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► To cite this version:

David Gill, Jessica Blythe, Nathan Bennett, Louisa Evans, Katrina Brown, et al.. Triple Exposure: Reducing negative impacts of climate change, blue growth, and conservation on coastal communities. *One Earth*, 2023, 6 (2), pp.118-130. 10.1016/j.oneear.2023.01.010 . hal-03996288

HAL Id: hal-03996288

<https://hal.science/hal-03996288>

Submitted on 19 Feb 2023

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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 climate, development, and area-based conservation 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 seek to: 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.

Acknowledgments: We would like to thank the Science for Nature and People Partnership (SNAPP) for facilitating a convening space for many of the authors to discuss this work, and the members of the Coastal Outcomes working group for their ideas that helped shape this manuscript. We thank all those involved in case studies for learning with us and helping the climate, development, and conservation community to evolve. We would also like to thank the reviewers whose input was critical in the development of this paper. This work is also a product of the Blue Justice working group funded by the synthesis center CESAB of the French Foundation for Research on Biodiversity (FRB; www.fondationbiodiversite.fr).

Declaration of interests: The authors declare no competing interests.

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 ¹.

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

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

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 Although these exposures can **and have produced** tangible benefits for coastal communities
48 (e.g., increased resilience, poverty reduction, species recovery), many cases exist where they
49 have unintentionally increased, rather than reduced, inequality and vulnerabilities^{4,16,19,20}. Yet,
50 research on the differential and novel potential negative impacts of these interacting exposures
51 on coastal communities is limited^{5,12,21}.

52

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

65

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

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

78

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

93

94 The global expansion of externally-driven area-based conservation is a third exposure, which
95 restructures how people around the world can access, interact with, and benefit from the ocean.
96 With over 27 million km² or 7.8% of the ocean currently within MPAs, area-based conservation

97 is arguably the most prolific biodiversity conservation tool used in the ocean today, and its
 98 application is accelerating⁹. Notably, many coastal areas such as those in the Global South are
 99 major conservation priorities given their high biodiversity value^{33,34}, with the majority of the
 100 world's 16,500 MPAs located within nearshore waters⁹. With effective and equitable
 101 implementation, area-based conservation that employs rights-based approaches can help
 102 protect marine biodiversity from anthropogenic threats (including climate change and
 103 unsustainable blue growth), safeguard social benefits from healthy marine ecosystems, as well
 104 as strengthen local rights and livelihoods^{35,36}. Nonetheless, numerous cases exist where
 105 externally conceived and poorly implemented conservation initiatives have failed to recognize
 106 local rights, needs, and voices, leading to increased vulnerability and inequality through
 107 conflict, disenfranchisement, and lost access to key resources (e.g.,^{17,18,37}).

108
 109 Based on current climate, conservation, and development projections, targets, and discourses,
 110 the expected impacts (**whether** positive or negative) of externally-driven climate change, blue
 111 growth, and area-based conservation will likely be immense, global in extent, and continue to
 112 rapidly accelerate^{2,5,38}. While these three exposures are not the only **change drivers affecting**
 113 coastal communities, they are three of the most significant externally-driven and interacting
 114 global change processes transforming ocean environments, economies, and governance at an
 115 unprecedented scale. They are also producing large and varied impacts on groups and
 116 communities that are already dealing with other exposures and inequitable social structures³⁹.
 117 Importantly, these three exposures do not operate in isolation, but interact to create novel and
 118 differential impacts. For example, in the Sundarban Biosphere Reserve in India, efforts to
 119 conserve critical species and habitats in light of climate impacts and local threats include
 120 restricting access to large areas within the wetland⁴⁰. However, for groups directly dependent
 121 on fisheries resources subject to historical and ongoing marginalization and repeated climate
 122 shocks, the seizure of assets, restricted fishing access based on ethnicity, and abuse from
 123 enforcement staff have severely compromised their wellbeing, increasing their vulnerability to
 124 economic exploitation and future climate shocks (See other examples in Box 1).

125

126 **Differential vulnerabilities to 'triple exposure'**

127 Differences in vulnerabilities to, and impacts of, interacting exposures often result from
 128 inequitable institutional structures, policies, and cultural norms⁴¹. Triple exposure can
 129 reinforce these entrenched inequalities, exacerbate vulnerability, and undermine the success of
 130 coastal initiatives.

131

132 Current and historical injustices and inequalities, including colonialism, power imbalances,
 133 inequitable policies, corruption, and gender norms, create and reinforce social structures and
 134 hierarchies that marginalize select coastal communities and individuals within them^{42,43}. For
 135 example, gendered processes or roles can often explain why women are more likely to be
 136 impacted by disasters⁴⁴, excluded from decision-making⁴⁵, or restricted in accessing marine
 137 resources after project implementation^{19,46,47}. As the Sundarban case illustrates, individual
 138 sensitivity to triple exposure is not only shaped by factors such as resource dependency but
 139 also by inequalities associated with gender, race, education level, economic status, and
 140 religious or ethnic identity^{39,46,48-50}.

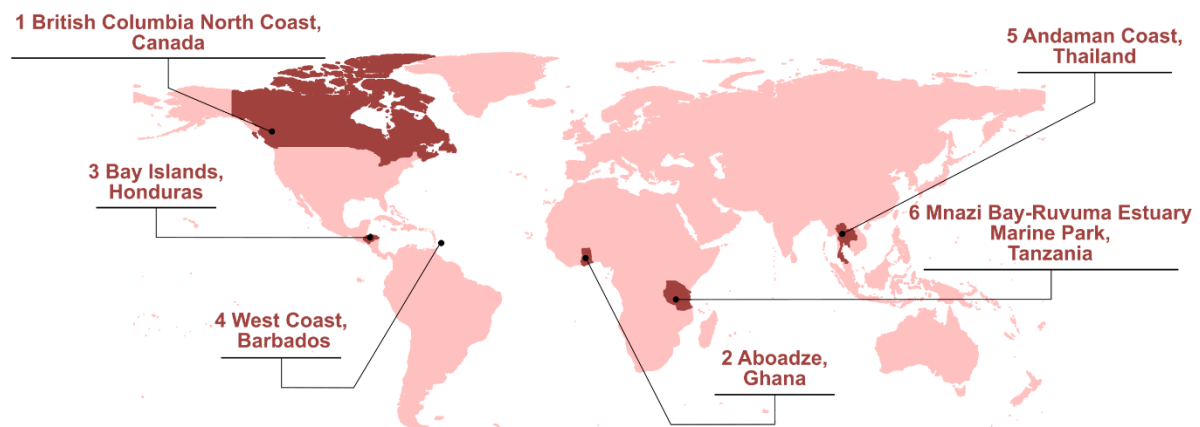
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142 For groups subject to marginalization, historical injustices and contextual inequalities can also
 143 hinder their ability to adapt to negative shocks from triple exposure (Box 1). In many coastal
 144 communities, access to resources or services (e.g., credit, healthcare, infrastructure, insurance),
 145 capabilities (e.g., education, language, occupational diversity, capacity to self-organize),
 146 power, institutions, and learning mechanisms are often limited and highly variable⁵¹. This

147 severely limits their ability to prepare for, adapt to, or recover from stressors or shocks (i.e.,
 148 adaptive capacity)^{50,52–54}. This limited access is often a product of long-standing social or
 149 economic policies of marginalization, or social or cultural norms that accept and reinforce
 150 inequalities and injustice. Triple exposure **can** interact with these reinforced structures and
 151 norms to further increase susceptibility of groups subject to marginalization to future shocks,
 152 exacerbating existing inequalities and vulnerabilities (Box 1). For example, in Aboadze,
 153 Ghana, increased coastal development associated with blue growth forced poorer individuals
 154 to live in exposed low-lying areas vulnerable to sea-level rise and reduced the farmland
 155 available to adapt to drought conditions²¹ (Box 1 – Ghana case). In the same case, competition
 156 with foreign industrial fishing fleets led many to resort to unsustainable fishing practices to
 157 make up for lost catch (e.g., dynamite fishing), compromising the integrity of the ecosystems
 158 they rely on.

159

160 **Box 1. Triple Exposure case studies where historical & current injustices hindered, or were exacerbated**
 161 **by, the implementation of coastal initiatives. See Supplementary Material for additional case information**
 162 **and references. Ghana case from Nolan et al²¹.**



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.

163

164

165

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

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

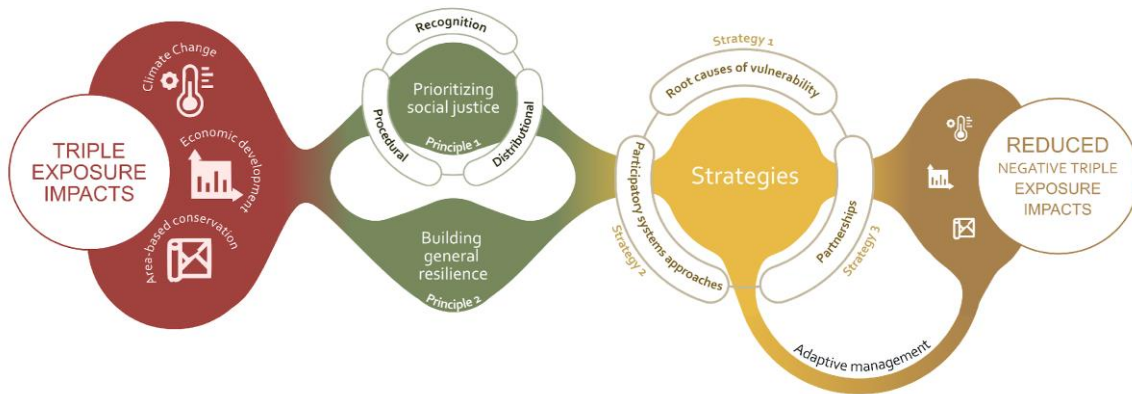
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179 **Transformational strategies**

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

196

197 In this section, we outline what social justice and general resilience offer as foundational
198 principles. We then propose three key strategies that implementors of coastal initiatives can
199 use to operationalise these principles: 1) identifying and addressing root causes of vulnerability
200 and inequality; 2) using participatory systems approaches to identify these root causes and
201 pathways towards building general resilience; and 3) developing and leveraging community-
202 centered, cross-scale and cross-sectoral partnerships between diverse actors to facilitate the
203 collaborative design and implementation of identified solutions (Fig 1). These strategies are
204 not exhaustive or mutually exclusive. They are also not intended to be prescriptive,
205 acknowledging the agency and diversity of worldviews, knowledge systems, values, and
206 priorities within coastal communities ⁵⁷. Nonetheless, these principles and strategies (outlined
207 below) —applied together and adapted to the local context—offer an opportunity to advance
208 current practice and research at the nexus of climate, development, and conservation sectors
209 towards more just and effective solutions.



210
 211 *Figure 1. Transformative strategies to reduce negative triple exposure impacts by prioritizing social justice and building*
 212 *general resilience. Strategies can be jointly applied to reduce triple exposure. For example, implementors can employ*
 213 *participatory systems approaches to identify root causes of vulnerability and inequality, potential impacts of future initiatives,*
 214 *identify appropriate solutions to address root causes, and avoid maladaptive/inequitable outcomes. Developing and*
 215 *leveraging inclusive cross-scale and cross-sectoral partnerships can facilitate implementing these participatory approaches*
 216 *by improving diversity, recognition, and integration in planning, and increasing capacity and coordination for*
 217 *implementation. See Supplementary Figure 1 for additional information on linkages between strategies.*

218

219

220 *Principle 1: Prioritizing social justice*

221 Prioritizing social justice—the right or fair treatment of all people—requires attention to three
 222 of its key dimensions: recognition, procedure, and distribution^{30,58,59}. Recognitional justice
 223 involves identifying, recognizing, and acknowledging the rights, needs, livelihoods,
 224 knowledge systems, worldviews, and values of different societal groups⁶⁰. This is especially
 225 important for groups that are marginalized within dominant governance systems and
 226 management processes. Recognition is increasingly acknowledged as underpinning the other two
 227 key justice dimensions⁶¹, where the recognition of all rights-holders and stakeholders and their
 228 diverse identities and values is a key first step to prioritizing justice⁶². For example, this means
 229 properly considering the nutritional, economic, and cultural dependence on aquatic foods of
 230 current and future generations in coastal areas when proposing conservation activities that
 231 restrict access to marine resources⁶³.

232

233 Second, prioritizing procedural justice involves the active participation and leadership of all
 234 relevant coastal rights-holders and stakeholders in decision-making to identify local people’s
 235 preferences and goals, key risks for various groups, and context-appropriate solutions that do
 236 not exacerbate existing vulnerability and inequalities^{50,57}. Procedural justice requires
 237 recognition of relevant decision-making participants, and proactive steps to address barriers to
 238 meaningful participation and local leadership in decision-making⁶⁴. For example, while
 239 “stakeholder participation” is a common refrain, effective engagement and collaboration must
 240 go beyond extending invitations to fostering key procedural justice criteria. This includes
 241 transparency and neutrality in decision-making processes, adequate voice, decision control,
 242 accessible conflict resolution mechanisms, and other elements of agency, respect, and
 243 politeness in interpersonal treatment^{61,65}. Some cases require supporting disenfranchised
 244 groups and local leaders for them to meaningfully engage and/or lead decision-making
 245 processes without exacerbating their capacity constraints for local issues or personal needs
 246 (e.g., considering the financial or time poverty of women)^{28,42}. In all cases it should involve
 247 supporting local leadership, which sometimes might involve establishing shared governance
 248 structures between local rights-holders, stakeholders, and other actors (Box 2).

249

250 Third, prioritizing distributional justice involves working with rights-holders and stakeholders
 251 to identify, monitor, and manage the realized (or potential) impacts of interventions and the
 252 distribution of those impacts among different societal groups ⁶⁶. This includes, for example,
 253 considering the differential impacts of initiatives on women, who are often overlooked in
 254 impact assessments and yet comprise around 47% of the workforce engaged in fishing and
 255 post-harvest operations ^{42,47,54,67}. Developing or adopting contextually-appropriate guidelines,
 256 social safeguards, and justice principles for recognizing and engaging with groups subject to
 257 marginalization (e.g., FAO Voluntary Guidelines for Securing Sustainable Small-Scale
 258 Fisheries ⁶⁸, Blue Economy Finance Principles ⁶⁹) can help facilitate more equitable benefit
 259 and cost sharing, mitigation actions, and compensatory mechanisms. Importantly,
 260 distributional equity is plural and situated in time, place, and in terms of what is being
 261 distributed among whom ^{48,62}. Thus, distributional justice requires going beyond “do no harm”
 262 and “net benefit” policies towards identification of local conceptions of what constitutes a fair
 263 distribution of costs and benefits. It also requires assessing the (mis)alignment of local
 264 conceptions with those embedded in coastal policy and tools, which are often developed in the
 265 Global North ⁶².

266

267 *Principle 2: Building general resilience*

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

281

282

283

284 *Strategy 1: Identify and address root causes of vulnerability*

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

300
301 Root causes of coastal vulnerability and inequality are often interconnected, remote, and multi-
302 scalar, and thus must be addressed at the appropriate spatial and temporal scale(s)^{84–86}. For
303 instance, some climate programs have been critiqued for missing opportunities to mitigate
304 climate risk by focusing solely on adaptation^{41,74,87,88}. Morrison et al.⁸⁴ showed how
305 conservation of the Great Barrier Reef focuses on regulating the behaviour of local reef users
306 rather than addressing the practices of multinational corporations that drive reef degradation
307 through investment in fossil fuels. Root causes can also stem from legacies of unjust state
308 institutions and policies which hinder the success of coastal initiatives. In Mnazi Bay, Tanzania
309 (Box 1), recent MPA and development initiatives were seen as a continuation of the state's
310 efforts to exert control and further disempower and disenfranchise local communities^{18,37}.
311 These initiatives resulted in increased conflict, food insecurity, and worsening wellbeing
312 outcomes¹⁸.

313
314 In these and other cases, addressing root causes requires accurate problem definition, shifting
315 focus away from the symptoms of climate change, unsustainable development, and poorly
316 implemented conservation (e.g., habitat loss, poor compliance), towards the deeper, root causes
317 of vulnerability to these global change processes. These include systemic issues at the local
318 (e.g., inequitable distribution of social services or power to influence decision-making),
319 national (e.g., weak environmental regulations, poor inter-agency coordination, exclusion of
320 local rights holders in governance, tax systems that support economic leakages), and global
321 (e.g., carbon emissions, exploitative North-South trade and tax systems) levels^{80,84,89–91}. In
322 many cases, addressing the root causes of vulnerability will require interrogating the capitalist,
323 gendered, and colonial underpinnings that lead to disproportionate vulnerability and outcomes
324 in coastal communities^{44,92–96}. An effective approach can be to start from examining the
325 outcomes we wish to address or avoid, and work backward towards identifying the causal
326 drivers. Carefully tailored social-ecological vulnerability assessments can help uncover
327 relevant drivers of vulnerability and inequality and help shape contextually appropriate
328 interventions at the right scale^{97–100}. Such interventions could then be tailored to address the
329 specific vulnerabilities of groups and sub-groups. This might include combining familiar
330 interventions in new ways, for example, pairing local conservation or restoration efforts with
331 stronger national climate mitigation policies (e.g., decarbonization)^{84,101,102}, revising existing
332 economic policies that promote leakages or marginalization as part of national blue growth
333 strategies, and more. Acknowledging root causes of vulnerability can point to levers of change
334 that when addressed intentionally, can advance recognitional, procedural, and distributional
335 dimensions of justice.

336
337 *Strategy 2: Use participatory systems approaches for planning and decision making*
338 Approaches to designing, implementing, and evaluating coastal interventions that draw on
339 systems thinking (hereafter, 'systems approaches') are well positioned to identify root causes
340 of vulnerability and inequality, avoid maladaptive and inequitable outcomes from coastal
341 initiatives, and identify pathways towards building general resilience^{76,103}. Coastal
342 communities are embedded within complex social-ecological systems, each influenced by
343 unique endogenous and exogenous processes, interactions, and feedbacks, including past and
344 present drivers of change. The complexity of coastal systems means that root causes of
345 vulnerability and inequality are often "hidden" and difficult to isolate within other interacting
346 social and ecological processes. This is especially true for root causes that are deeply
347 embedded within the social system (e.g., cultural norms) or those that are distal and remote
348 (e.g., non-point sources of pollution). This complexity also adds to the challenge of predicting
349 the potential impacts of new coastal initiatives, as these initiatives might interact with other

350 drivers to produce a novel set of disparate outcomes. Failure to consider the system interactions
 351 between triple exposure and the social-ecological context can therefore lead to misdiagnoses
 352 and maladaptive responses that fail to address root causes, resulting in unintended feedbacks,
 353 ineffective policies, and social-ecological traps^{57,84,104–106}.

354
 355 Participatory systems approaches can help identify how root causes and planned initiatives
 356 intersect with change processes to affect distinct groups or different aspects of wellbeing^{57,107}.
 357 Participatory approaches can provide a forum for disenfranchised individuals and groups to
 358 communicate their perspectives and experiences regarding current or historical factors that
 359 drive local inequality and vulnerability, and to co-develop inclusive strategies to address these
 360 issues (e.g., Box 2 - Madagascar case). Thus, participatory approaches can foster recognitional
 361 and procedural justice in decision-making, and thus, distributive justice (Figure 2). Such
 362 approaches can also highlight potential unintended socioecological feedbacks, inequitable
 363 impacts and trade-offs, thresholds, and processes that exacerbate vulnerability from planned
 364 initiatives^{74,108,109}. For example, participatory model building and scenario exercises can be
 365 used to identify how a proposed development might interact with a current climate adaptation
 366 project, and/or conflict with the goals and aspirations of local and external actors.
 367 Implementors can also gain insight on how climate shocks and current initiatives are jointly
 368 affecting important nursery habitats, or what might happen to resource-dependent individuals
 369 if an area is closed for conservation purposes and a major storm or economic shock were to
 370 subsequently affect alternative income streams. They can also highlight opportunities, such as
 371 conservation initiatives for mitigating the spread of zoonotic disease and future pandemics or
 372 applying rights-based approaches within planned cross-sectoral initiatives (Box 2). In addition
 373 to strategy development, implementers can collectively identify appropriate indicators for
 374 monitoring root causes and evaluating progress in addressing them. Combining the rich
 375 knowledge bases of local actors with emerging technologies and data (e.g., remote sensing
 376 products, long-term monitoring datasets, predictive modelling) can inform such systems model
 377 building and scenario building processes to identify viable paths towards building general
 378 resilience^{98,103,110,111}.

379
 380 *Strategy 3: Leverage cross-scale and cross-sectoral partnerships*

381 Addressing the complexity of challenges presented by triple exposure and other change drivers
 382 is beyond the scope of a single actor or work at a single scale¹¹². Developing strategies to
 383 address triple exposure requires proactive efforts to improve integration, coordination, and
 384 recognition through cross-sectoral and cross-scale collaborations, often between unlikely
 385 partners. Partnerships with those most affected by, and responsible for, change, can support
 386 effective solutions through: 1) better identification of appropriate and equitable strategies and;
 387 2) providing the capacity to implement them.

388
 389 Inclusive collaborations that bring together affected groups with decision-makers foster
 390 recognition and procedural justice and greater integration. Such collaborations also generate
 391 innovative and context-specific solutions that are more likely to be considered legitimate by
 392 local actors. Bringing together diverse ways of knowing can improve participatory planning
 393 processes (e.g., systems approaches and scenario building) through improved problem
 394 definition, better identification of root causes, key system interactions and processes, and
 395 facilitating more plausible assessments of potential trade-offs from future policies or
 396 disturbances^{73,109,113}. For example, the Watershed Interventions for Systems Health in Fiji
 397 (WISH Fiji) project is a cross-scale, multi-actor initiative that uses a participatory systems
 398 approach to identify culturally appropriate interventions to address social-ecological impacts
 399 from climate, development, and poorly planned conservation within Fijian watersheds (Box 2).

400 Including “non-traditional” actors that are responsible for, or have the power to influence,
401 exogenous root causes also increases the likelihood of developing solutions that address
402 processes driving vulnerability and inequality. Coordinated multi-sectoral and cross-scale
403 planning involving the “traditional” marine sectors (e.g., shipping, tourism, fisheries) and other
404 sectors such as finance, business, education, public health, disaster management, and
405 insurance) can help facilitate better coordination in planning across sectors and governance
406 levels ¹¹⁴. Such collaborations can also help identify (mis)alignments between planned
407 initiatives and current and future activities.

408

409 Cross-scale and cross-sectoral partnerships can also provide the capacity, coordination, and
410 mechanisms needed for implementation. By pooling technical and financial capacity between
411 partners and leveraging their influence, agency, authority, and networks, coastal initiatives are
412 more likely to address root causes at the appropriate scale. In Eastern Indonesia, collaborations
413 between local communities, provincial and national governments, and international NGOs,
414 created a network of MPAs to improve coral reef resilience and protect local rights by building
415 on, and reinforcing, local customary tenure rules with provincial regulations and national level
416 support ¹¹⁵. **Cross-scale partnerships may also be necessary to effectively respond to shocks.** In
417 Mauritius, a local NGO leveraged its pre-existing local and regional networks and
418 infrastructure to serve as a hub for the volunteer response to a major oil spill that severely
419 impacted sensitive coastal habitats ¹¹⁶. However, community members lacked the necessary
420 protective equipment to safely address the spill. In this case, strong cross-scale partnerships
421 between local actors and those at higher levels of governance could have ensured that adequate
422 resources were available to avoid unnecessary health risks. To effectively address root drivers
423 in other contexts partnerships may require national actors to address unsustainable or
424 inequitable national economic policies, producers in the agricultural sector to address upstream
425 watershed pollution (Box 2 - Fiji case), or local community leaders to address unjust practices
426 regarding groups subject to marginalization. At a global scale, leveraging existing cross-
427 sectoral initiatives, such as the UN Decade on Ocean Sciences, UN Global Compact, and the
428 United Nations’ Sustainable Development Goals (SDGs), can take advantage of the multiple
429 intersections between global targets and agendas, and provide a supportive platform or starting
430 point to advance synergistic policy development ^{114,117,118}.

431

432 **Overcoming barriers to transformation**

433 Implementing the three strategies we outline above is not without significant challenges
434 given that trade-offs can exist between the climate, development, and conservation agendas,
435 particularly across geographic and temporal scales ^{119,120}. Such partnerships will require
436 going beyond “stakeholder participation” practices that commonly do not constitute
437 meaningful engagement ⁶¹, taking proactive steps to address power imbalances, pre-existing
438 injustices, and conflicts that prevent broad and equitable participation and local leadership in
439 integrated planning.

440

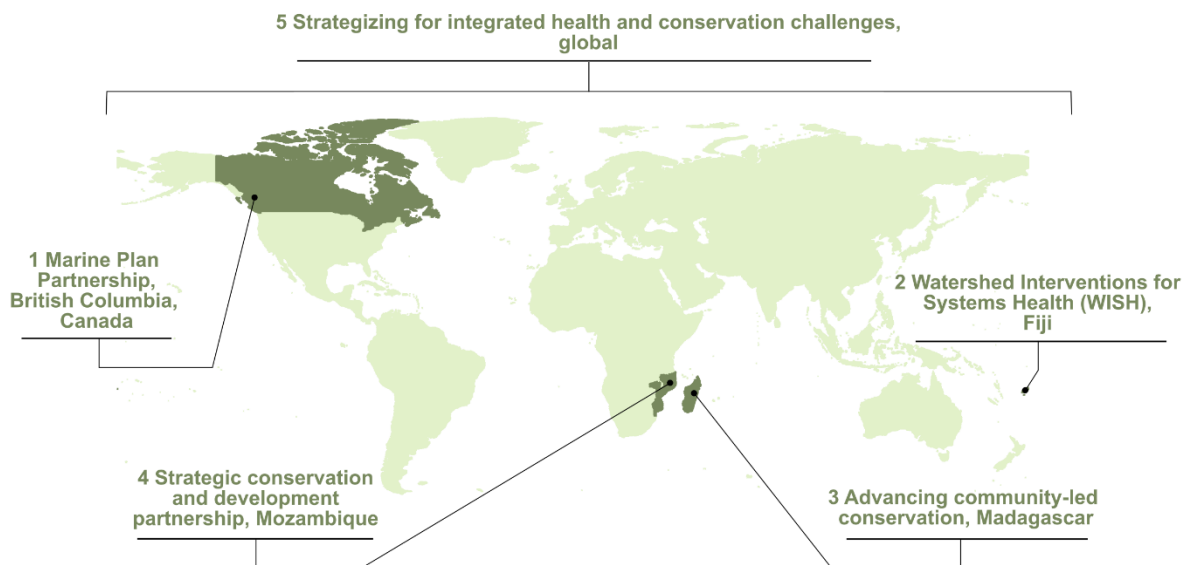
441 Leveraging and learning from existing partnerships and approaches that forefront justice and
442 equity issues can be a useful strategy to achieve more just outcomes. For example, the
443 Indigenous and Community Conserved Areas Consortium [ICCAs] and the Conservation
444 through Reconciliation Partnership are taking steps to address prior injustices and empower
445 disenfranchised groups who might be disadvantaged by large-scale initiatives. Formalizing
446 shared and locally-led resource governance arrangements, rights-based approaches,
447 collaborations with human rights organisations, or the use of national or international courts
448 can also empower local actors to address historical marginalization ¹²¹. Such mechanisms
449 have been successfully used to challenge powerful forces. For example, Viglione ¹²² reports

450 an increase in litigious responses to climate change, documenting the example of a Peruvian
451 farmer who has brought a legal case against the largest emitter of CO₂ in the European
452 Union. In some cases, restorative justice (e.g., reparations) could be warranted to address
453 historical injustices, as demonstrated by the fisheries and forestry reparations for Maori
454 populations in New Zealand ¹²³ and ongoing efforts in British Columbia, Canada to foster
455 reconciliation with Indigenous peoples through collaborative fisheries governance ¹²¹ (Box 2
456 -Canada case). In other cases, it will require significant transformation of current structures
457 and mechanisms. For example, current funding mechanisms are biased towards organizations
458 who can navigate the bureaucratic complexities of funding bodies. Making these funding
459 mechanisms more accessible to local rights-holders can facilitate greater self-determination
460 by allowing them to develop and implement initiatives themselves.

461

462

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



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.

466 The approaches recommended here will require long-term investment of time, energy, and
 467 resources to ensure sustained effectiveness in addressing triple exposure. Efforts to address
 468 pre-existing power imbalances, historical injustices, conflict, limited capacity, and siloed
 469 governance that hinder effective collaboration require long-term investment beyond traditional
 470 donor cycles. Similarly, developing local capacity for increased local leadership and ongoing
 471 participation in partnerships also requires sustained investment. As such, addressing triple
 472 exposure requires advancing beyond the one-off or sporadic multi-stakeholder interventions
 473 that are currently employed, towards creating mechanisms that enable and sustain broad
 474 participation in decision-making, ongoing dialogue, trust-building, conflict resolution, and
 475 difficult conversations surrounding historical injustices ¹²⁴ (Box 2) The rapidly accelerating
 476 changes brought about by triple exposure also necessitate enduring and adaptive governance
 477

478 and monitoring systems. With ongoing investment in collaboration, partners can continuously
 479 share insights on emerging drivers of vulnerability and inequality, novel trade-offs and impacts
 480 generated by recent policies or disturbances, and co-develop or adaptively manage strategies
 481 to appropriately respond¹²⁵.

482

483 **Conclusion**

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

502

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881

882 **Figure Legends**

883 Figure 1. Transformative strategies to reduce negative triple exposure impacts by prioritizing
884 social justice and building general resilience. Strategies can be jointly applied to reduce triple
885 exposure. For example, implementors can employ participatory systems approaches to identify
886 root causes of vulnerability and inequality, potential impacts of future initiatives, identify
887 appropriate solutions to address root causes, and avoid maladaptive/inequitable outcomes.
888 Developing and leveraging inclusive cross-scale and cross-sectoral partnerships can facilitate
889 implementing these participatory approaches by improving diversity, recognition, and

890 integration in planning, and increasing capacity and coordination for implementation. See
891 Supplementary Figure 1 for additional information on linkages between strategies.