

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 drivers of global change: climate change, economic development, and the expansion of area-based conservation, leading to a scenario we refer to as ‘triple exposure’. Despite efforts to maximize social benefits from coastal initiatives, externally driven processes can sometimes converge to amplify vulnerabilities and inequalities. Pre-existing social injustices increase the sensitivity of affected individuals to social, environmental, and policy change, and limit their capacity to adapt to, or benefit from, the interacting impacts of triple exposure. Beyond recognizing triple exposure, we argue that external implementing agencies cannot effectively and equitably achieve climate, economic, and conservation goals without prioritizing social justice and building general resilience. To advance this justice and resilience orientation, we recommend that climate, development, and conservation actors: 1) address root causes of vulnerability, namely pre-existing social injustices; 2) use participatory systems approaches to improve understanding of the local context and potential (un)intended consequences of proposed initiatives, and; 3) develop and leverage inclusive partnerships between diverse actors to facilitate the collaborative design and implementation of identified strategies. In a world of rapid change, these strategies—applied together, and adapted to the local context—offer an opportunity to develop coastal initiatives that support wellbeing, justice, and resilience within coastal populations.

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

Author contributions: DG, JB, and NB developed the main conceptual ideas for the paper with critical input from LE, KB, RT, and NCB. SJ, SM, SM, NB, CW, NCB, JN, RT, DB, and DG provided information from case studies for this work. NL, VB, and JB developed the figures and maps. DG, JB, NB, LE, KB, and RT led the writing of the manuscript with input from all authors who provided critical feedback to shape the current manuscript.

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1 Introduction

2 Twenty years ago, O'Brien and Leichenko ¹ challenged us to consider the impacts of climate
3 change and globalization simultaneously rather than in isolation. In their influential paper, they
4 introduced the concept of 'double exposure' as a framework for examining the cumulative
5 impacts of the two exposures. Critically, they argued that the complex interactions between
6 climate change and globalization would create new, and uneven, vulnerabilities across regions,
7 sectors, ecosystems, and social groups. Their 'double exposure' framework highlighted the
8 need to examine how these interacting exposures produce novel sets of impacts, often
9 exacerbating marginalization and inequality. Today, the 'double exposure' framework remains
10 highly relevant, particularly for coastal communities.

11
12 Both climate change and globalization continue to accelerate in marine and coastal systems.
13 Unprecedented changes in the physical and chemical properties of the ocean are changing
14 seasonality and abundance of oceanic and coastal organisms ². For example, marine heat waves
15 have doubled in frequency over the 20th century, leading to more extreme tropical storms and
16 recurrent mass coral bleaching events, threatening sensitive marine ecosystems and the lives
17 and livelihoods of billions of people ³. Similarly, increased economic development in the
18 oceans from increased international trade, foreign investment, and interest from transnational
19 corporations (termed 'blue growth') is re-shaping local marine resource extraction and
20 consumption, biodiversity loss, and patterns of inequality globally ^{4,5} with revenues
21 increasingly concentrated in the hands of a few corporate actors ⁶.

22
23 Since the publication of the 'double exposure' framework, a third important driver of change
24 has emerged for coastal communities. The rapid expansion of area-based marine conservation
25 is producing radical policy change in biodiverse locations in less economically-developed
26 regions. In particular, the global coverage of marine protected areas (MPAs) has increased 15-
27 fold within the last two decades ^{7,8}. Additionally, area-based conservation targets are likely to
28 increase to 30% by the year 2030 ('30 x 30 target') when the Post-2020 Global Biodiversity
29 Framework is adopted by the Parties to the Convention on Biological Diversity ⁹. While several
30 marine conservation initiatives have slowed biodiversity loss and improved the well-being of
31 many ¹⁰⁻¹², others are ineffectively and inequitably managed ¹³⁻¹⁵ and have harmed local people
32 through displacement, increased inequality, violence, and human rights abuses ¹⁶⁻¹⁸.
33 Regardless of impact, the adoption and implementation of the 30 x 30 target will transform
34 marine resource access and use on a staggering scale.

35
36 In this paper, we build on O'Brien and Leichenko ¹ to include area-based marine conservation
37 as a third exposure that is interacting with climate change and blue growth to produce novel
38 impacts in coastal communities¹. In doing so, we propose 'triple exposure' as a framework to
39 examine the cumulative and differential impacts of these three global exposures in coastal
40 communities. We identify climate change, blue growth, and area-based conservation as
41 'exposures' based on their shared characteristics. We argue that in most cases they represent
42 rapidly advancing, high impact, externally-driven, global change processes over which many
43 communities have limited influence. This also encompasses the increasing number of
44 externally-driven climate initiatives that seek to achieve climate adaptation and mitigation
45 through biodiversity conservation or economic development (e.g., blue carbon initiatives).
46 Although these exposures can produce tangible benefits for coastal communities (e.g.,

¹ Acknowledging the literature on the challenges associated with defining community (Agrawal et al. 1997), we use the term coastal communities to mean groups whose way of life, cultural identity, livelihoods, and food security are inextricably connected to the ocean.

47 increased resilience, poverty reduction, species recovery), many cases exist where they have
48 unintentionally increased, rather than reduced, inequality and vulnerabilities^{4,16,19,20}. Yet,
49 research on the differential and novel impacts of these interacting exposures on coastal
50 communities is limited^{5,12,21}.

51
52 Recognising the significant knowledge gaps and implications for those on the frontlines of
53 these three accelerating exposures^{2,22}, this paper examines the cumulative and differential
54 impacts of triple exposure on coastal communities, and the implications for the design and
55 implementation of climate, development, and area-based conservation initiatives (hereafter
56 termed coastal initiatives). We first describe the ‘triple exposure’ framework in more detail to
57 justify our focus on these three exposures within a suite of multiple interacting exposures. We
58 then examine factors that shape differential vulnerability to triple exposure, demonstrating how
59 current and historical inequalities can undermine the successful and equitable implementation
60 of coastal initiatives. Finally, we propose promoting social justice and building general
61 resilience as two mutually-reinforcing principles to minimize the negative impacts of ‘triple
62 exposure’ in coastal populations, and provide tangible, transformational strategies to advance
63 them.

64

65 **Coastal communities at the ‘triple exposure’ frontier**

66 Climate change is recognized as a key and growing driver of vulnerability in coastal
67 communities², disproportionately impacting marine ecosystems and resource-dependent
68 populations in less economically-developed regions^{2,3,23}. For example, ocean warming is
69 predicted to result in severe food and nutritional security consequences in the tropics, with
70 potential losses of up to 40% in marine capture fisheries and over 80% of sensitive ecosystems
71 such as coral reefs^{24–26}. At the same time, climate adaptation and mitigation initiatives can also
72 exacerbate vulnerability and inequality within coastal communities^{19,20}. Cases exist where
73 coastal infrastructure aimed at protecting against sea-level rise and coastal storms impeded
74 important hydrological processes, resulting in increased vulnerability to flooding,
75 environmental damage, and sanitation risk^{19,21}. Elsewhere, externally driven “blue carbon”
76 initiatives have also been said to undermine local rights and livelihoods²⁷.

77

78 Many coastal areas are being framed as “prime for development” or “uncommodified spaces”
79 by national and foreign actors seeking to advance their economic interests under the emerging
80 ‘blue economy’ or ‘blue growth’ agendas^{4,21,28}. Blue growth can result in powerful economic
81 actors controlling where and how marine resources are used, conserved, and managed (WFFP
82 2014, p. 3 as cited in Barbesgaard²²). These actors are seeking to capitalize on a blue economy
83 that is expected to grow to \$3 trillion per annum by 2030^{5,29}. Focal areas then become hubs
84 for externally-driven investment, including in industrial fisheries, aquaculture, shipping,
85 tourism, and renewable energy. In some cases, external economic investment is contributing
86 to lost access due to appropriation of coastal resources by foreign actors, as well as extensive
87 resource extraction and associated environmental degradation^{4,30,31}. For example,
88 technological advances and national “investments” in marine capture fisheries in the form of
89 over \$25 billion in annual subsidies have led many wealthy countries to exploit fishing areas
90 in less wealthy nations, further depleting dwindling, often climate-sensitive, fish stocks
91 important to small-scale fisheries^{21,32}.

92

93 The global expansion of area-based conservation is a third exposure, which restructures how
94 people around the world can access, interact with, and benefit from the ocean. With over 27
95 million km² or 7.8% of the ocean currently within MPAs, area-based conservation is arguably
96 the most prolific biodiversity conservation tool used in the ocean today, and its application is

97 accelerating ⁹. Notably, many coastal areas such as those in the Global South are major
 98 conservation priorities given their high biodiversity value ^{33,34}, with the majority of the world's
 99 16,500 MPAs located within nearshore waters ⁹. Numerous cases exist where externally
 100 conceived and poorly implemented conservation initiatives have failed to recognize local
 101 voices and rights, leading to increased vulnerability and inequality through conflict,
 102 disenfranchisement, and lost access to key resources (e.g., ^{17,18,35}).

103

104 Based on climate predictions, and current conservation and development discourses and
 105 targets, the expected impacts of climate change, blue growth, and area-based conservation will
 106 likely be immense, global in extent, and continue to rapidly accelerate ^{2,5,36}. While these three
 107 exposures are not the only challenges facing coastal communities, they are three of the most
 108 significant externally-driven and interacting global change processes transforming ocean
 109 environments, economies, and governance at an unprecedented scale. They are also producing
 110 high and varied impacts on groups and communities that are already dealing with other
 111 exposures and inequitable social structures ³⁷. Importantly, these three exposures do not operate
 112 in isolation but interact to create novel and differential impacts. For example, in the Sundarban
 113 Biosphere Reserve in India, efforts to conserve critical species and habitats in light of climate
 114 impacts and local threats include restricting access to large areas within the wetland ³⁸.
 115 However, for groups directly dependent on fisheries resources subject to ongoing
 116 marginalization and repeated climate shocks, the seizure of assets, restricted fishing access
 117 based on ethnicity, and abuse from enforcement staff have severely compromised their
 118 wellbeing, increasing their vulnerability to economic exploitation and future climate shocks
 119 (See other examples in Box 1).

120

121 **Differential vulnerabilities to ‘triple exposure’**

122 Differences in vulnerabilities to, and impacts of, interacting exposures often result from
 123 inequitable institutional structures, policies, and cultural norms ³⁹. Triple exposure can
 124 reinforce these entrenched inequalities, exacerbate vulnerability, and undermine the success of
 125 coastal initiatives.

126

127 Current and historical injustices and inequalities, including colonialism, power imbalances,
 128 inequitable policies, corruption, and gender norms, create and reinforce social structures and
 129 hierarchies that marginalize select coastal communities and individuals within them ^{40,41}. For
 130 example, gendered processes or roles can often explain why women are more likely to be
 131 impacted by disasters ⁴², excluded from decision-making ⁴³, or restricted in accessing marine
 132 resources after project implementation ^{19,44,45}. As the Sundarban case illustrates, individual
 133 sensitivity to triple exposure is not only shaped by factors such as resource dependency but
 134 also by inequalities associated with gender, race, education level, economic status, and
 135 religious or ethnic identity ^{37,44,46-48}.

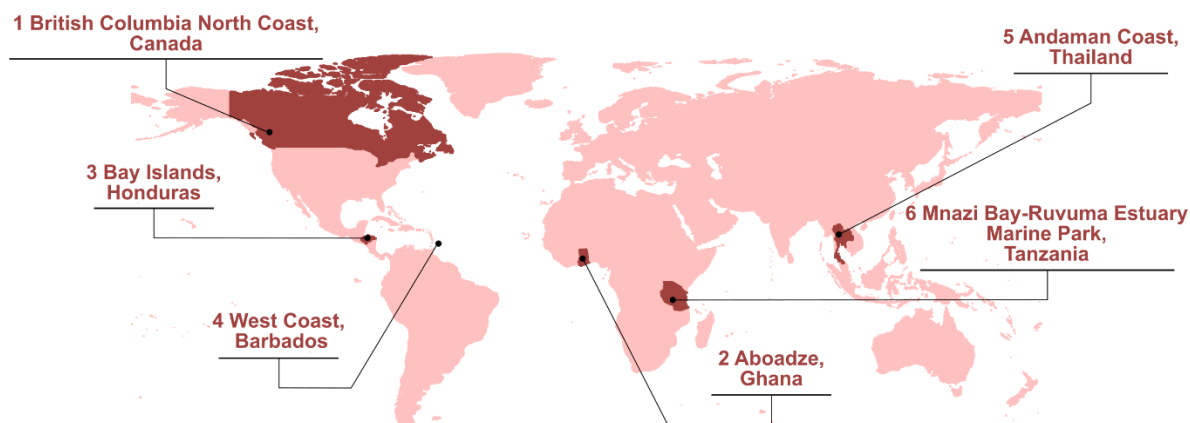
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137 For groups subject to marginalization, historical injustices and contextual inequalities can also
 138 hinder their ability to adapt to negative shocks from triple exposure (Box 1). In many coastal
 139 communities, access to resources or services (e.g., credit, healthcare, infrastructure, insurance),
 140 capabilities (e.g., education, language, occupational diversity, capacity to self-organize),
 141 power, institutions, and learning mechanisms are often limited and highly variable ⁴⁹. This
 142 severely limits their ability to prepare for, adapt to, or recover from stressors or shocks (i.e.,
 143 adaptive capacity) ^{48,50-52}. This limited access is often a product of long-standing social or
 144 economic policies of marginalization, or social or cultural norms that accept and reinforce
 145 inequalities and injustice. Triple exposure interacts with these reinforced structures and norms
 146 to further increase susceptibility of groups subject to marginalization to future shocks,

147 exacerbating existing inequalities and vulnerabilities (Box 1). For example, in Aboadze,
 148 Ghana, increased coastal development associated with blue growth forced poorer individuals
 149 to live in exposed low-lying areas vulnerable to sea-level rise and reduced the farmland
 150 available to adapt to drought conditions ²¹ (Box 1 – Ghana case). In the same case, competition
 151 with foreign industrial fishing fleets led many to resort to unsustainable fishing practices to
 152 make up for lost catch (e.g., dynamite fishing), compromising the integrity of the ecosystems
 153 they rely on.

154

155 **Box 1. Triple Exposure case studies where historical & current injustices hindered, or were exacerbated**
 156 **by, the implementation of coastal initiatives. See Supplementary Material for additional case information**
 157 **and references. Ghana case from Nolan et al ²¹.**



1 British Columbia North Coast, 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. sea wall 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 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, Tanzania

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.

158

159 Social and economic marginalization can also limit one's ability to benefit from coastal
 160 initiatives. Differences in access and power between implementers and affected individuals can
 161 result in policies and initiatives that are designed by, and deliver disproportionate benefits to,
 162 external actors or local elites, further disenfranchising communities and individuals subject to
 163 marginalization ^{19,28,49}. For example, while conservation and related economic opportunities
 164 can benefit local resource users through improved marine ecosystem health, those benefits only
 165 accrue to those with the ability to use or access them ¹². Thus benefits often flow to select actors

166 (e.g., local elites, large commercial operators) with greater influence in conservation design
 167 and rule-making or the capacity to capitalize on benefits (e.g., ^{17,43,45}). Gustavsson et al. ⁴⁴
 168 describe how a conservation and tourism development project in Zanzibar resulted in increased
 169 economic activity, yet local people were relegated to low-paying jobs, due to language and
 170 cultural barriers, with higher-paying jobs going to non-locals. Further, female seaweed farmers,
 171 who lacked a voice in decision-making fora, were displaced from their farms.

172

173 **Transformational strategies**

174 To meaningfully mitigate negative impacts from triple exposure and avoid maladaptive and
 175 inequitable responses, we argue that a radical reorientation of climate, blue economy, and area-
 176 based conservation policy and practice is required. The cases above and other research show
 177 that efforts to make coastal initiatives more effective and equitable through integrative
 178 approaches (e.g., integrated conservation and development, nature-based solutions to climate
 179 change, integrated ocean management, etc.) and attempts to mitigate social costs (e.g., “do no
 180 harm” policies, alternative livelihood programs, etc.), may not translate well in practice
 181 ^{17,19,27,53}. To address this gap, we argue two principles are key. First, prioritizing social justice
 182 needs to be a foundational principle through which these initiatives are designed and
 183 implemented. Second, implementers should prioritize building general resilience given the
 184 uncertainty surrounding triple exposure as it interacts with other endogenous and exogenous
 185 drivers of change. Here general resilience is defined as the capacity of a social-ecological
 186 system to adapt or transform in response to a range of disturbances ⁵⁴. It contrasts with specific
 187 resilience as the capacity to respond to a particular type of disturbance, such as sea-level rise
 188 or protected area access restrictions.

189

190 In this section, we outline what social justice and general resilience offer as foundational
 191 principles. We then propose three key strategies that implementors of coastal initiatives can
 192 use to operationalise these principles: 1) identifying and addressing root causes of vulnerability
 193 and inequality; 2) using participatory systems approaches to identify these root causes and
 194 pathways towards building general resilience; and 3) developing and leveraging community-
 195 centered, cross-scale and cross-sectoral partnerships between diverse actors to facilitate the
 196 collaborative design and implementation of identified solutions (Fig 1). These strategies are
 197 not exhaustive or mutually exclusive. They are also not intended to be prescriptive,
 198 acknowledging the agency and diversity of worldviews, knowledge systems, values, and
 199 priorities within coastal communities ⁵⁵. Nonetheless, these principles and strategies (outlined
 200 below) —applied together and adapted to the local context—offer an opportunity to advance
 201 current practice and research at the nexus of climate, development, and conservation sectors
 202 towards more just and effective solutions.

203

204 *Principle 1: Prioritizing social justice*

205 Prioritizing social justice—the right or fair treatment of all people—requires attention to three
 206 of its key dimensions: recognition, procedure, and distribution ^{30,56,57}. Recognitional justice
 207 involves identifying, recognizing, and acknowledging the rights, needs, livelihoods,
 208 knowledge systems, worldviews, and values of different societal groups ⁵⁸. This is especially
 209 important for groups that are marginalized within dominant governance systems and
 210 management processes. Recognition is increasingly acknowledged as underpinning the other two
 211 key justice dimensions ⁵⁹, where the recognition of all rights-holders and stakeholders and their
 212 diverse identities and values is a key first step to prioritizing justice. For example, this means
 213 properly considering the nutritional, economic, and cultural dependence on aquatic foods of
 214 current and future generations in coastal areas when proposing conservation activities that
 215 restrict access to marine resources ⁶⁰.

216

217 Second, prioritizing procedural justice involves the active participation and leadership of all
 218 relevant coastal rights-holders and stakeholders in decision-making to identify local people's
 219 preferences and goals, key risks for various groups, and context-appropriate solutions that do
 220 not exacerbate existing vulnerability and inequalities^{48,55}. Procedural justice requires
 221 recognition of relevant decision-making participants, and proactive steps to address barriers to
 222 meaningful participation and local leadership in decision-making⁶¹. For example, while
 223 "stakeholder participation" is a common refrain, effective engagement and collaboration must
 224 go beyond extending invitations to fostering key procedural justice criteria, such as
 225 transparency and neutrality in decision-making processes, adequate voice, decision control,
 226 and other elements of agency, respect, and politeness in interpersonal treatment, and accessible
 227 conflict resolution mechanisms^{59,62}. Some cases require developing capacity in
 228 disenfranchised groups and local leaders to allow them to meaningfully engage and/or lead
 229 decision-making processes without exacerbating their capacity constraints for local issues or
 230 personal needs (e.g., financial or time poverty of women)^{28,40}. In all cases it should involve
 231 supporting local leadership, which sometimes might involve establishing shared governance
 232 structures between local rights-holders, stakeholders and other actors (Box 2).

233

234 Third, prioritizing distributional justice involves working with rights-holders and stakeholders
 235 to identify, monitor, and manage the realized (or potential) impacts of interventions and the
 236 distribution of those impacts among different societal groups⁶³. This includes, for example,
 237 considering the differential impacts of initiatives on women, who are often overlooked in
 238 impact assessments and yet comprise around 47% of the workforce engaged in fishing and
 239 post-harvest operations^{40,45,52,64}. Developing or adopting contextually-appropriate guidelines,
 240 social safeguards, and justice principles for recognizing and engaging with groups subject to
 241 marginalization (e.g., FAO Voluntary Guidelines for Securing Sustainable Small-Scale
 242 Fisheries⁶⁵, Blue Economy Finance Principles⁶⁶) can help facilitate more equitable benefit
 243 and cost sharing, mitigation actions, and compensatory mechanisms. Importantly,
 244 distributional equity is plural and situated in time, place, and in terms of what is being
 245 distributed among whom^{46,67}. Thus, distributional justice requires going beyond "do no harm"
 246 and "net benefit" policies towards identification of local conceptions of what constitutes a fair
 247 distribution of costs and benefits. It also requires assessing the (mis)alignment of local
 248 conceptions with those embedded in coastal policy and tools, which are often developed in the
 249 Global North⁶⁷.

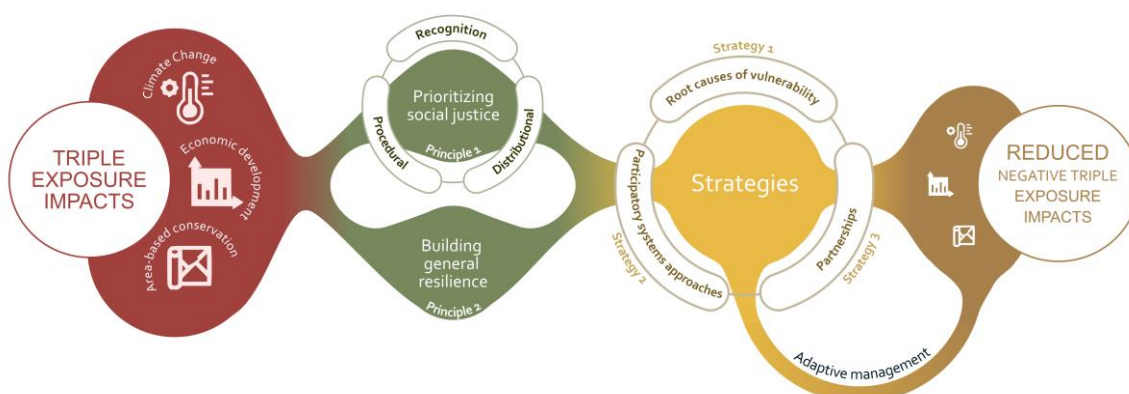
250

251 *Principle 2: Building general resilience*

252 While many coastal communities are accustomed to change, their resilience has been
 253 undermined by exogenous and endogenous forces of inequality and vulnerability from past
 254 impacts^{28,68}. Moreover, their specific resilience is potentially insufficient to respond to one
 255 exposure (e.g. climate change) while dealing with negative impacts from maladaptive and
 256 inequitable coastal initiatives (i.e., triple exposure)^{38,69}. There are many examples where
 257 coastal initiatives were successful in building specific resilience to a particular stressor, but
 258 compromised long-term, general resilience and increased inequality (e.g., Aboadze case in
 259 Ghana- Box 1)^{19,54,70}. Prioritising general resilience as a goal in coastal initiatives can better
 260 capture the need for increasing the capacity of diverse actors to respond to the myriad of
 261 environmental, political, economic, and socio-cultural changes and uncertainties catalysed by
 262 triple exposure and other shocks⁷¹. This can include developing initiatives that facilitate
 263 increased agency, flexibility, learning, collective action, and access to key resources, services,
 264 power, and institutions^{50,71}.

265

266



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Figure 1. Transformative strategies to reduce negative triple exposure impacts by prioritizing social justice and building general resilience. 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 Supplementary Figure 1 for additional information on linkages between strategies.

275

276 Strategy 1: Identify and address root causes of vulnerability

277 Transformational solutions aiming to prioritize social justice and build general resilience must
278 dismantle the root causes of vulnerability and inequality, both those external to, and embedded
279 within, the local socio-environmental context^{39,53,72,73}. Root causes of vulnerability can be:
280 social (e.g., social marginalization, systematic racism, conflict), economic (e.g.,
281 intergenerational poverty, unjust neoliberal trade policies, aid conditionality), political (e.g.,
282 colonial legacies, exclusion, disproportionate corporate lobbying power), or environmental
283 (e.g., unsustainable resource use, non-point sources of pollution)^{53,74–77}. From tourism
284 development initiatives that result in elite capital accumulation and undermine disenfranchised
285 groups⁷⁸ to conservation enforcement strategies that exacerbate the very social vulnerabilities
286 that drive non-compliance^{18,38,79}, failure to address root causes can lead to ineffective policies
287 and unjust outcomes^{19,53}.

288

289 Addressing the root causes of vulnerability will require interrogating the capitalist, gendered,
290 and colonial underpinnings that lead to disproportionate vulnerability and outcomes in coastal
291 communities^{42,80–84}. Root causes are often interconnected, remote, and multi-scalar, and thus
292 must be addressed at the appropriate spatial and temporal scale(s)^{85–87}. For instance, some
293 climate programs have been critiqued for missing opportunities to mitigate climate risk by
294 focusing solely on adaptation^{39,72,88,89}. Morrison et al.⁸⁵ showed how conservation of the Great
295 Barrier Reef focuses on regulating the behaviour of local reef users rather than addressing the
296 practices of multinational corporations that drive reef degradation through investment in fossil
297 fuels. Root causes can also stem from legacies of unjust state institutions and policies which
298 hinder the success of coastal initiatives. In Mnazi Bay, Tanzania (Box 1), recent MPA and
299 development initiatives were seen as a continuation of the state's efforts to exert control and
300 further disempower and disenfranchise local communities, and led to increased conflict, food
301 insecurity, and worsening wellbeing outcomes¹⁸.

302

303 In these and other cases, addressing root causes requires accurate problem definition, shifting
304 focus away from the symptoms of climate change, unsustainable development, and poorly
305 implemented conservation (e.g., habitat loss, poor compliance, tourism revenue leakages, etc.),
306 towards the deeper, root causes of vulnerability to these global change processes. These include

307 systemic issues at the local (e.g., inter-group conflict, inequitable distribution of social
 308 services), national (e.g., weak environmental regulations, poor inter-agency coordination, tax
 309 systems that support economic leakages), and global (e.g., carbon emissions, exploitative
 310 North-South trade and tax systems) levels^{76,85,90–92}. Carefully tailored social-ecological
 311 vulnerability assessments can help uncover relevant drivers of vulnerability and help shape
 312 contextually appropriate management interventions at the right scale^{93–96}. Such interventions
 313 could then be tailored to address the specific vulnerabilities of groups and sub-groups. This
 314 might include combining familiar interventions in new ways, for example, pairing local
 315 conservation or restoration efforts with stronger national climate mitigation policies (e.g.,
 316 decarbonization)^{85,97,98}, revising existing economic policies that promote leakages or
 317 marginalization as part of national blue economy strategies, and more. Acknowledging root
 318 causes of vulnerability can point to levers of change that when addressed intentionally, can
 319 advance recognitional, procedural, and distributional dimensions of justice.

320

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

322 Approaches to designing, implementing, and evaluating coastal interventions that draw on
 323 systems thinking (hereafter, 'systems approaches') are well positioned to identify root causes
 324 of vulnerability and inequality, avoid maladaptive and inequitable outcomes of coastal
 325 initiatives, and identify pathways towards building general resilience^{99,100}. Coastal
 326 communities are embedded within complex social-ecological systems, each influenced by
 327 unique endogenous and exogenous processes, interactions, and feedbacks, including past and
 328 present drivers of change. Many root causes of vulnerability represent “slow variables”,
 329 fundamental and long-term structures or processes that underpin or undermine desirable
 330 outcomes and change^{99,101}. Whether it be imbalanced power relations, value systems, or
 331 economic systems of accumulation, these slow variables often explain how and why triple
 332 exposure and other drivers of change disproportionately affect some and not others. The
 333 complexity of coastal systems means that these root causes are often “hidden” and difficult to
 334 isolate within other interacting social and ecological processes, especially those that are deeply
 335 embedded within the social system (e.g., cultural norms) or those that are distal and remote
 336 (e.g., non-point sources of pollution). The complexity also adds to the challenge of predicting
 337 the potential impacts of new coastal initiatives, as new initiatives might interact with other
 338 drivers to produce a novel set of disparate outcomes. Failure to consider the system interactions
 339 between triple exposure and the social-ecological context can therefore lead to misdiagnosis
 340 and maladaptive responses that fail to address root causes, resulting in unintended feedbacks
 341 and social-ecological traps^{55,85,102–104}.

342

343 Participatory systems approaches can help identify how root causes and planned initiatives
 344 intersect with change processes to affect distinct groups or different aspects of wellbeing^{55,105}.
 345 Participatory approaches can provide a forum for disenfranchised individuals and groups to
 346 communicate their perspectives and experiences regarding current or historical factors that
 347 drive local inequality and vulnerability, and to co-develop inclusive strategies to address these
 348 issues (e.g., Box 2 - Madagascar case). Thus, participatory approaches can foster recognitional
 349 and procedural justice in decision-making, and thus, distributive justice (Figure 2). Such
 350 approaches can highlight potential unintended socioecological feedbacks, inequitable impacts
 351 and trade-offs, thresholds, and processes that exacerbate vulnerability from planned initiatives
 352^{72,106,107}. For example, participatory model building and scenario exercises can be used to
 353 identify how a proposed development might interact with a current climate adaptation project,
 354 and/or conflict with the goals and aspirations of local and external actors. Implementors can
 355 also gain insight on how climate shocks and current initiatives are jointly affecting important
 356 nursery habitats, or what might happen to resource-dependent individuals if an area is closed

357 for conservation purposes and a major storm or economic shock were to subsequently affect
 358 alternative income streams. They can also highlight opportunities, such as conservation
 359 initiatives for mitigating the spread of zoonotic disease and future pandemics (Box 2). In
 360 addition to strategy development, implementers can collectively identify appropriate indicators
 361 for monitoring root causes and evaluating progress in addressing them. Combining the rich
 362 knowledge bases of local actors with emerging technologies and data (e.g., remote sensing
 363 products, long-term monitoring datasets, predictive modelling) can inform such systems model
 364 building and scenario building processes to identify viable paths towards building general
 365 resilience^{94,100,108,109}.

366

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

368 Addressing the complexity of challenges presented by triple exposure and other change drivers
 369 is beyond the scope of a single actor or work at a single scale¹¹⁰. Developing strategies to
 370 address triple exposure requires proactive efforts to improve integration, coordination, and
 371 recognition through cross-sectoral and cross-scale collaborations, often between unlikely
 372 partners. Partnerships with those most affected by, and responsible for, change, can support
 373 effective solutions through: 1) better identification of appropriate and equitable strategies and;
 374 2) providing the capacity to implement them.

375

376 Inclusive collaborations that bring together affected groups with decision-makers fosters
 377 recognition and procedural justice, greater integration, and generate innovative and context-
 378 specific solutions that are more likely to be considered legitimate by local actors. Bringing
 379 together diverse ways of knowing can improve participatory planning processes (e.g., systems
 380 approaches and scenario building) through improved problem definition, better identification
 381 of root causes, key system interactions and processes, and facilitating more plausible
 382 assessments of potential trade-offs from future policies or disturbances^{71,107,111}. For example,
 383 the Watershed Interventions for Systems Health in Fiji (WISH Fiji) project is a cross-scale,
 384 multi-actor initiative that uses a participatory systems approach to identify culturally
 385 appropriate interventions to address social-ecological impacts from climate, development, and
 386 poorly planned conservation within Fijian watersheds (Box 2). Including “non-traditional”
 387 actors that are responsible for, or have the power to influence, exogenous root causes also
 388 increases the likelihood of developing solutions that address processes driving vulnerability
 389 and inequality. Coordinated multi-sectoral planning processes involving the “traditional”
 390 marine sectors (e.g., shipping, tourism, fisheries) and other sectors such as finance, business,
 391 education, public health, disaster management, and insurance¹¹² at various scales can help
 392 facilitate better coordination in planning across sectors and governance levels, and help identify
 393 (mis)alignments between planned initiatives and current and future activities.

394

395 Cross-scale and cross-sectoral partnerships can also provide the capacity, coordination, and
 396 mechanisms needed for implementation. By pooling technical and financial capacity between
 397 partners and leveraging their influence, agency, authority, and networks, coastal initiatives are
 398 more likely to address root causes at the appropriate scale. In Mauritius, a local NGO leveraged
 399 its pre-existing local and regional networks and infrastructure to serve as a hub for the volunteer
 400 response to a major oil spill that severely impacted sensitive coastal habitats¹¹³. However,
 401 community members lacked the necessary protective equipment to safely address the spill. In
 402 this case, strong cross-scale partnerships between local actors and those at higher levels of
 403 governance could have ensured that adequate resources were available to avoid unnecessary
 404 health risks. To effectively address root issues, partnerships may require national actors to
 405 address unsustainable or inequitable national economic policies, producers in the agricultural
 406 sector to address upstream watershed pollution (Box 2 - Fiji case), or local community leaders

407 to address unjust practices regarding groups subject to marginalization. At a global scale,
408 leveraging existing cross-sectoral initiatives, such as the UN Decade on Ocean Sciences, UN
409 Global Compact, and the United Nations' Sustainable Development Goals (SDGs), can take
410 advantage of the multiple intersections between global targets and agendas, and provide a
411 supportive platform or starting point to advance synergistic policy development ^{112,114,115}.

412

413 **Overcoming barriers to transformation**

414 Implementing the three strategies we outline above is not without significant challenges
415 given that trade-offs can exist between the climate, development, and conservation agendas,
416 particularly across geographic and temporal scales ^{116,117}. Such partnerships will require
417 going beyond “stakeholder participation” practices that commonly do not constitute
418 meaningful engagement ⁵⁹, taking proactive steps to address power imbalances, pre-existing
419 injustices, and conflicts that prevent broad and equitable participation and local leadership in
420 integrated planning.

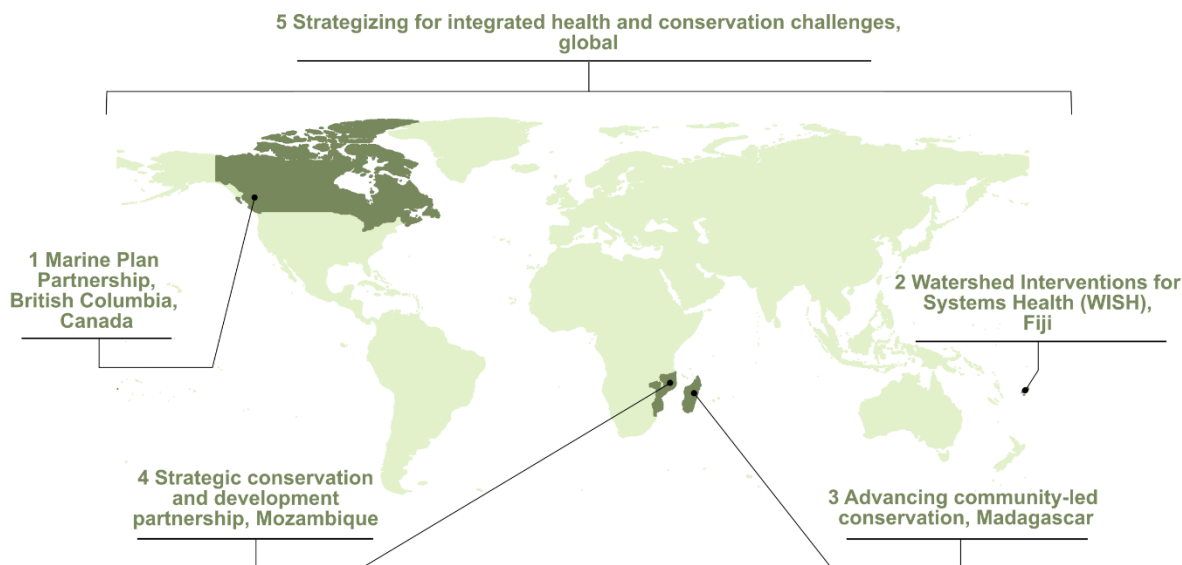
421

422 Leveraging and learning from existing partnerships and approaches that forefront justice and
423 equity issues can be a useful strategy to achieve more just outcomes. For example, the
424 Indigenous and Community Conserved Areas Consortium [ICCAs] and the Conservation
425 through Reconciliation Partnership, are taking steps to address prior injustices and empower
426 disenfranchised groups who might be disadvantaged by large-scale initiatives. Formalizing
427 shared and locally-led resource governance arrangements, collaborations with human rights
428 organisations, or the use of national or international courts can also empower local actors to
429 address historical marginalization ¹¹⁸. Such mechanisms have been successfully used to
430 challenge powerful forces. For example, Viglione ¹¹⁹ reports an increase in litigious
431 responses to climate change, documenting the example of a Peruvian farmer who has brought
432 a legal case against the largest emitter of CO₂ in the European Union. In some cases,
433 restorative justice (e.g., reparations) could be warranted to address historical injustices, as
434 demonstrated by the fisheries and forestry reparations for Maori populations in New Zealand
435 ¹²⁰ and ongoing efforts in British Columbia, Canada to foster reconciliation with Indigenous
436 peoples through collaborative fisheries governance ¹¹⁸ (Box 2 -Canada case). In other cases, it
437 will require significant transformation of current structures and mechanisms. For example,
438 current funding mechanisms are biased towards organizations who can navigate the
439 bureaucratic complexities of funding bodies. Making these funding mechanisms more
440 accessible to local rights-holders can facilitate greater self-determination by allowing them to
441 develop and implement initiatives themselves.

442

443

444 **Box 2. Examples of implementing transformative strategies that prioritize social justice and resilience**
 445 **building to address triple exposure and root causes. See Supplementary Material for additional case**
 446 **information.**



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 emphasized the importance of 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.

447
 448 The approaches recommended here will require long-term investment of time, energy, and
 449 resources to ensure sustained effectiveness in addressing triple exposure. Efforts to address
 450 pre-existing power imbalances, historical injustices, conflict, limited capacity, and siloed
 451 governance that hinder effective collaboration require long-term investment beyond traditional
 452 donor cycles. Similarly, developing local capacity for increased local leadership and ongoing
 453 participation in partnerships also requires sustained investment. As such, addressing triple
 454 exposure requires advancing beyond the one-off or sporadic multi-stakeholder interventions
 455 that are currently employed, towards creating mechanisms that enable and sustain broad
 456 participation in decision-making, ongoing dialogue, trust-building, conflict resolution, and
 457 difficult conversations surrounding historical injustices¹²¹. The rapidly accelerating changes
 458 brought about by triple exposure also necessitate enduring and adaptive governance systems.

459 With ongoing investment in collaboration, partners can continuously share insights on
 460 emerging drivers of vulnerability, novel trade-offs, and impacts generated by recent policies or
 461 disturbances, and co-develop or adaptively manage strategies to appropriately respond ¹²².

462

463 **Conclusion**

464 While coastal societies stand to benefit the most from resilient coastal ecosystems and strong
 465 local economies, they are also the most highly susceptible to increased vulnerability stemming
 466 from triple exposure to climate change, blue growth, and the rapid expansion of area-based
 467 conservation. With the current momentum behind expanding climate adaptation, blue
 468 economy, and conservation efforts globally, implementors have an opportunity to proactively
 469 develop initiatives that prioritize social justice and build general resilience by employing
 470 systems-based planning approaches to identify and address root causes of vulnerability and
 471 inequality, and developing novel partnerships for collective action. Doing this likely requires
 472 rethinking existing operating and funding structures, which will entail strong leadership,
 473 sustained support, and carefully facilitated organizational change processes. By leveraging and
 474 advancing beyond existing integrated management initiatives and approaches, climate,
 475 development, and conservation actors can proactively address systemic injustices, power
 476 imbalances, and other factors that undermine the effectiveness and fairness of current
 477 initiatives. The strategies we recommend here may be resisted or intractable in some contexts.
 478 Nonetheless, compared to the consequences of triple exposure, even small steps towards
 479 promoting social justice and resilience within coastal communities are a worthwhile
 480 investment.

481

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817

818 **Figure Legends**

819 Figure 1. Transformative strategies to reduce negative triple exposure impacts by prioritizing
820 social justice and building general resilience. Strategies can be jointly applied to reduce triple
821 exposure. For example, implementors can employ participatory systems approaches to identify
822 root causes of vulnerability and inequality, potential impacts of future initiatives, and identify
823 appropriate solutions to address root causes and avoid maladaptive/inequitable outcomes.
824 Developing and leveraging inclusive cross-scale and cross-sectoral partnerships can facilitate
825 implementing these participatory approaches by improving diversity, recognition, and
826 integration in planning, and increasing capacity and coordination for implementation. See
827 Supplementary Figure 1 for additional information on linkages between strategies.