information on linkages between strategies.

Box 1: Triple Exposure case studies where historical & current injustices hindered, or were exacerbated by, the implementation of coastal initiatives. See Supplemental Notes S1-S6 for additional case information and references.

1 North Coast of British Columbia, Canada

For Indigenous communities and local stakeholders already experiencing climate food security impacts, effective engagement in collaborative marine planning has been hindered by historical distrust and marginalization, including decades of colonization, and conflicts regarding unsustainable, externally-driven development such as oil and gas pipelines

2 Aboadze, Ghana (Nolan et al (2022))

Efforts to improve climate resilience and economic development (e.g., seawall and power plant construction) have further compromised the adaptive capacity of poor residents by increasing sanitation risks, rent prices, and reduced land available for farming.

3 Bay Islands, Honduras

Pre-existing social and economic inequalities resulted in tourists and local elites receiving more benefits from various conservation and development programs to the detriment of indigenous groups. These groups are also experiencing considerable social, cultural, and environmental impacts from climate change and unsustainable coastal tourism development.

4 West Coast, Barbados

The establishment of an MPA without the collaboration of local fishers has contributed to decades of resentment and distrust of government officials, hindering subsequent conservation efforts for coral reefs that are heavily impacted by climate change and coastal development.

5 Andaman Coast, Thailand

Small-scale fishers experienced exclusion from a system of MPAs created without their input and from aquaculture development in mangrove areas. These individuals already face resource competition from illegal and destructive fishing practices from industrial fleets and aquaculture feed collectors.

6 Mnazi Bay-Ruvuma Estuary Marine Park

After decades of social and economic marginalization including prioritizing conservation and development programming over local access rights, many local community members have been displaced, dispossessed, and even killed in conflicts over both offshore gas development and marine park management.

Box 2: Examples of implementing transformative strategies that prioritize social justice and resilience building to address triple exposure and root causes. See Supplemental Notes S7-S11 for additional case information and references.

1 Marine Plan Partnership, British Columbia, Canada

A partnership between 17 First Nations and the provincial government is co-leading the development and implementation of plans for current and future marine uses, thereby promoting greater recognition and coordination in marine planning, including recognizing each other's authority and jurisdiction.

2 Watershed Interventions for Systems Health (WISH), Fiji

A cross-scale, cross-sectoral collaboration took an inclusive systems approach to watershed management to identify culturally appropriate solutions that simultaneously address impacts from

climate, development, and poorly planned conservation, applying mechanisms to improve local self-determination and the inclusion of key groups, such as women, in decision-making.

3 Advancing community-led conservation, Madagascar

A group of conservation NGOs convened a multi-stakeholder dialogue and used participatory systems tools to facilitate honest discussion on root challenges facing community-led approaches to conservation and to advance towards a shared vision of the future.

4 Strategic conservation and development partnership, Mozambique

A strategic partnership between a conservation and development organization prioritizes integrated programming that centers rightsholders' leadership and social-ecological resilience, investing in collaborative and adaptive monitoring, evaluation, and learning, including evaluating the disaggregated impacts on women and men.

5 Strategizing for integrated health and conservation challenges, Global

Using tools inspired by systems thinking, a group of conservationists and 50+ stakeholders from across different sectors and countries built consensus regarding paths forward for conservationists and the global health community to collaboratively reduce the risk of future zoonotic disease spillover and future pandemics.