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Creating a space for place and multi-dimensional well-being: lessons learned from localizing the SDGs

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FRONT MATTER

Title

Full title: Navigating Multidimensional Measures of Sustainability and Well-Being Across Scales
Short title: Multidimensional Measures of Sustainability and Well-Being

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Abstract

Achieving sustainable development globally requires multi-scale and interdisciplinary efforts and perspectives. Global goals shape national-level priorities and actions, creating cascading impacts realized at the local level through international aid and implementation of programs intended to achieve progress towards these metrics. We compare the UN Sustainable Development Goals (SDGs) to regionally-developed dimensions of Pacific Well-being. Some dimensions related to human health and access to infrastructure and finances are well represented in the SDGs, whereas others, such as those regarding connections between people and connections to place, are not. We identify challenges in applying SDG indicators at the local level and provide lessons learned for national-level reporting to foster equitable and holistic approaches and outcomes for sustainability: Enhance systems-based approaches to policy and management; Draw on locally-relevant well-being definitions to develop indicators; Develop indicators on the connections between both people and place, and on Indigenous and local knowledge; Recognize potential biases towards easy-to-measure metrics; and Carefully consider how data are collected.

1 MAIN TEXT

2
3 **Introduction**

4 The 2030 Agenda for Sustainable Development and Sustainable Development Goals (SDGs),
5 adopted by the United Nations in 2015, lays out a shared vision for a more prosperous,
6 equitable, and environmentally sustainable world where no one will be left behind. The SDGs are
7 the result of a complex and extensive negotiation process (1) and encompass 17 broad and
8 conceptually interlinked global goals, each with underlying targets and nested indicators (Fig. 1).
9 While the SDGs are presented as an indivisible whole, in practice there is little guidance or detail
10 regarding potential or realized trade-offs and synergies between and across the goals (2).
11 Achieving the interrelated SDGs will require systems approaches, explicitly considering the
12 structure (elements and interactions), purpose, and emergent behavior of complex adaptive
13 systems (3). This can facilitate a better understanding of how (i) various SDG goals, targets, and
14 indicators interconnect (2, 4); (ii) SDGs are underpinned by biodiversity and ecosystem services
15 or nature's contributions to people (5); and (iii) SDGs impact human well-being at the local scale.
16 An analysis by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem
17 Services (IPBES) finds that efforts to maximize SDGs relating to energy, economic growth,
18 industry and infrastructure, sustainable consumption and production, poverty, food security, and
19 cities could produce trade-offs for nature that in turn negatively affect human well-being and the
20 achievement of interlinked goals (5). Global frameworks do ultimately impact local communities
21 through the direction of financial resources and through on-the-ground implementation of
22 development strategies. Ignoring complex interactions within and across social-ecological
23 systems risks increased potential for misdiagnosis and implementation of interventions with
24 unintended and potentially negative outcomes for communities at local scales (6).

25 National-level reporting agencies (such as National Statistics Offices) are in a unique
26 position to be able to address interrelationships across goals while also setting national priorities,
27 programs, targets, and associated indicators based on their country's geographic, political,
28 technological, and other development-related contexts (2). With this in mind, national-level
29 reporting agencies should be able to identify metrics (including goals and targets) that are
30 relevant to people of that nations' varied viewpoints, aspirations, and cultural settings. One
31 critical viewpoint to consider, especially given Member States' commitment to leave no one
32 behind in the 2030 Agenda, is that of Indigenous Peoples and local communities (IPLCs), who
33 manage or have tenure rights over more than a quarter of the world's land surface and whose
34 participation and inclusion in environmental governance enhance environmental conservation,
35 restoration, and sustainable use for broader society (5). Indigenous and local expert
36 observations and knowledge are based upon and highlight the interconnections between parts of
37 a system (7), and could help to connect across hierarchically structured global metrics (Fig. 1).

38 In addition, measurement of multidimensional well-being can be an integrated way for
39 countries to assess culturally-relevant progress towards disparate sustainable development
40 goals (4, 8). A multidimensional well-being lens focuses by definition at a systems level, on both
41 humans and non-humans, and builds on context-specific perceptions of health and well-being.
42 Using a well-being lens can also provide insights into the power dynamics among social groups,
43 community decision-making, and the drivers of change (9), and allows social values and
44 priorities to inform policies and management (10). Recognizing this point, several groups and
45 organizations across multiple locations have attempted to operationalize a multidimensional well-
46 being focus for monitoring societal progress that is aligned to specific local contexts with
47 sensitivity across a broad range of human dimensions. For instance, in Aotearoa New Zealand,
48 the Government has structured national budgeting around well-being, and will assess progress
49 using indicators of intergenerational well-being (11). Other examples include "buen vivir" and
50 associated Indigenous concepts in Central America (12), "ubuntu" value systems in eastern

51 Africa (13), Bhutan's Gross National Happiness Index (14), Melanesian Well-being Indicators
52 (15), the United Kingdom National Wellbeing Measures (16), and the California Current
53 Integrated Ecosystem Assessment (17).

54 In order to explore how the SDGs can best support local human well-being and
55 environmental health, we systematically compare the SDG indicators with a list of regionally-
56 derived well-being factors for the Pacific Islands (18) (hereafter "Factors"), which were developed
57 by biological and social scientists and community members and organizers who all collaborate
58 with communities from across the Pacific Islands on resource management or cultural vitality.
59 The Pacific Islands region is distinguished by its high biological and cultural diversity, and by
60 historical and contemporary resilience to environmental and social variability (19, 20). The
61 Factors are grouped into eight dimensions (hereafter "Dimensions") (Tables 1, S1). Collectively
62 the list encompasses critical components of well-being and social-ecological resilience across
63 the Pacific and is intended as a dynamic/living product, which can be adapted relative to needs
64 and priorities of the groups that use it.

65 Here we seek to answer three main questions: (i) what are the overlaps and gaps
66 between the SDG indicators and the Pacific Islands Well-being Dimensions?; (ii) to what extent
67 are the SDG indicators applicable for measuring well-being at the local level in the Pacific?, and
68 (iii) based on the above, what are the trade-offs or challenges in national reporting and
69 implementing of SDGs? Our analysis of overlaps and differences between local and global
70 scales and approaches can assist decision makers to navigate the synergies and trade-offs
71 between the SDGs, and result in better-informed efforts at different scales (Fig. 1). In closing, we
72 provide a set of lessons learned for SDG indicator development and reporting at the national
73 scale.

74 **Results**

75 *Gap Analysis*

76 We coded linkages between SDG indicators and Well-being Factors and identified 447 linkages
77 that were made by at least two individual coders. The greatest number of linkages to the SDGs
78 were from Factors within two Well-being Dimensions: *Human Health* (n=140) and *Access to*
79 *Infrastructure, Civic Services, and Financial Resources (Infrastructure/Finance)* (n=126) (Figs. 2,
80 S1). Within *Human Health*, the Factors with the greatest number of linkages were related to
81 physical health (n=47) and individual and/or collective security and safety (n=26). For *Access to*
82 *Infrastructure, Civic Services, and Financial Resources*, the Factors with the highest number of
83 linkages were related to access to and use of health infrastructure and services (n=25) and
84 equitable access to and use of financial resources and services in vulnerable populations (n=18)
85 (for further detail see table S2). Only a handful of SDG indicators were associated with Well-
86 being Dimensions *Connectedness to People and Place (People & Place)* (n=3) and *Indigenous*
87 *and Local Knowledge, Skills, Practice, Values, and Worldviews (Indigenous and Local*
88 *Knowledge)* (n=2). The greatest number of linkages were found with those SDG indicators within
89 SDG 3 - Good Health and Well-being (n=101) (fig. S2).

90 To understand how effectively each Well-being Dimension was represented by the SDGs,
91 we calculated the percentage of Factors in each Dimension that were linked to at least one
92 indicator (Fig. 3). Of the 89 Factors scored (table S1), 62 (70%) have linkages with at least one
93 SDG indicator. All individual Factors within three Dimensions, *Sustainability Management*,
94 *Infrastructure/Finance*, and *Human Health* were linked to at least one SDG indicator, as shown in
95 Fig. 3. Only 20% of the Well-being Factors in the Dimension *People & Place* and 25% of the
96 *Indigenous and Local Knowledge* Factors were linked with an SDG indicator.

97 Through the coding activity and subsequent small working group discussions, we
98 identified concepts present in the SDG indicators that had strong bearing on well-being but were
99 not clearly articulated in the regionally-derived Factors. These topics were woven into an
100 updated iteration of the Well-being Factors (table S1, new additions in bold) through the creation
101 of four new Factors (e.g., *Access to and use of education-related infrastructure and services*),
102 strengthening of existing Factors (e.g., expanding the Factor on individual or collective security to
103 focus on social and economic risks in addition to environmental risk), and in revisions to the
104

105 framing and language used. Gender and other forms of social equity are part of several Well-
106 being Factors, but do not have distinct Dimensions or Factors.

107 *Applicability, Trade-off, and Indicator Measurement Challenges Analyses*

108 In addition to identifying overlaps and gaps between SDG indicators and Factors, we also drew
109 on our experience working with communities across the Pacific, using a systems approach to
110 assess if SDG indicators would be applicable to measure the Factors at the local scale, and if
111 there are any potential trade-offs or measurement challenges. We deemed 160 SDG indicators,
112 or 99% of the 162 indicators analyzed (see Methods, table S3), to have trade-off and applicability
113 issues in some way at the local level, encapsulated in 913 coder assessment comments in total
114 from across the 14 coders. We summarized the comments into seven categories that describe
115 the nature of trade-offs and measurement challenges (Table 2).

117 Perceived practical challenges to indicator measurement encompassed issues such as
118 ‘Disaggregation’, ‘Feasibility’, ‘Links to Target’, and ‘Scale’. For instance, in terms of
119 ‘Disaggregation’, SDG 14.5.1: “protected area in relation to marine areas” may be more
120 applicable with greater specificity in detail on governance type or spatial measures (e.g., include
121 the proportion of protected area covered by customary marine tenure, which is not traditionally
122 counted under “protected areas” but is increasingly being considered via categories such as
123 Other Effective Area-Based Conservation Measures promulgated by the International Union for
124 Conservation of Nature). Further, the spatial extent itself is arbitrary if it does not account for
125 ecological characteristics, such as habitat type (sand flat, seagrass, mangrove, reef, etc.) and
126 the life histories of species that may inhabit the protected area. Several SDG indicators pose
127 potential ‘Feasibility’ issues, which can arise from lack of technical capacity and/or insufficient
128 methodologies to meaningfully and accurately collect data. For example, different localities may
129 have limited technical ability and resources to comprehensively track financial flows, and flows of
130 goods and services (e.g., indicators 16.4.1, 16.4.2) resulting in large data gaps.

131 In ‘Links to Target’ challenges, an existing indicator might measure one link to a target
132 and overlook other important aspects of the target. For instance, SDG 15.7.1 on the proportion of
133 traded wildlife that was poached or illicitly trafficked does not adequately cover all aspects of the
134 target it is nested under, which aims to enhance global support to combat poaching, including
135 through increased capacity of local communities to pursue sustainable livelihood opportunities.
136 Regarding ‘Scale’ challenges, as one example SDG 2.5.1 measures the number of genetic
137 resources for food and agriculture saved in medium or long term conservation facilities. These
138 facilities tend to be *ex situ* and are often difficult for communities to access when needed. This
139 could impede food security at the local scale if local conservation facilities such as community
140 seed banks do not receive attention.

141 The greatest number of the ‘Focus/Bias’ category coder assessments were characterized
142 by cultural biases towards a particular knowledge system to the exclusion of other ways of
143 knowing. In the ‘Social Harm Trade-off’ category, these biases translated into the potential for
144 unfavorable and unintended consequences of, for instance, overlooking social-cultural values
145 and norms surrounding concepts such as poverty, food security, or livelihoods. For example,
146 coders identified a bias towards formal employment, which could promote the uptake of low-
147 wage employment at the expense of traditional subsistence livelihoods. In addition, indicator
148 8.3.1 measures the proportion of informal employment in non-agriculture sectors with the intent
149 to identify informal labor markets that take advantage of marginalized individuals where legal and
150 social protection is limited. However, intent does not always equal impact -- the idea that work
151 within the informal economy is inherently problematic could lead to degradation of subsistence
152 labor, including fishing, which is increasingly recognized as substantial and valuable, and should
153 be included in labor statistics (21). In the ‘Environmental Harm Trade-off’ category, coder
154 assessments related to indicators that could encourage environmental degradation. For instance,
155 coder assessments classified as ‘Environmental Harm Trade-off’ identified that indicator 9.2.1
156 (concerning manufacturing value as a proportion of GDP) could also promote non-
157 environmentally friendly manufacturing practices and encourage unsustainable use of natural
158 resources over their conservation.

159 Across all categories of challenges, many coder assessment comments identified trade-
160 offs and measurement challenges with indicators that emphasize monetary transactions for
161 goods and services. This prompted us to undertake an additional analysis to assess the extent to
162 which indicators rely on “monetary economy-based” metrics to denote success. Out of 162
163 indicators, 25 (15%) included components focusing on or directly relating to the monetary
164 economy. In our analysis, coder assessments fell into one or both of two groupings: failure to
165 convey the full breadth of well-being and diversity of local perspectives, and failure to encompass
166 the nature and quality of economic growth. In the first grouping, coder assessments pointed out
167 that indicators related to monetary compensation (e.g., indicator 8.5.1 regarding hourly earnings
168 of employees) overlook other aspects of an individual’s livelihood that may be key in subsistence
169 communities. Monetary economy-based indicators can risk over-representing single perspectives
170 on, and contribution to, sustainability (challenges of both ‘Focus/Bias’ as well as ‘Scale’). For
171 example, emphasis on industries (e.g., indicator 9.b.1 regarding the proportion of medium and
172 high-tech industry value added in total value added) may overlook other important community or
173 Indigenous activities that make strong contributions to social cohesion and community well-
174 being.

175 In the second grouping, failure to encompass the nature and quality of economic growth,
176 coders found that a focus on measuring changes in monetary economy-based indicators fails to
177 convey other important factors. For instance, coder assessments regarding indicator 8.4.2
178 (related to domestic material consumption), pointed out that this indicator encourages material
179 consumption growth which could lead to greater use of natural resources. It does not measure
180 other factors such as the sustainability of such growth, including its environmental impact and
181 potential for social harm. Coders also raised the point that focusing on expenditures for activities
182 intended to promote sustainable development overlooks the potential negative impacts of these
183 activities -- more funds being spent does not necessarily imply success or beneficial impacts. For
184 example, coder assessments regarding indicator 17.17.1 (concerning the amount of dollars
185 committed to public-private and civil society partnerships) does not lend any insight into whether
186 these partnerships were equitable or effective. These indicators are relatively easily measured,
187 but may not be meaningful on their own.

188 Overall, coder assessments underscored that very few indicators, or sets of indicators
189 under a target, adequately addressed the potential for trade-offs or other feedbacks between
190 goals, pointing to an important next step for SDG reporting efforts. The assessments also noted
191 that some indicators could better reflect trade-offs and be better adapted to local use with minor
192 modifications such as greater disaggregation, whereas others might be best addressed through
193 reporting on metrics more relevant to local and national contexts. Coders called out already
194 existing language useful to address these problems, such as is found in indicator 1.2.2:
195 Proportion of men, women and children of all ages living in poverty in all its dimensions
196 *according to national definitions (emphasis added).*

197 198 199 **Discussion**

200 Meeting the interconnected SDGs at a global level, while also supporting local and regional
201 sustainable development, entails a careful framing of what success looks like (5). Our research
202 shows that, in the context of the Pacific, there are overlaps but also significant gaps between
203 local and regional conceptions of well-being and the globally-derived SDGs. Furthermore,
204 internationally generated indicators may result in trade-offs and measurement challenges in local
205 or regional contexts. While the SDGs themselves result from extensive negotiations and
206 represent fixed global commitments, the implementation of the global sustainability agenda
207 hinges on each country’s sustainable development policies, plans, and programs. Our analysis
208 highlights opportunities for national reporting organizations to describe and achieve progress
209 toward these goals and targets in culturally and locally attuned ways.

210 211 *Assessing the Overlaps and Gaps*

212 Cross-referencing the Pacific Island Well-being Factors with SDG indicators yielded important
213 insights regarding overlaps and gaps between regional and global scales. Our analysis shows

214 that some Well-being Dimensions are very well-represented in global metrics. In fact, all
215 individual Factors within three Dimensions, *Sustainability Management*, *Infrastructure/Finance*,
216 and *Human Health*, were linked to at least one SDG indicator.

217 However, other Dimensions of locally important well-being, including *People & Place* and
218 *Indigenous & Local Knowledge*, are under-represented or are only obliquely referenced in the
219 SDG indicators. These are problematic omissions. The *People & Place* Dimension encompasses
220 important reciprocal relationships humans maintain with one another and with the environment
221 (5, 22, 23). These relationships, which are often paired with corresponding social and cultural
222 norms, codes of conduct, and responsibilities, manifest in different ways based on the social-
223 cultural setting. The relationships contribute to individual/community well-being and
224 environmental sustainability (18, 24, 25). For instance, *varivagana* is an important cultural
225 concept in Simbo, Solomon Islands, centered on generosity and reciprocal obligations across
226 social networks (26); in Hawai'i *laulima* emphasizes collective action supported by strong social
227 networks (23). Connections and networks within communities can facilitate knowledge transfer
228 and learning as well as exchange of resources, particularly in times of need, and their
229 composition can have an outsized impact on support, self-organization, and resilience in the face
230 of challenges (6). A growing number of international efforts aim to articulate and evaluate these
231 types of connections, such as the Organization for Economic Co-operation and Development's
232 Better Life Initiative metrics on support networks (27). These could serve as models for national
233 agencies in reporting on these critical connections.

234 Furthermore, in many places around the world, connections between people cannot be
235 discussed in the absence of connections to place. In developing the Pacific Well-being Factors
236 (18), community visioning workshop participants emphasized that relationships between people
237 and their related connections to a place are fundamental to healthy communities. For instance,
238 the Fijian term *vanua* (lit. land) encompasses the interconnectedness of all living things
239 (including people) and their surrounding environment as well as the associated knowledge,
240 practices, and skills that maintain those interactions (28), a concept mirrored throughout the
241 Pacific (e.g., *whenua* in Māori, *fanua* in Samoan) (29). The value systems associated with
242 "alternative" economies, such as those that draw heavily on subsistence and other place-based
243 practices, often inform cultural norms oriented around long-term sustainable interactions
244 between humans and their environment (22). There is also an emerging literature on the concept
245 of "solastalgia" - the sense of loss when people's connection to place is disrupted because of
246 changes to that place that can lead to grief, anguish, and ill-health (30). Synthesis of these
247 important values into global goals and policies and the full and effective participation of
248 Indigenous Peoples and local communities (IPLCs) in environmental governance is crucial to
249 sustaining well-being in place-based communities and broader society (5).

250 The *Indigenous and Local Knowledge* Dimension concerns the processes by which
251 Indigenous Peoples and local communities develop, refine, and transmit knowledge. Traditional
252 occupations based on Indigenous and local knowledge (ILK), such as subsistence fishing and
253 farming, relate directly to food security and sovereignty and are also crucial for social cohesion,
254 the perpetuation of place-based practices, and the maintenance of knowledge, values, and
255 cultural protocols associated with those practices (31). However, ILK is impacted by a number of
256 factors, including government policy: for example, numerous governments treat wildlife harvest
257 practices on Indigenous territories (e.g. subsistence hunting and fishing) as unsustainable and
258 characterize these practices as illegal poaching (32). An absence of ILK consideration in
259 resource management planning can result in cascading negative impacts on communities
260 involved in environmental management (7, 18, 32).

261 Our comparison between the SDGs and Pacific Well-being Factors also uncovered gaps
262 in the latter, specifically related to labor rights, education-related infrastructure, corruption, and
263 harassment (table S1, new additions in bold). While gender and other forms of social equity are
264 considered to be cross-cutting issues and feature in several Well-being Factors, gender equity
265 does not have separate Dimensions or Factors because of its broadly applicable relevance (33).
266 In practice this made it difficult to undertake the gap analysis with specific SDG gender-equity
267 indicators, and underscores the challenges for national level reporting agencies in grappling with
268 cross-cutting concepts that can be unintentionally omitted.

270 *Gauging Applicability, Trade-offs and Measurement Challenges of Globally Developed Indicators* 271 *at the Local Level*

272 Our analyses revealed not just gaps in connections between the regional Well-being Factors and
273 SDG indicators; we also found that 99% of assessed indicators presented potential trade-offs or
274 measurement challenges that could be problematic in some way for local-level use in Pacific
275 Islands. The implementation process established for the SDGs anticipates this outcome, which is
276 why countries have the freedom to develop tailored reporting tools built on indicators that are
277 most relevant to their situations (2). We identified measurement challenges that range from
278 relatively minor issues (e.g., concerns about interpretation) to more fundamental issues,
279 including troubling trade-offs. With the former, small changes to some indicators (e.g., providing
280 greater disaggregation information on governance type) might result in increased relevance at
281 the local level. However, significant trade-offs arise when there are differing values at the global
282 versus local scales.

283 Many indicators are based on social norms that may not be applicable in all cultural
284 contexts, and good intentions can actually lead to trade-offs within a system, resulting in social
285 harm. For example, existing SDG education indicators ignore informal learning opportunities,
286 such as when children learn from helping their parents with work, where they can gain local
287 knowledge to enhance productivity, adaptation, and resilience over the long term [e.g., (34)]. We
288 found that prioritizing formal employment in order to improve social and legal protections for
289 workers creates a trade-off for subsistence-oriented traditional occupations. This can perpetuate
290 the systematic disenfranchisement and further marginalization of Indigenous Peoples and local
291 communities and the ILK systems that underpin aspects of resilience, particularly in rural areas.
292 National reporting agencies should follow the guidance of the International Labour Organization
293 and recognize traditional occupations, such as subsistence farming and fishing, within the scope
294 of “productive employment” and “decent work.”

295 Furthermore, we found that some indicators could drive activities that harm rights and
296 access for IPLCs. For instance, several SDG indicators imply that central and national
297 governments should safeguard natural or cultural heritage, when in many regions such
298 maintenance is more likely to be supported at the local level [e.g., Melanesia (34)]. Indicators
299 prioritizing strict protected areas may promote the rights of central government at the expense of
300 IPLCs. This can lead to disenfranchisement, community displacement, and potentially the
301 replacement of effective local stewardship with ineffective/absentee management (35).

302 Similarly, some indicators (e.g., ownership or secure rights of land as outlined in SDG
303 1.4.2, relying on legally recognized documentation to land) are based on privatization and
304 individual land rights, ideas that may clash with culturally-mediated relationships to and
305 interactions with place (36). Legally recognized documentation is not standard for land tenure
306 systems in all communities and there may be other ways to articulate that communities “perceive
307 their rights to land as secure”. Resource privatization (for example, with the introduction of
308 individual fishing quotas in Kodiak Alaska as described in (36)), can have divisive, negative
309 impacts on the cultural norms, values, and lifestyles that contribute to maintaining reciprocal
310 relationships and well-being across people and place. We, the authors, have observed that in
311 Indigenous communities the term “rights” is often paired with the term “responsibilities” (22, 37).
312 Placing emphasis on property or access rights without reference to responsibility could break
313 down existing stewardship structures, for instance collective or communal resource management
314 systems (7). Adaptive understandings of access and ownership will be increasingly important as
315 communities around the world begin to experience the impacts of global climate change (for
316 instance those losing their ancestral lands to sea-level rise).

317 Our analysis also indicated that the SDG indicators tended to center the monetary
318 economy as a development pathway, which may fail to align with local norms and values and
319 reflects a lack of a systems approach in considering the many interacting factors at play. We
320 found that an overemphasis on the monetary economy can cause social or cultural harm by
321 devaluing other important forms of reciprocity-oriented social norms (38). Economic assumptions
322 such as individual maximization are often at odds with Indigenous and local perspectives on
323 collective well-being and with long-standing community practices in which the non-monetary

324 benefits of reciprocal human and environmental interactions may outweigh financial incentives or
325 returns (39). One such imperiled value encompasses the knowledge and practice of growing and
326 sharing food within and across communities, which ultimately impacts food security and
327 sovereignty (37). Economic models that commodify natural resources and prioritize optimization
328 and utility can lead to unsustainable resource use, which, in turn, may result in both
329 environmental and social harm (33, 40). This may lead to policies, regulations, and management
330 actions that prioritize individualistic pursuits of benefits (i.e., income generation) at the expense
331 of social norms, community cohesion, and community trust which in turn can drive political and
332 social instability (37). In addition, prioritizing ecosystem services that are the most easily
333 assessed using monetary valuation techniques can diminish the importance of other values of
334 nature, for instance relational, intrinsic, cultural heritage, and subsistence values (31). A
335 systematic review of the literature on well-being outcomes of marine protected areas found
336 disproportionate focus on economic indicators of well-being, and limited representation of
337 indicators from other social and cultural domains, raising the prospect that the most quantifiable
338 indicators have come to dominate the scholarship on well-being outcomes (41). We note that this
339 unevenness may stem from societal bias towards economic outcomes and the consequent
340 abundance of relatively easily gathered data on economic indicators.

341 Stressing financial attributes, for instance with SDG indicators focusing disproportionately
342 on quantifying economic status or income level with an emphasis on GDP-driven indicators (42,
343 43), causes an imbalance in how countries are perceived (15) and can change the way people
344 are perceived within their own community. Indicators that run counter to social norms potentially
345 limit the ability to collect accurate data, and may also have long term impacts on communities
346 such as “deficit thinking” in response to vulnerability frameworks (44).

347 Monetary prioritization can facilitate negative trade-offs with other aspects of well-being
348 and it is important to focus on the nature and quality of growth, rather than volume of growth
349 alone (4). Undesirable types of growth include *voiceless growth*, which suppresses democracy
350 and includes growth that comes as a result of political repression and/or authoritarian regimes
351 that silence dissenting voices; and *rootless growth*, which is detrimental to cultural identity, and
352 includes instances when growth amplifies the power of the cultural majority which it uses to
353 impose cultural uniformity (e.g., by negatively impacting cultural minority groups through actions
354 such as choosing a national language). A disproportionate focus on economic growth also fails to
355 take into account that above a certain income level more growth does not necessarily lead to
356 greater well-being (4).

357 *Key lessons learned*

358 Building on the remarkable work already undertaken in the context of SDGs, we offer five
359 lessons learned, which will be relevant to national reporting agencies charged with developing
360 locally and nationally-relevant reporting and implementing tools. We provide overarching lessons
361 to address the most critical challenges identified in our work.

- 362 **1. Enhance systems-based approaches to designing and evaluating policy and**
363 **management.** A growing literature is acknowledging and investigating the
364 interrelationships among the SDGs, and within other policies that impact well-being
365 sectors (5, 45). This systems approach allows for identification, mapping, and leveraging
366 synergies between and across multidimensional measures of sustainability and well-
367 being. Seeking to understand the cross-sectoral synergies for policy and action can
368 produce co-benefits across goals and targets, and improve indicators and datasets for
369 national-level reporting. At the same time, intent does not equal impact. People
370 developing or choosing to use an indicator should carefully consider the broader context
371 and anticipate the dynamic interactions within complex adaptive systems that might lead
372 to negative consequences for human well-being and environmental health.
- 373 **2. Draw on locally-relevant definitions of well-being to develop monitoring and**
374 **evaluation indicators.** Nations should spend more effort and attention on understanding
375 what well-being means to their citizens in order to collectively move towards
376 sustainability. Reporting bodies should be attentive to local and national priorities and
377 values and recognize the importance of co-created knowledge and action. This helps
378

379 avoid unintended harmful consequences in complex adaptive systems of development
380 interventions based on globally defined standards or approaches. In locations with high
381 cultural diversity and/or low social cohesion, identifying commonalities and focusing on
382 indicators around those is a good place to start.

- 383 **3. Foster identification and use of meaningful indicators on the connections between**
384 **both people and place, and on Indigenous and local knowledge.** Understanding the
385 ways people connect with place and with one another is essential for sustainable
386 outcomes. Small changes to some indicators (e.g., providing greater disaggregation
387 information on governance type such as community-conserved areas as well as
388 government-led protected areas) might result in increased relevance at the local level,
389 whereas larger efforts need to be made where there are significant disconnects in values.
390 For instance, indicators that measure collective well-being and not just individual well-
391 being would be important to consider.
- 392 **4. Recognize potential biases towards easy-to-measure metrics.** To paraphrase Elliot
393 Eisner, not everything that is easily measurable is important and not everything that is
394 important is easily measured. For instance, focusing sustainability efforts on data-rich
395 areas to the exclusion of other biologically and culturally important areas may
396 unintentionally contribute to the continued marginalization of IPLCs and their ability to
397 determine their own development priorities. Furthermore, reporting agencies should
398 consider options beyond existing standardized quantitative metrics that may miss
399 important place-based nuances (46) and opt for a combination of qualitative and
400 quantitative metrics. This may include a focus on not just endpoints, like population sizes
401 of species, but also on the processes that contribute to effective population management
402 such as local knowledge and social relationships (18).
- 403 **5. Carefully consider how data are collected.** Global goals shape national-level priorities
404 and actions, creating cascading impacts realized at the local level through international
405 aid and implementation of programs intended to achieve progress towards these
406 metrics. Consequently, data collection should be conducted with empathy, follow place-
407 based cultural protocols, align with standards of Free, Prior, and Informed Consent (see,
408 for example, guidelines developed by the International Society of Ethnobiology), and be
409 mindful of power dynamics within and across scales. Ultimately the successful
410 implementation of indicators can depend on how and in what context data are collected
411 rather than the specifics of the indicator itself.

412 **Conclusion**

413 Despite differences in framing or intention, efforts at global, national, sub-national, and local
414 scales have significant potential to draw inspiration from one another and compare indicators to
415 enable adaptive learning and evaluation. Transformative sustainable development requires
416 interlinked policy objectives across sectors such that synergies can emerge during planning and
417 implementation (6, 47). Identifying synergies and differences between indicators used at local
418 and global scales and related approaches can result in stronger conceptualization and
419 implementation at each scale (Fig. 1). Cross-scale comparison is not without its challenges;
420 however, as we have shown, coordinated efforts can identify common ground leading to
421 complementary metrics tailored to each scale. The critical role of international frameworks like
422 the SDGs in national-level priority settings underscores the importance of indicators that
423 acknowledge and address diverse community-based perspectives and cultural contexts. In the
424 face of increasing calls for coordination across sectors to link goals and interventions, national
425 level agencies can take a systems approach that addresses potential synergies and trade-offs
426 across the SDGs. Our analysis points to areas of focus for further work, for instance on metrics
427 connecting people and place.

428
429 Lessons learned from our analyses can inform national-level reporting on existing
430 indicators, monitoring and reporting criteria developed by international funders and conservation
431 and development implementers, and new agreements under negotiation (e.g., post-2020
432 biodiversity agenda discussions). While our work focuses on the Pacific Islands, the participatory
433 process, the expert elicitation approach, and analytical method we used, as well as the key

434 lessons learned, are transferable to other geographic areas with existing well-being frameworks.
435 We recommend complementary regionally-focused analyses to further clarify and weave local
436 values, cultural practices, and Indigenous priorities into monitoring and evaluation programs
437 across scales.

438 **Materials and Methods**

439 ***SDG indicators***

440 We compiled the 232 SDG indicators as of March 2017. Our analyses examined the local
441 applicability of these key indicators; consequently, we screened the indicator list before our
442 analyses to eliminate those that were only intended to be measured across nations (e.g., SDG
443 1.5.3 Number of countries that adopt and implement national disaster risk reduction strategies in
444 line with the Sendai Framework for Disaster Risk Reduction 2015-2030). Of note, due to removal
445 of redundant and national level indicators, we did not include any indicators under SDG 13:
446 Climate Action. The resulting list had 162 SDG indicators (table S3).

447 ***Pacific Island Well-being Factors***

448 These analyses use a list of Well-being Factors (table S1), developed by biological and social
449 scientists and community members and organizers who all collaborate with communities from
450 across Pacific Islands on resource management or cultural vitality, to assess the local
451 applicability of international indicators (Fig. 4). Taken together, these Factors represent our
452 current understanding of the critical dimensions of well-being and biological and cultural
453 resilience in different communities across the Pacific. Our comparative analyses used the 89
454 well-being Factors and eight overarching Dimensions, including detailed descriptions and place-
455 based examples of each Factor drawn from an iterative process involving community visioning
456 workshops and small working group triangulation (18).

457 In 2016, our small team of researchers organized and executed a series of visioning
458 workshops in Fiji, Solomon Islands, Republic of the Marshall Islands, French Polynesia, and
459 Hawai'i, engaging Indigenous Peoples and local community members and conservation
460 professionals who work closely with them. Workshop participants brought a diverse array of
461 experience with resilience and well-being through policy, management, and/or implementation
462 via place-based practices. During a series of interactive and deliberative discussions,
463 participants were asked to describe what "a good life" looks like in each of their communities.
464 Building on the workshop results, a small working group of researchers and conservation
465 professionals convened to further triangulate and contextualize results drawn from across the
466 region. The working group process led to further framework iterations. Ultimately, the results of
467 the community visioning workshops combined with the small group work resulted in a framework
468 of Factors organized into eight thematic Dimensions (18). For further detail on the development
469 of the Well-being Factors see (18). The Well-being Factors will continue to evolve relative to the
470 needs and priorities of communities in the Pacific. Additional Factors were identified as part of
471 this research, and additional Dimensions could be identified in future iterations of the list.

472 ***Coding: Cross-referencing SDG Indicators and Well-being Factors***

473 Comparisons of SDG Indicators and Well-Being Factors was undertaken using a multi-stage
474 expert elicitation approach with a multi-disciplinary team of coders. Twenty-two coders undertook
475 a pilot coding of all indicators and Well-being Factors using custom tailored excel spreadsheets
476 during a workshop in 2017. We then developed a custom, web-based coding interface and
477 proceeded in three major stages of coding. First, a subset of eight coders practiced with the
478 interface to determine ease of use. Second, a group of 15 coders (see below for coding team
479 description) conducted a gap analysis between the SDG indicators and the Factors. In this stage,
480 every indicator was coded by at least four individuals. Coders were asked to independently
481 assess each indicator in their assigned subset against each of the 89 Factors. Coders
482 determined which indicators had a strong link with the Factors, meaning the indicator could be an
483 effective and accurate measure for that Factor. Coders had the ability to choose multiple Factors
484 for an indicator; similarly, a Factor could be linked with multiple indicators. Coders noted if there

489 were no corresponding Factors for an indicator. Third, coders used a systems approach to
490 assess if the indicator was relevant and well-aligned with community decision making needs in
491 the Pacific Islands. If indicators were considered potentially problematic in relation to
492 components or relationships with a system, coders identified the reason(s) using a basic
493 typology of common indicator issues (Tables 2, 3); coders were able to select multiple issues or
494 none at all. They provided detailed comments to justify the ways in which indicators may not be
495 aligned with Well-being Factors. This draft typology of trade-off and measurement challenges,
496 based on initial coding trials, was developed in working groups between 2015 and 2017 and
497 aligns with the within SDG interaction scores proposed by (2) ranging from indivisible to
498 consistent to cancelling.

499
500 *Coders:* A total of 15 individuals participated in coding a comparison between SDGs indicators
501 and the Well-being Factors. The coding team belongs to a variety of academic disciplines and
502 professional backgrounds, including natural sciences (both terrestrial and marine), social
503 sciences, and community-based natural resource management. They collectively possess
504 considerable professional and lived experience spanning diverse areas of the Pacific. Coders
505 were assigned indicators that align to their expertise wherever possible and were encouraged to
506 opt out of coding a particular indicator if they felt it to be outside their expertise.

507 **Analyses**

508 *To assess our question on links between SDG indicators and well-being indicators, we only*
509 *included links that were noted by two or more of the four coders, leaving a total of 447 verified*
510 *links. As previously mentioned, a unique characteristic of the coding team was that all have key*
511 *experience in one or more Pacific Islands and collectively they represent highly diverse*
512 *academic disciplines and professional backgrounds. These diverse perspectives were valuable*
513 *in providing an interdisciplinary and holistic context for our analyses. It also means that it would*
514 *be unrealistic to expect consensus across replicates. We extracted basic descriptive statistics*
515 *from the resulting database. After determining that the indicator linkages were unevenly*
516 *distributed across Dimensions, we took a more granular look to understand which specific*
517 *Factors were and were not well-represented by the SDG indicators (table S2; fig. S3). Table S2*
518 *provides a full list of specific Factors with a high number of linkages to the SDG indicators, and*
519 *those with no linkages.*

520
521
522 *To assess our questions on applicability and trade-offs and measurement challenges between*
523 *SDG indicators and Pacific Island Well-being Factors, we used methods in qualitative data*
524 *analysis including pairwise comparisons and inductive content analysis. We also ensured that*
525 *every coding exercise was done independently by at least two people with the results discussed*
526 *amongst at least four people and undertook member checks (where manuscript authors*
527 *reviewed results and analyses at multiple stages) to validate the qualitative data and analysis*
528 *(48). We extracted all coder assessments and conducted a qualitative three-stage analysis. In*
529 *the first stage, three coders used inductive logic (49) to review the assessments, test against the*
530 *draft typology, and identify patterns within categories. In the second stage a team of four coders*
531 *reviewed every assessment against the categories, noting where category descriptions were not*
532 *sufficient and recommending greater detail. This resulted in rich descriptions of the trade-offs*
533 *and measurement challenges between the international metrics and the Well-being Factors. In*
534 *the third stage, four coders conducted a detailed scan of the comments to extract examples to*
535 *illustrate the categories, including comments that noted the emphasis on monetary economy-*
536 *based aspects (i.e., monetary transactions for goods and services) of the indicators. A team of 6*
537 *coders further coded all 162 indicators to identify indicators with monetary economy-based*
538 *components or criteria and undertake an additional analysis to assess the extent to which*
539 *indicators rely on “monetary economy-based” metrics to denote success.*

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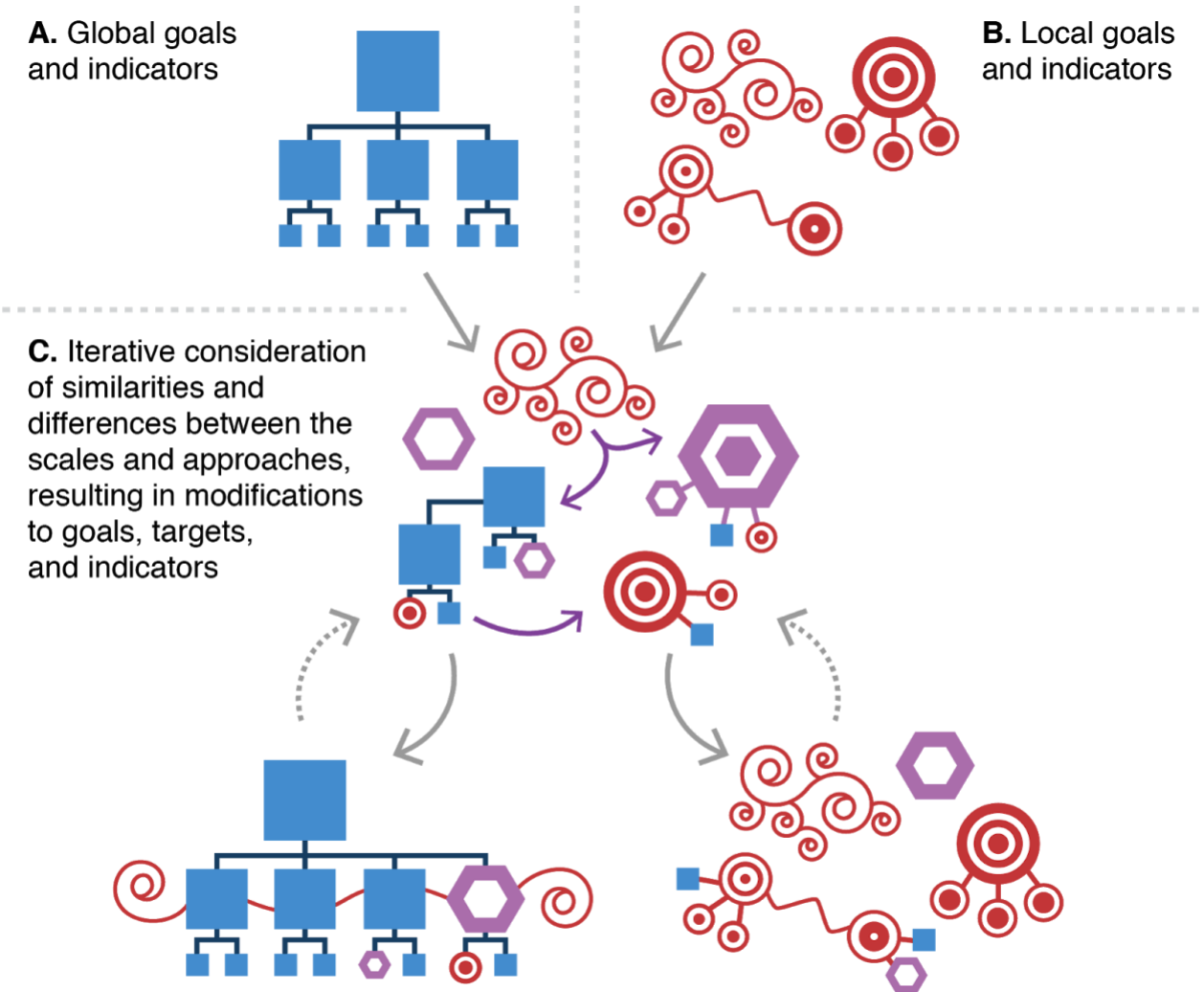
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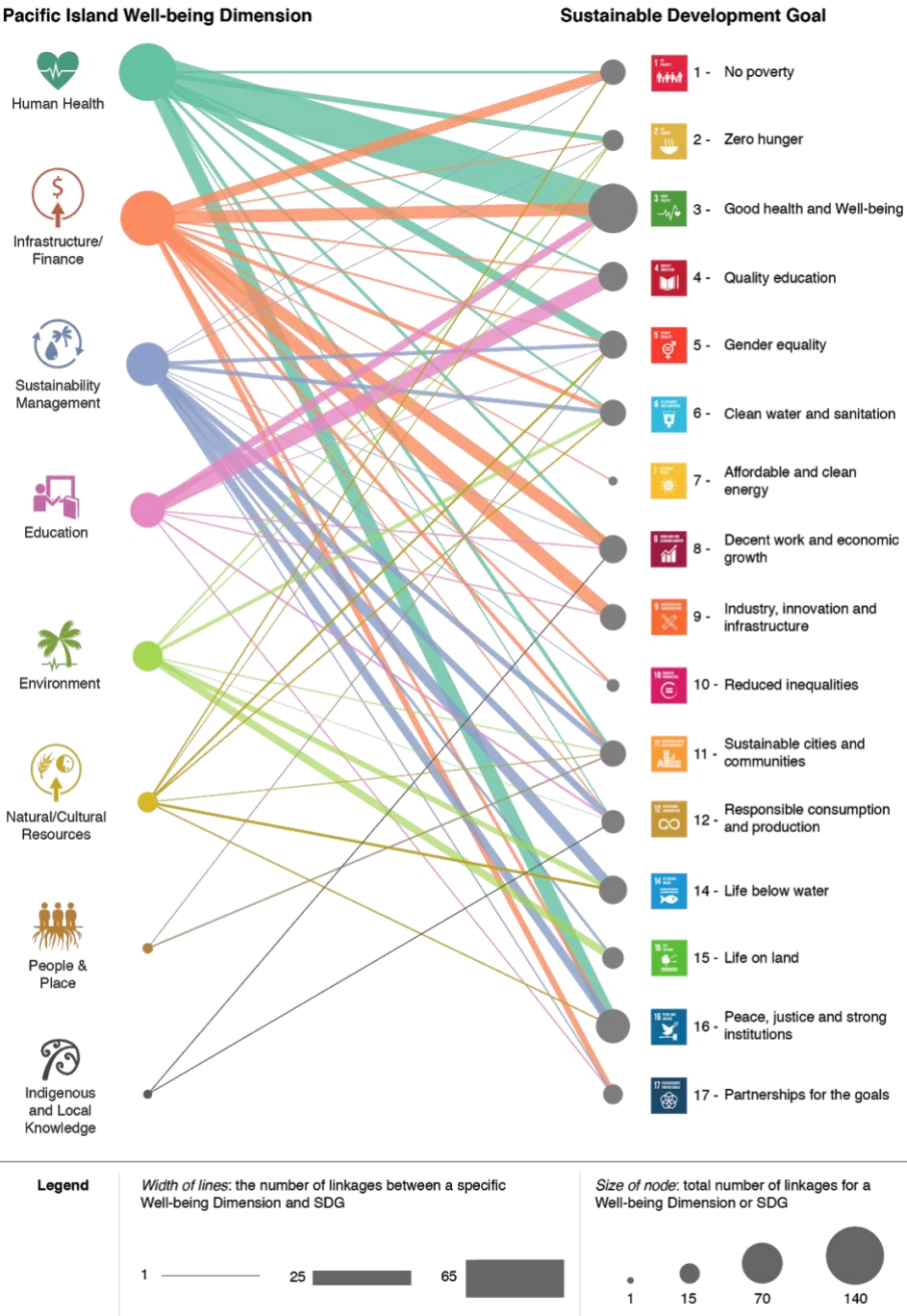
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Figures and Tables



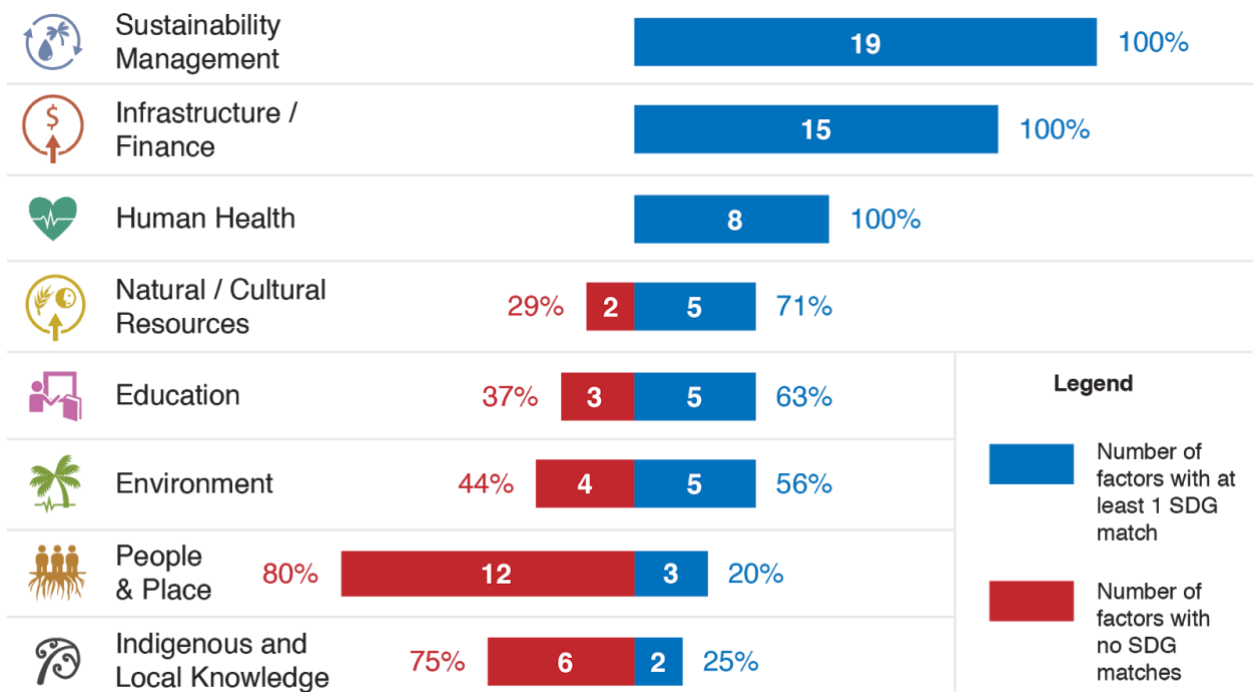
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Fig. 1. Approaches to development of goals and indicators: learning across scales. (A) Global goals and indicators are frequently derived using a consensus process and result in highly hierarchical systems where categorized overarching outcomes can be reached through achieving sub-goals and targets (represented by blue boxes). (B) Indigenous and local perspectives that drive action can result from expert observations and lived and experienced knowledge that emphasize the interconnections between parts of a system (represented by red graphics). (C) Iterative consideration of similarities and differences between these scales and approaches can result in stronger efforts at both the local and global scales (represented by hybrid colors and shapes).



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Fig. 2. Gap analysis of the number of linkages (selected by two or more coders) between Well-being Dimensions and the SDGs, encompassing each linkage made between an underlying Well-being Factor and an SDG indicator. The corresponding circle size and line width are proportional to the number of linkages; larger circles and thicker lines represent Dimensions or SDGs with a greater number of linkages.



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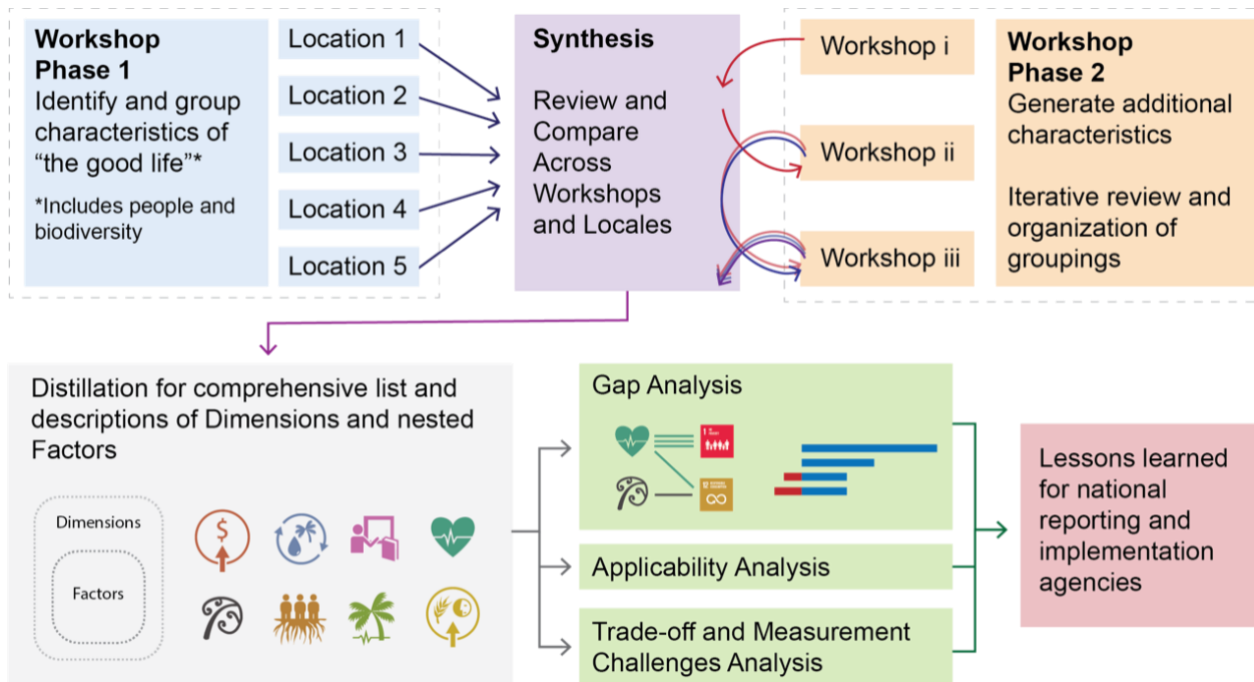
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Fig. 3. Analysis of Well-being Dimensions and links between the underlying Factors and at least one SDG indicator. Bar length represents the total number of Pacific Island Well-being Factors in each Dimension; percentages represent proportion of Factors within each Dimension that have at least one SDG linkage (blue) or no SDG linkages (red).



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Fig. 4. Iterative process used to develop dimensions and nested factors, and subsequent analyses. As noted in (18), during Phase 1 workshops across multiple locations, a team identified and conceptually grouped characteristics of “the good life”, including people and biodiversity. Through an iterative process the team synthesized the results and brought versions of the synthesis to Phase 2 workshops to generate additional characteristics and to review

organization of groupings. A subset of the team then distilled the results into a comprehensive list with descriptions of the Dimensions and nested Factors. The authors of this article compared this list with 162 SDG indicators (table S3) to undertake three analyses: a gap analysis, an applicability analysis, and a trade-off and measurement challenges analysis. These resulted in lessons learned for SDG national reporting and implementation agencies.

Table 1. The eight Pacific Islands Well-being Dimensions, including the number of underlying Factors in each Dimension, an associated icon, and a brief description of each. A complete list of Factors can be found in table S1 and in (18).

Pacific Islands Well-being Dimensions (abbreviations in parentheses) and No. of Factors	Description
Sustainability Management <i>19 Factors</i> 	Sustainability management includes all processes and governance structures involved in extractive and non-extractive resource use, sustainability, and enforcement of rules, norms, and actions collectively involved in management of natural/cultural resources. Management coordinates, balances, and equitably accounts for multiple resource users and uses of a place. This is based on the best available knowledge, which may stem from multiple sources. Sustainability management encourages adaptability, accountability, prosperity, empowerment, and equitable access to resources and benefit sharing.
Access to Infrastructure, Civic Services, and Financial Resources (Infrastructure/Finance) <i>15 Factors</i> 	Equitable access to, and use of, infrastructure, civic services, and financial resources is critical to support activities that communities deem important for well-being. This could include development of livelihood opportunities, microcredit schemes, and other community services. Where communities perceive a need, this may include proximity to roads, public transportation, water supplies, waste management, communication systems (phone networks, internet), access to civic infrastructure (clinics, schools, and government offices) and their corresponding civic services, and access to markets for trade and sustainable tourism.
Human Health <i>8 Factors</i> 	Physical, emotional, spiritual, and mental health are critical components of the well-being of individuals, families, and communities and may be reflected in adaptability or resourcefulness in response to change. Knowledge of what supports healthy people exists across multiple dimensions of wellness.
Access to Natural and Cultural Resources (Natural/Cultural Resources) <i>7 Factors</i> 	The ability to physically, appropriately, and equitably access a place for non-extractive or extractive sustainable use of natural and cultural resources. Access is sufficient to fulfill values and needs for subsistence, health, cultural, spiritual, aesthetic, emotional, or economic purposes. Recognition can be formalized by policy, law, or through customary practices.

<p>Education</p> <p>8 Factors</p> 	<p>Access to knowledge, networks, and qualifications from both formal and informal educational systems includes appropriate and contextualized sources of knowledge, well trained and supported educators, and clean, safe, and inclusive facilities. This Dimension also includes scientific and technical information that may be useful to communities, including for sustainable resource management, waste management, health, and wellness. Local forms of knowledge described in other categories also play a significant role in this category.</p>
<p>Environmental State (Environment)</p> <p>9 Factors</p> 	<p>Includes the ecological, biological, physical, chemical, and human components of the environment and their interrelationships, functionalities, and resilience to change.</p>
<p>Connectedness to People and Place (People & Place)</p> <p>15 Factors</p> 	<p>Connectedness to place has strong bearing on cultural identity, rootedness and belonging, sense of responsibility and stewardship, social engagement, and natural resource management. Connectedness to place encompasses historical, physical, emotional, and spiritual bonds between people and their local environment. It is often informed and driven by knowledge of events and history, and experiences of survival and thriving in place. Connection to people includes relationships based on material (e.g., food, resources, land) or immaterial (e.g., trust, labor, knowledge, time, kinship, social alliances) circulation among individuals and within and across households and communities.</p>
<p>Indigenous and Local Knowledge, Skills, Practice, Values, and Worldviews (Indigenous and Local Knowledge)</p> <p>8 Factors</p> 	<p>Indigenous and local knowledge, skills, practices, values, and worldviews are dynamic, adaptive, and transmitted across and between generations. They are embedded within a worldview and ethos, and often include spiritual connections to place, including to specific species, landscapes, and ancestors.</p>

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742 **Table 2. Trade-off or measurement challenge categories and descriptions**, including the
743 number of indicators classified under each category; this reflects responses for the 160
744 indicators (out of 162 analyzed) considered to have trade-off or measurement challenges. Note:
745 A single indicator can be listed under multiple categories.
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Trade-off or Measurement Challenge	Description of Trade-off or Measurement Challenge	No. of Indicators
Focus/Bias	The indicator may focus on one value system at the expense of locally-important criteria, or exhibit bias towards one system, strategy, priority, or agenda to the exclusion of others. This could include, for instance, lack of recognition of different management, governance, education, or health systems and strategies.	120

Feasibility	Globally relevant indicators may not be feasible to measure at the local scale, due to lack of supporting personnel, technical skills, and/or opportunities for capacity development. There may also be challenges with data collection/analysis methods, such as social norms that preclude accurate responses to queries.	90
Links to Target	The indicator may not be sufficient to address progress towards the target and may not adequately account for additional components. The indicator may also have poor or weak links to the intended target.	79
Scale	The indicator is set at a scale or unit of measurement that may be meaningful at the national or global scale, but is not so at the local level, making it challenging to accurately or appropriately ascertain local progress.	67
Disaggregation	The indicator itself may be appropriate at the local level, but the suggested element measured does not adequately convey locally-important characteristics.	67
Social Harm Trade-off	The indicator may be inappropriate to local contexts and measuring this indicator has the potential to cause social or cultural harm.	83
Environmental Harm Trade-off	The indicator may not adequately account for negative environmental externalities and making decisions based mainly on this indicator has the potential to cause environmental harm.	24

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Supplementary Materials

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Navigating Multidimensional Measures of Sustainability and Well-Being Across Scales

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This PDF file includes:

figs. S1- S3
tables S1- S3

Supplementary Figures

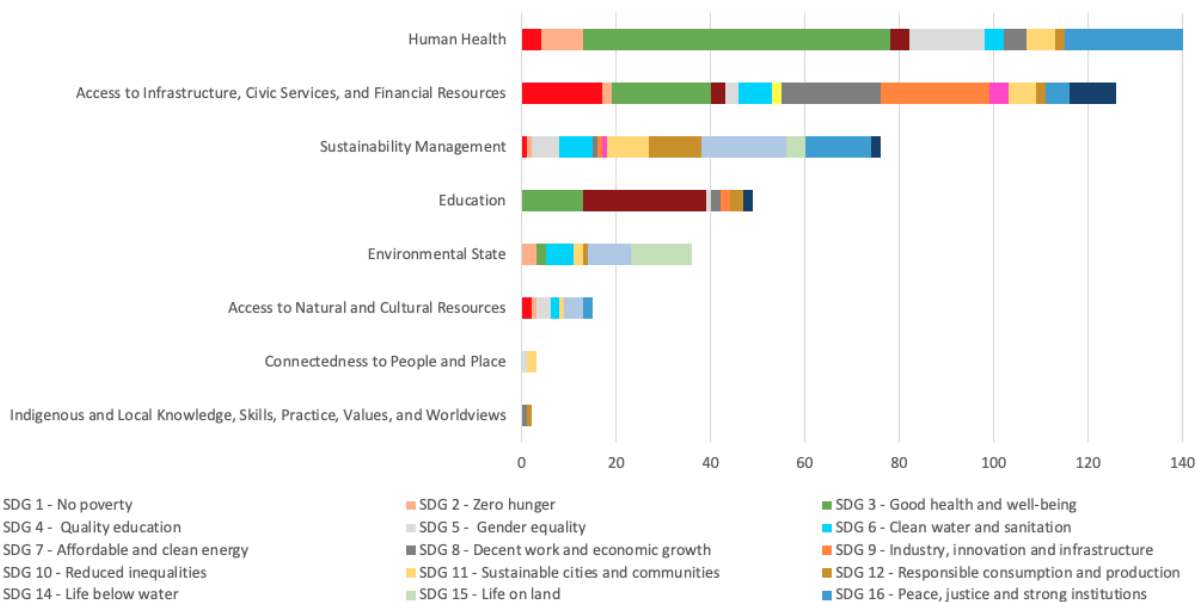


Fig. S1. Number of SDG indicators linked with Well-being Factors, by Dimension (includes only linkages made by two or more coders).

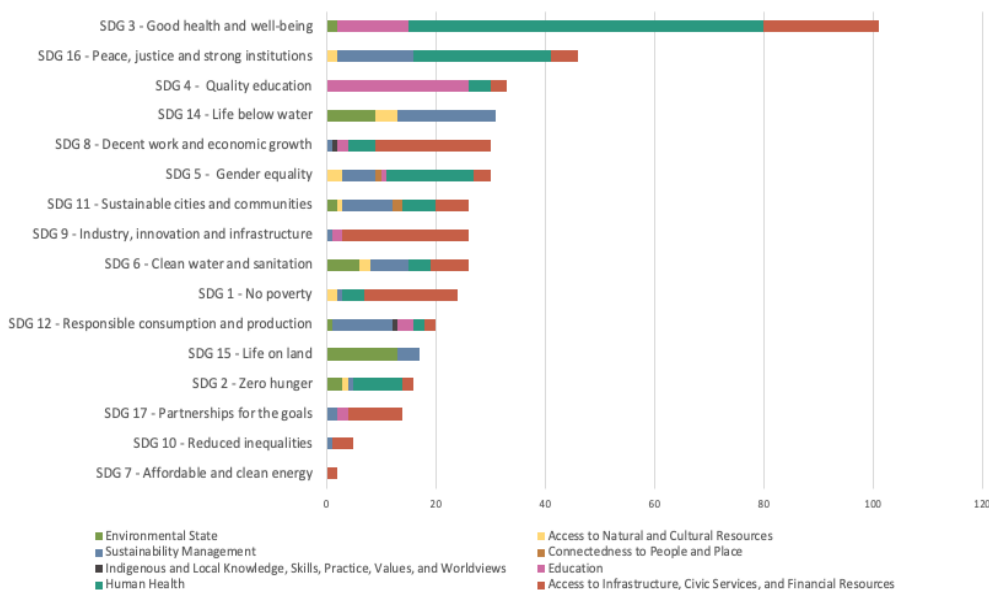


Fig. S2. Number of SDG indicators linked with Well-being Factors, by Goal (includes only linkages made by two or more coders).

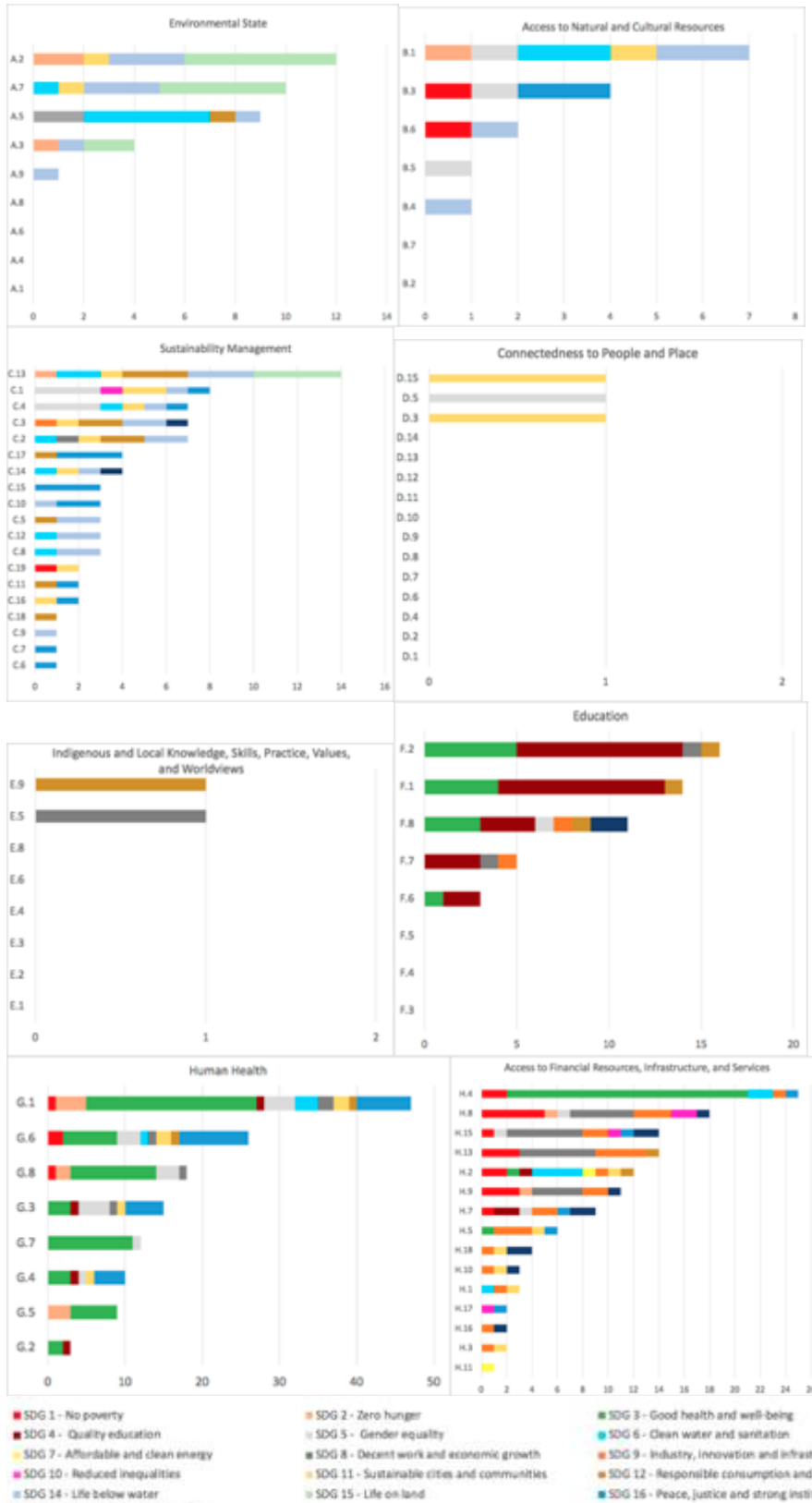


Fig. S3. Well-being Factor overlap with SDG indicators, by Dimension and underlying Factor. The Well-being Factors are represented by the letter/number designations laid out in table S1.

Supplementary Tables

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Table S1. Pacific Island Well-being Factors nested within eight overarching Dimensions. Developed through an iterative process including community visioning workshops and small group work, the table below depicts a total of 93 Pacific Island Well-being Factors nested within eight overarching Dimensions and includes Dimension descriptions. The four Factors highlighted in bold indicate new additions as a result of this coding activity.

Dimension A: Environmental State
Dimension description: Includes the ecological, biological, physical, chemical, and human components of the environment and their interrelationships, their functionalities, and resilience to change.
A.1 Ability of ecological systems to reorganize or recover after disturbance
A.2 State/status of biologically and culturally important populations, species, and varieties
A.3 Proportion of native species in danger of extinction
A.4 Extent, range, and control of invasive species
A.5 State/status of non-biological culturally important resources (water sources, rock quarries, clay deposits, etc.)
A.6 Level of habitat diversity for land- and seascapes
A.7 Proportion of functionally intact ecosystem(s) across land- and seascapes
A.8 Status of ecosystem connectivity
A.9 Local perceptions of the aesthetics of environmental surroundings
Dimension B: Access to Natural and Cultural Resources
Dimension description: The ability to physically, appropriately, and equitably access a place for non-extractive or extractive sustainable use of natural and cultural resources. Access is sufficient to fulfill values and needs for subsistence, health, cultural, spiritual, aesthetic, emotional, or economic purposes. Recognition can be formalized by policy, law, or through customary practices.
B.1 Access to and agency over a sufficient quality and quantity of natural and cultural resources
B.2 Appropriate access to cultural resources, supported and recognized by local and/or national rules
B.3 Customary rights and tenure, supported by national or regional-level laws
B.4 Legal rights that are known, respected, and practiced
B.5 Customary rights and responsibilities that are known, respected, and practiced
B.6 Community access to resources they are entitled to based on social relationships including kinship
B.7 Knowledge of culturally significant places, sites, landscapes, and species
Dimension C: Sustainability Management
Dimension description: Sustainability management includes all processes and structures involved in extractive and non-extractive resource use, sustainability, and enforcement of rules, norms, and actions collectively involved in management of natural/cultural resources. Management coordinates, balances, and equitably accounts for multiple resource users and uses of a place, based on the best available knowledge, which may stem from multiple sources. Sustainability management encourages adaptability, accountability, prosperity, empowerment, and equitable access to resources and benefit sharing.
C.1 Presence of a local sustainability ethos
C.2 Presence of a national sustainability ethos
C.3 Relevant and well-defined boundaries (i.e. land or seascape units, community boundaries, use-rights, decision-making processes)
C.4 Extent of overlap between decision-making boundaries and ecological processes
C.5 Identification and involvement of stakeholders and stakeholder groups in decision making
C.6 Well-defined decision-making roles and processes
C.7 Representation of local and traditional values in stakeholder decisions
C.8 Equitable decision-making outcomes within or across social groups
C.9 Agency across local, regional, and national scales
C.10 Well-coordinated interactions between institutions, and between individuals within institutions
C.11 Accountability across institutions and stakeholders including both formal and informal measures to limit corruption
C.12 Transparent management, governance systems, or governance norms
C.13 Resource planning and management towards sustainable land and seascapes
C.14 Local compliance with resource management rules
C.15 Presence and implementation of appropriate consequences to rule breaking (relative to local norms)
C.16 Presence and implementation of conflict resolution mechanisms
C.17 Local perceptions of management outcomes
C.18 Presence of adaptive practice (practices informed by evidence, knowledge, experience)
C.19 Adaptability or capacity to respond to shorter-term impacts (e.g. natural disasters) or longer-term impacts (e.g. climate change)
Dimension D: Connectedness to People and Place
Dimension description: Connectedness to place has strong bearing on cultural identity, rootedness and belonging, sense of responsibility and stewardship, social engagement, and natural resource management. Connectedness to place encompasses historical, physical, emotional, and/or spiritual bonds between people and their local environment. It is often informed and driven by knowledge of events and history, and experiences of survival and thriving in place. Connection to people includes relationships based on material (e.g., food, resources, land) or immaterial (e.g., trust, labor, knowledge, time, kinship, social alliances) circulation among individuals and within and across households and communities. A highly-connected system is one in which there is trust, cohesion, respect, and a high degree of connectedness to place.
D.1 Knowledge of traditional place names or landscape terms
D.2 Local perceptions of ecological and environmental risks
D.3 Knowledge and practice of social and cultural norms related to place-based practices
D.4 Connections within and between communities and social groups
D.5 Knowledge and practice of individual and collective rights and obligations towards people and place
D.6 Knowledge and practice of genealogical connections related to rights, access, and management of land and seascapes

D.7 Reciprocity and exchange within and between communities
D.8 Reciprocity between people and place
D.9 Cooperation and social cohesion
D.10 Intergenerational connections including practices of respect
D.11 Connection to ancestors
D.12 Religious or spiritual practices and connections to entities (living and non-living)
D.13 Makeup and extent of migration, diaspora, and other forms of mobility
D.14 Effects of environmental, social, and cultural change on identity
D.15 Community-level engagement in activism and advocacy
Dimension E: Indigenous and Local Knowledge, Skills, Practice, Values, and Worldviews
Dimension description: Indigenous and Local Knowledge, skills, practices, values and worldviews are dynamic, adaptive, and transmitted across and between generations. They are embedded within a worldview and ethos, and often include spiritual connections to place, including to specific species, landscapes, and ancestors.
E.1 Use of local biodiversity in cultural practices
E.2 Knowledge and practice of cultural expressions
E.3 Use and vitality of local language(s)
E.4 Knowledge and practice of culturally significant social interaction norms
E.5 Inter- or intra-generational transmission of knowledge, skills, practice, values, and belief
E.6 Innovation in knowledge and practice based on tradition
E.7 Presence of locally and culturally informed processes for knowledge management
E.8 Indigenous and / or local knowledge, protected by legislation, where appropriate (i.e. intellectual property rights)
E.9 Knowledge of socio-ecological connections, interdependence, and feedbacks
Dimension F: Education
Dimension description: Access to knowledge, networks, and qualifications from both formal and informal educational systems includes appropriate and contextualized sources of knowledge, well trained and supported educators, and clean, safe, and inclusive facilities. This Dimension also includes scientific and technical information that may be useful to communities, such as for sustainable resource management, waste management, health and wellness, among others. Local forms of knowledge described in other categories also play a significant role in this category.
F.1 Quality of formal education
F.2 Access to and use of formal education pathways
F.3 Role of local knowledge in formal education
F.4 Role of local language in formal education
F.5 Local beliefs or values towards formal and informal education
F.6 Diverse (formal and informal) learning opportunities
F.7 Access to and use of vocational training
F.8 Access to and use of technical and scientific information
Dimension G: Human Health
Dimension description: Physical, emotional, spiritual, and mental health are critical components of the well-being of individuals, families, and communities and may be reflected in adaptability or resourcefulness in response to change. Knowledge of what supports healthy people exists across multiple Dimensions of wellness.
G.1 Physical health
G.2 Spiritual health
G.3 Emotional health
G.4 Mental health
G.5 Individual and/or collective self-sufficiency and resourcefulness
G.6 Individual and/or collective security and safety
G.7 Diverse sources of health and wellness knowledge
G.8 Familial or community-based support for individual or collective health
Dimension H: Access to Infrastructure, Civic Services, and Financial Resources
Dimension description: Equitable access to, and use of, infrastructure, civic services, and financial resources is critical to support activities that communities deem important for well-being. This could include development of livelihood opportunities, conservation programs, and other community services. Where communities perceive a need, this may include proximity to roads, public transportation, water supplies, waste management, communication systems (phone networks, internet), access to civic infrastructure (clinics, schools, and government offices) and their corresponding civic services, and access to markets for trade and sustainable tourism.
H.1 Presence of adaptable, flexible, and or resilient infrastructure or services
H.2 Access to and use of physical infrastructure and services
H.3 Access to and use of affordable housing
H.4 Access to and use of health infrastructure and services
H.5 Access to and use of transportation infrastructure and services
H.6 Access to and use of education-related infrastructure and services
H.7 Access to and use of communication tools and infrastructure
H.8 Equitable access to and use of financial resources and services in vulnerable populations
H.9 Access to and use of markets
H.10 Access to and use of green infrastructure
H.11 Access to and use of sustainable energy sources
H.12 Access to and use of biosecurity infrastructure and services
H.13 Access to and use of diverse sources of income generation
H.14 Access to safe, secure, and locally-desirable occupations
H.15 Equitable access to financial resources and infrastructure, recognized locally or nationally
H.16 Local ability to control, manage, or influence external funding sources
H.17 Financial or other resources derived from community members living overseas, in diaspora, or those who have migrated

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Table S2. List of the two Well-being Factors with the highest number of linkages to SDG indicators for each Dimension (if more than two factors are listed it is the result of factors having the same number of linkages), as well as Well-being Factors that were not linked with any SDG indicators. (See fig. S3 for summary).

Pacific Well-being Dimension	Factors with the Highest Number of Linkages to SDG indicators	Factors with No Linkages to SDG indicators
Environmental State	<p>A.2 State/status of biologically and culturally important populations, species, and varieties</p> <p>A.7 Proportion of functionally intact ecosystem(s) across land- and seascapes</p>	<p>A.1 Ability of ecological systems to reorganize or recover after disturbance</p> <p>A.6 Level of habitat diversity for land- and seascapes</p> <p>A.8 Status of ecosystem connectivity</p>
Access to Natural and Cultural Resources	<p>B.1 Access to and agency over a sufficient quality and quantity of natural and cultural resources</p> <p>B.3 Customary rights and tenure, supported by national or regional-level laws</p>	<p>B.2 Appropriate access to cultural resources, supported and recognized by local and/or national rules</p> <p>B.7 Knowledge of culturally significant places, sites, landscapes, and species</p>
Sustainability Management	<p>C.1 Presence of a local sustainability ethos</p> <p>C.13 Resource planning and management towards sustainable land and seascapes</p>	n/a
Connectedness to People and Place	<p>D.3 Knowledge and practice of social and cultural norms related to place-based practices</p> <p>D.5 Knowledge and practice of individual and collective rights and obligations towards people and place</p> <p>D.15 Community-level engagement in activism and advocacy</p>	<p>D.1 Knowledge of traditional place names or landscape terms</p> <p>D.2 Local perceptions of ecological and environmental risks</p> <p>D.4 Connections within and between communities and social groups</p> <p>D.6 Knowledge and practice of genealogical connections related to rights, access, and management of land and seascapes</p> <p>D.7 Reciprocity and exchange within and between communities</p> <p>D.8 Reciprocity between people and place</p> <p>D.9 Cooperation and social cohesion</p> <p>D.10 Intergenerational connections including practices of respect</p> <p>D.11 Connection to ancestors</p> <p>D.12 Religious or spiritual practices and connections to entities (living and non-living)</p>

		D.13 Makeup and extent of migration, diaspora, and other forms of mobility D.14 Effects of environmental, social, and cultural change on identity
Indigenous and Local Knowledge, Skills, Practice, Values, and Worldviews	E.5 Inter- or intra-generational transmission of knowledge, skills, practice, values, and belief E.9 Knowledge of socio-ecological connections, interdependence, and feedbacks	E.1 Use of local biodiversity in cultural practices E.2 Knowledge and practice of cultural expressions E.3 Use and vitality of local language(s) E.4 Knowledge and practice of culturally significant social interaction norms E.6 Innovation in knowledge and practice based on tradition E.8 Indigenous and / or local knowledge, protected by legislation, where appropriate (i.e. intellectual property rights)
Education	F.1 Quality of formal education (S) F.2 Access to and use of formal education pathways (S)	F.3 Role of local knowledge in formal education F.4 Roll of local language in formal education F.5 Local beliefs or values towards formal and informal education
Human Health	G.1 Physical health G.6 Individual and/or collective security and safety	n/a
Access to Infrastructure, Civic Services, and Financial Resources	H.4 Access to and use of health infrastructure and services H.8 Equitable access to and use of financial resources and services in vulnerable populations	n/a

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Table S3. List of 162 SDG indicators used in this analysis

Indicator	Description
1.1.1	Proportion of population below the international poverty line, by sex, age, employment status and geographical location (urban/rural)
1.2.1	Proportion of population living below the national poverty line, by sex and age
1.2.2	Proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions
1.3.1	Proportion of population covered by social protection floors/systems, by sex, distinguishing children, unemployed persons, older persons, persons with disabilities, pregnant women, newborns, work-injury victims and the poor and the vulnerable
1.4.1	Proportion of population living in households with access to basic services

1.4.2	Proportion of total adult population with secure tenure rights to land, with legally recognized documentation and who perceive their rights to land as secure, by sex and by type of tenure
1.5.1	Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population
1.5.4	Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies
2.1.1	Prevalence of undernourishment
2.1.2	Prevalence of moderate or severe food insecurity in the population, based on the Food Insecurity Experience Scale (FIES)
2.2.1	Prevalence of stunting (height for age <-2 standard deviation from the median of the World Health Organization (WHO) Child Growth Standards) among children under 5 years of age
2.2.2	Prevalence of malnutrition (weight for height >+2 or <-2 standard deviation from the median of the WHO Child Growth Standards) among children under 5 years of age, by type (wasting and overweight)
2.3.1	Volume of production per labour unit by classes of farming/pastoral/forestry enterprise size
2.3.2	Average income of small-scale food producers, by sex and indigenous status
2.4.1	Proportion of agricultural area under productive and sustainable agriculture
2.5.1	Number of plant and animal genetic resources for food and agriculture secured in either medium or long-term conservation facilities
2.5.2	Proportion of local breeds classified as being at risk, not-at-risk or at unknown level of risk of extinction
3.1.1	Maternal mortality ratio
3.1.2	Proportion of births attended by skilled health personnel
3.2.1	Under-five mortality rate
3.2.2	Neonatal mortality rate
3.3.1	Number of new HIV infections per 1,000 uninfected population, by sex, age and key populations
3.3.2	Tuberculosis incidence per 100,000 population
3.3.3	Malaria incidence per 1,000 population
3.3.4	Hepatitis B incidence per 100,000 population
3.3.5	Number of people requiring interventions against neglected tropical diseases
3.4.1	Mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease
3.4.2	Suicide mortality rate
3.5.1	Coverage of treatment interventions (pharmacological, psychosocial and rehabilitation and aftercare services) for substance use disorders
3.5.2	Harmful use of alcohol, defined according to the national context as alcohol per capita consumption (aged 15 years and older) within a calendar year in litres of pure alcohol
3.6.1	Death rate due to road traffic injuries
3.7.1	Proportion of women of reproductive age (aged 15-49 years) who have their need for family planning satisfied with modern methods
3.7.2	Adolescent birth rate (aged 10-14 years; aged 15-19 years) per 1,000 women in that age group
3.8.1	Coverage of essential health services (defined as the average coverage of essential services based on tracer interventions that include reproductive, maternal, newborn and child health, infectious diseases, non-communicable diseases and service capacity and access, among the general and the most disadvantaged population)

3.8.2	Proportion of population with large household expenditures on health as a share of total household expenditure or income
3.9.1	Mortality rate attributed to household and ambient air pollution
3.9.2	Mortality rate attributed to unsafe water, unsafe sanitation and lack of hygiene (exposure to unsafe Water, Sanitation and Hygiene for All (WASH) services)
3.9.3	Mortality rate attributed to unintentional poisoning
3.a.1	Age-standardized prevalence of current tobacco use among persons aged 15 years and older
3.b.1	Proportion of the target population covered by all vaccines included in their national programme
3.b.3	Proportion of health facilities that have a core set of relevant essential medicines available and affordable on a sustainable basis
3.c.1	Health worker density and distribution
3.d.1	International Health Regulations (IHR) capacity and health emergency preparedness
4.1.1	Proportion of children and young people: (a) in grades 2/3; (b) at the end of primary; and (c) at the end of lower secondary achieving at least a minimum proficiency level in (i) reading and (ii) mathematics, by sex
4.2.1	Proportion of children under 5 years of age who are developmentally on track in health, learning and psychosocial well-being, by sex
4.2.2	Participation rate in organized learning (one year before the official primary entry age), by sex
4.3.1	Participation rate of youth and adults in formal and non-formal education and training in the previous 12 months, by sex
4.4.1	Proportion of youth and adults with information and communications technology (ICT) skills, by type of skill
4.5.1	Parity indices (female/male, rural/urban, bottom/top wealth quintile and others such as disability status, Indigenous Peoples and conflict-affected, as data become available) for all education indicators on this list that can be disaggregated
4.6.1	Proportion of population in a given age group achieving at least a fixed level of proficiency in functional (a) literacy and (b) numeracy skills, by sex
4.7.1	Extent to which (i) global citizenship education and (ii) education for sustainable development, including gender equality and human rights, are mainstreamed at all levels in: (a) national education policies, (b) curricula, (c) teacher education and (d) student assessment
4.a.1	Proportion of schools with access to: (a) electricity; (b) the Internet for pedagogical purposes; (c) computers for pedagogical purposes; (d) adapted infrastructure and materials for students with disabilities; (e) basic drinking water; (f) single-sex basic sanitation facilities; and (g) basic handwashing facilities (as per the WASH indicator definitions)
4.c.1	Proportion of teachers in: (a) pre-primary; (b) primary; (c) lower secondary; and (d) upper secondary education who have received at least the minimum organized teacher training (e.g. pedagogical training) pre-service or in-service required for teaching at the relevant level in a given country
5.1.1	Whether or not legal frameworks are in place to promote, enforce and monitor equality and non-discrimination on the basis of sex
5.2.1	Proportion of ever-partnered women and girls aged 15 years and older subjected to physical, sexual or psychological violence by a current or former intimate partner in the previous 12 months, by form of violence and by age

5.2.2	Proportion of women and girls aged 15 years and older subjected to sexual violence by persons other than an intimate partner in the previous 12 months, by age and place of occurrence
5.3.1	Proportion of women aged 20-24 years who were married or in a union before age 15 and before age 18
5.3.2	Proportion of girls and women aged 15-49 years who have undergone female genital mutilation/cutting, by age
5.4.1	Proportion of time spent on unpaid domestic and care work, by sex, age and location
5.5.1	Proportion of seats held by women in (a) national parliaments and (b) local governments
5.5.2	Proportion of women in managerial positions
5.6.1	Proportion of women aged 15-49 years who make their own informed decisions regarding sexual relations, contraceptive use and reproductive health care
5.a.1	(a) Proportion of total agricultural population with ownership or secure rights over agricultural land, by sex; and (b) share of women among owners or rights-bearers of agricultural land, by type of tenure
5.b.1	Proportion of individuals who own a mobile telephone, by sex
6.1.1	Proportion of population using safely managed drinking water services
6.2.1	Proportion of population using safely managed sanitation services, including a hand-washing facility with soap and water
6.3.1	Proportion of wastewater safely treated
6.3.2	Proportion of bodies of water with good ambient water quality
6.4.1	Change in water-use efficiency over time
6.4.2	Level of water stress: freshwater withdrawal as a proportion of available freshwater resources
6.5.1	Degree of integrated water resources management implementation (0-100)
6.5.2	Proportion of transboundary basin area with an operational arrangement for water cooperation
6.6.1	Change in the extent of water-related ecosystems over time
6.a.1	Amount of water- and sanitation-related official development assistance that is part of a government-coordinated spending plan
6.b.1	Proportion of local administrative units with established and operational policies and procedures for participation of local communities in water and sanitation management
7.1.1	Proportion of population with access to electricity
7.1.2	Proportion of population with primary reliance on clean fuels and technology
8.3.1	Proportion of informal employment in non-agriculture employment, by sex
8.4.1	Material footprint, material footprint per capita, and material footprint per GDP
8.4.2	Domestic material consumption, domestic material consumption per capita, and domestic material consumption per GDP
8.5.1	Average hourly earnings of female and male employees, by occupation, age and persons with disabilities
8.5.2	Unemployment rate, by sex, age and persons with disabilities
8.6.1	Proportion of youth (aged 15-24 years) not in education, employment or training
8.7.1	Proportion and number of children aged 5-17 years engaged in child labour, by sex and age
8.8.1	Frequency rates of fatal and non-fatal occupational injuries, by sex and migrant status
8.9.2	Proportion of jobs in sustainable tourism industries out of total tourism jobs

8.10.1	(a) Number of commercial bank branches per 100,000 adults and (b) number of automated teller machines (ATMs) per 100,000 adults
8.10.2	Proportion of adults (15 years and older) with an account at a bank or other financial institution or with a mobile-money-service provider
8.b.1	Existence of a developed and operationalized national strategy for youth employment, as a distinct strategy or as part of a national employment strategy
9.1.1	Proportion of the rural population who live within 2 km of an all-season road
9.1.2	Passenger and freight volumes, by mode of transport
9.2.1	Manufacturing value added as a proportion of GDP and per capita
9.2.2	Manufacturing employment as a proportion of total employment
9.3.1	Proportion of small-scale industries in total industry value added
9.3.2	Proportion of small-scale industries with a loan or line of credit
9.4.1	CO2 emission per unit of value added
9.5.2	Researchers (in full-time equivalent) per million inhabitants
9.a.1	Total official international support (official development assistance plus other official flows) to infrastructure
9.b.1	Proportion of medium and high-tech industry value added in total value added
9.c.1	Proportion of population covered by a mobile network, by technology
10.1.1	Growth rates of household expenditure or income per capita among the bottom 40 per cent of the population and the total population
10.2.1	Proportion of people living below 50 per cent of median income, by sex, age and persons with disabilities
10.3.1	Proportion of population reporting having personally felt discriminated against or harassed in the previous 12 months on the basis of a ground of discrimination prohibited under international human rights law
10.7.1	Recruitment cost borne by employee as a proportion of yearly income earned in country of destination
10.c.1	Remittance costs as a proportion of the amount remitted
11.1.1	Proportion of urban population living in slums, informal settlements or inadequate housing
11.2.1	Proportion of population that has convenient access to public transport, by sex, age and persons with disabilities
11.3.1	Ratio of land consumption rate to population growth rate
11.3.2	Proportion of cities with a direct participation structure of civil society in urban planning and management that operate regularly and democratically
11.4.1	Total expenditure (public and private) per capita spent on the preservation, protection and conservation of all cultural and natural heritage, by type of heritage (cultural, natural, mixed and World Heritage Centre designation), level of government (national, regional and local/municipal), type of expenditure (operating expenditure/investment) and type of private funding (donations in kind, private non-profit sector and sponsorship)
11.5.1	Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population
11.6.1	Proportion of urban solid waste regularly collected and with adequate final discharge out of total urban solid waste generated, by cities
11.6.2	Annual mean levels of fine particulate matter (e.g. PM2.5 and PM10) in cities (population weighted)
11.7.1	Average share of the built-up area of cities that is open space for public use for all, by sex, age and persons with disabilities
11.7.2	Proportion of persons victim of physical or sexual harassment, by sex, age, disability status and place of occurrence, in the previous 12 months

11.a.1	Proportion of population living in cities that implement urban and regional development plans integrating population projections and resource needs, by size of city
12.3.1	Global food loss index
12.4.2	Hazardous waste generated per capita and proportion of hazardous waste treated, by type of treatment
12.6.1	Number of companies publishing sustainability reports
12.8.1	Extent to which (i) global citizenship education and (ii) education for sustainable development (including climate change education) are mainstreamed in (a) national education policies; (b) curricula; (c) teacher education; and (d) student assessment
12.b.1	Number of sustainable tourism strategies or policies and implemented action plans with agreed monitoring and evaluation tools
14.1.1	Index of coastal eutrophication and floating plastic debris density
14.3.1	Average marine acidity (pH) measured at agreed suite of representative sampling stations
14.4.1	Proportion of fish stocks within biologically sustainable levels
14.5.1	Coverage of protected areas in relation to marine areas
14.7.1	Sustainable fisheries as a proportion of GDP in small island developing States, least developed countries and all countries
15.1.1	Forest area as a proportion of total land area
15.1.2	Proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas, by ecosystem type
15.2.1	Progress towards sustainable forest management
15.3.1	Proportion of land that is degraded over total land area
15.4.1	Coverage by protected areas of important sites for mountain biodiversity
15.4.2	Mountain Green Cover Index
15.5.1	Red List Index
15.7.1	Proportion of traded wildlife that was poached or illicitly trafficked
16.1.1	Number of victims of intentional homicide per 100,000 population, by sex and age
16.1.2	Conflict-related deaths per 100,000 population, by sex, age and cause
16.1.3	Proportion of population subjected to physical, psychological or sexual violence in the previous 12 months
16.1.4	Proportion of population that feel safe walking alone around the area they live
16.2.1	Proportion of children aged 1-17 years who experienced any physical punishment and/or psychological aggression by caregivers in the past month
16.2.2	Number of victims of human trafficking per 100,000 population, by sex, age and form of exploitation
16.2.3	Proportion of young women and men aged 18-29 years who experienced sexual violence by age 18
16.3.1	Proportion of victims of violence in the previous 12 months who reported their victimization to competent authorities or other officially recognized conflict resolution mechanisms
16.3.2	Unsentenced detainees as a proportion of overall prison population
16.4.1	Total value of inward and outward illicit financial flows (in current United States dollars)
16.4.2	Proportion of seized, found or surrendered arms whose illicit origin or context has been traced or established by a competent authority in line with international instruments

16.5.1	Proportion of persons who had at least one contact with a public official and who paid a bribe to a public official, or were asked for a bribe by those public officials, during the previous 12 months
16.5.2	Proportion of businesses that had at least one contact with a public official and that paid a bribe to a public official, or were asked for a bribe by those public officials during the previous 12 months
16.6.1	Primary government expenditures as a proportion of original approved budget, by sector (or by budget codes or similar)
16.6.2	Proportion of population satisfied with their last experience of public services
16.7.1	Proportions of positions (by sex, age, persons with disabilities and population groups) in public institutions (national and local legislatures, public service, and judiciary) compared to national distributions
16.7.2	Proportion of population who believe decision-making is inclusive and responsive, by sex, age, disability and population group
16.9.1	Proportion of children under 5 years of age whose births have been registered with a civil authority, by age
16.10.1	Number of verified cases of killing, kidnapping, enforced disappearance, arbitrary detention and torture of journalists, associated media personnel, trade unionists and human rights advocates in the previous 12 months
16.a.1	Existence of independent national human rights institutions in compliance with the Paris Principles
17.4.1	Debt service as a proportion of exports of goods and services
17.6.2	Fixed Internet broadband subscriptions per 100 inhabitants, by speed
17.7.1	Total amount of approved funding for developing countries to promote the development, transfer, dissemination and diffusion of environmentally sound technologies
17.8.1	Proportion of individuals using the Internet
17.9.1	Dollar value of financial and technical assistance (including through North-South, South-South and triangular cooperation) committed to developing countries
17.12.1	Average tariffs faced by developing countries, least developed countries and small island developing States
17.15.1	Extent of use of country-owned results frameworks and planning tools by providers of development cooperation
17.17.1	Amount of United States dollars committed to public-private and civil society partnerships

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