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1 **Public views of the Sustainable Development Goals across countries**

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## Public views of the Sustainable Development Goals across countries

The United Nation's 17 Sustainable Development Goals (SDGs) offer an extensive framework for coordinating and shaping government policies, and for engaging the public with sustainability. Public understandings of the SDGs and sustainability can influence this engagement, as people are more likely to accept and share information consistent with their own understanding. We identify public understandings of SDGs through the mental maps of how people relate the SDGs to the three elements of environmental, social, and economic sustainability. Using responses from 12 developed/developing countries (N=2134), we identified four mental maps that varied mainly on two dimensions that diverged from some expert models. First, some people's mental maps identified a tension between achieving environmental v. social sustainability, whereas for others the main tension was between economic and the other two sustainability elements. Second, some people related different SDGs to each element of sustainability, whereas others saw all SDGs as targeting the same sustainability element(s). These findings highlight opportunities and challenges to engage the public with sustainability more effectively, especially with wide-ranging initiatives such as a "Green New Deal". We observed cultural differences, but we also identified a dominant mental map across countries that could serve as a default model for communicating sustainability internationally.

A critical global challenge is to ensure that current and future generations experience the social and economic conditions that allow them to lead fulfilling lives without degrading the natural environment. Combining the social/economic concept of development with the more ecological concept of sustainability<sup>1</sup>, the United Nations developed the 17 Sustainable Development Goals (SDGs)<sup>2</sup> to coordinate national and international policies and agreements to achieve an environmentally, socially, and economically sustainable world<sup>3, 4, 5</sup>.

The SDGs are not just for policymaking – they are also intended as a framework for public communication, stakeholder engagement, and outreach to promote sustainability<sup>6</sup>. Increasing public engagement and support are important to increase adoption of sustainable technologies and initiatives<sup>7</sup>, support for sustainability programs, and to increase public pressure to hold authorities and businesses to account for delivering sustainable outcomes<sup>8</sup>.

Substantial efforts have been devoted to how policymakers should understand and use the SDGs to improve policy development<sup>9, 10, 11, 12, 13, 14, 15</sup>. Yet we know little about how the public perceives sustainability, at least beyond specific issues such as climate change<sup>16</sup>. Understanding public views about the SDGs can inform sustainability communication, showing which messages are more likely to be accepted by the public and shared with others. This is because people view information consistent with their own beliefs as more appealing and credible<sup>17, 18</sup>, and such information is more likely to spread through social networks<sup>19, 20</sup>.

While we have some information about the priorities assigned to SDGs on average<sup>21</sup>, we lack a deeper understanding of people's "mental maps" of sustainability. We use mental map to denote a visual representation of cognitive associations between constructs, in this case how people relate each SDG to the achievement of environmental, social, and economic sustainability. For example, SDG7 (Affordable and Clean Energy) might be seen as primarily targeting people's wellbeing (social), financial security (economic), or the health of the

65 natural world (environmental); or all three equally. Knowing what people think about what  
66 the SDGs are supposed to achieve can help practitioners promote sustainable energy policies  
67 and initiatives, by framing them in ways consistent with public views.

68 People's mental maps of sustainability reveal which SDGs are seen to be in tension,  
69 where pursuing some SDGs competes with attention to others. For example, if people believe  
70 pursuing SDG13 (Climate Action) is in tension with SDG8 (Decent Work and Economic  
71 Growth), this can be a hurdle for convincing the public to accept green industries. Those who  
72 see them as aligned, however, may respond positively to green industry initiatives. This  
73 knowledge about the relations between SDGs can highlight where to refine sustainability  
74 communication to highlight alignments and downplay/address tensions.

75 Some models in the literature on sustainability emphasise alignment between social  
76 and environmental elements, with one or both contrasted with economic productivity<sup>12, 22, 23</sup>.  
77 However, it is unclear whether this distinction is common among people or whether they  
78 view the relations of these sustainability elements differently. For instance, it may be more  
79 common to see social and economic sustainability as aligned, and in competition with  
80 sustainable environmental outcomes. Identifying mental maps offers these insights into these  
81 broader public perceptions of sustainability.

82 Hence, our goal was to understand these "mental maps" of sustainability and how  
83 they vary across people. Some people's mental maps may be quite straightforward, believing  
84 all SDGs are focused only on environmental (or social, or economic) sustainability. Other  
85 people may draw clear distinctions between SDGs, where some are focused on the  
86 environment, others on people's wellbeing, and others on the economy.

87 Mental maps may also vary across countries with differing socio-economic  
88 conditions. Some argue that environmental sustainability may be less prominent in  
89 developing economies than in developed economies<sup>24</sup>, instead placing more emphasis on  
90 social or economic sustainability. Therefore, we aimed to identify the mental maps held in  
91 both economically developed and developing countries.

92 To identify mental maps, we used a survey company to obtain participants from their  
93 national panels in 12 developed and developing countries (final N=2134). On separate survey  
94 pages, participants read definitions of environmental, economic, or social sustainability (also  
95 called three "pillars" of sustainability<sup>5</sup>; see Table 1 for descriptions used) followed by  
96 descriptions of each SDG without labels (Table 2). They rated the extent to which each SDG  
97 was targeted at achieving each sustainability element on a 7-point scale (1, *Not at all*; 4,  
98 *Moderately*; 7, *Very much*). Presentation order of sustainability elements and SDG  
99 descriptions was randomised.

100 To understand who holds different views we also obtained information about their  
101 demographics and their life-guiding principles ("values"<sup>25</sup>), which are known to influence  
102 attitudes to environmental sustainability issues such as climate change<sup>26</sup>. To identify if some  
103 mental maps were more pro- or anti-sustainability, we also measured the priority they thought  
104 should be given to sustainability in their country.

105 Identifying these mental maps requires simultaneous analysis across three dimensions  
106 (or modes): SDGs, the three sustainability elements, and participants. For this we used three-  
107 mode principal component analysis<sup>27, 28</sup> (described in Supplementary Information, S2). This  
108 version of principal component analysis aims to identify systematic patterns in how SDGs

109 and sustainability elements are related, while allowing these relations to differ across  
110 participants. We focused on patterns of relationships between SDGs and sustainability  
111 elements, rather than on people overall degree of endorsement about whether SDGs target  
112 sustainability. Accordingly, we removed each person's average rating of the goals across  
113 sustainability elements ("centering").

## 114 RESULTS

115 A model with four components for participants (mental maps) provided the best trade-  
116 off between model simplicity and model fit, explaining 42% of the variation in ratings (model  
117 selection is explained in Supplementary Information, S2). Each mental map could be  
118 represented using two dimensions.

119 The existence of four mental maps clearly indicates that there was no single "public"  
120 view of sustainability. However, one mental map was dominant, accounting for over half  
121 (52%) of the explained variation, and endorsed by the majority of participants in every  
122 country. Shown in Fig. 1, the arrows represent the three sustainability elements – for  
123 interpretation their direction is most important (their length indicates the relative amount of  
124 variance explained), and the SDGs are represented by points. Relations between SDGs and  
125 sustainability elements are determined by projecting the point for an SDG orthogonally onto  
126 the line for a sustainability element – the further from the origin (0,0) this projection is on the  
127 positive side (solid arrow), the stronger the SDG is seen to target that sustainability element.  
128 An orthogonal projection on the negative side (represented by dashed arrows in Fig. 1),  
129 means the SDG is seen to target a sustainability element relatively weakly.

130 These relationships are illustrated for SDG14 (Oceans) in Fig. 1. Projections are  
131 shown using dashed line from the point representing Oceans to the arrows for each  
132 sustainability element. These show that Oceans was seen to target environmental  
133 sustainability more strongly than all other SDGs (intersecting with the solid green arrow  
134 furthest from the origin), and was least relevant to achieving both social sustainability  
135 (dashed blue arrow) and economic sustainability (dashed red arrow). Using the same  
136 approach, it can be seen that SDG5 (Gender) was targeted more than other SDGs at economic  
137 and social sustainability, and least at environmental sustainability. To aid interpretation,  
138 coloured ellipses show the SDGs that targeted each sustainability element more strongly than  
139 average. For all mental maps, most variance was explained by the first dimension (horizontal  
140 axis) and this axis is the most important for interpretation.

141 Fig. 1 shows that the dominant mental map reflects a primary tension between  
142 environmental and social sustainability, as shown by their arrows pointing in opposing  
143 directions. That is, SDGs seen to focus more on improving the viability of the natural world  
144 were seen to be less targeted at improving people's wellbeing/quality of life (and vice versa).  
145 Economic sustainability was a largely independent consideration (orthogonal to the other two  
146 elements), consistent with some economic analyses demonstrating that environmental and  
147 economic sustainability can be achieved independently<sup>12</sup>.

148 In this mental map, most SDGs were seen to target either environmental or social  
149 sustainability, with only SDG7 (Energy) targeting both. Most SDGs were seen as less  
150 relevant to achieving economic sustainability (negative loadings), even those ostensibly with  
151 an economic focus such as SDG9 (Infrastructure), for which social sustainability was more  
152 relevant. This suggests that achieving most SDGs is seen to come at some cost to economic

153 sustainability, except for a small set where social and economic sustainability are aligned  
154 (including equality, growth, education, peace, and reducing poverty).

155 Although the dominant mental map in Fig. 1 was common across countries, it was  
156 held more strongly in Russia than in all other countries, consistent with a view identified in  
157 economic and qualitative research that Russians view environmental protection and social  
158 wellbeing as conflicting<sup>29, 30</sup>. This mental map was also more prominent in the Americas  
159 (USA, Brazil, Argentina) than in China and France, and stronger in Brazil than in India.  
160 These differences did not correspond to established dimensions of cultural variability<sup>31</sup> (e.g.,  
161 individualism-collectivism) or economic development, suggesting that these effects are  
162 specific to each country rather than reflecting broader cultural dimensions.

163 There were also demographic and value differences (for detailed analyses see  
164 Supplementary Information, S4). Overall, meta-analyses of relationships across countries  
165 showed that this dominant mental map was held more strongly by younger participants,  
166 females, and the less religious. It was not related to political orientation overall (despite the  
167 political divide on sustainability issues such as climate change<sup>32, 33</sup>), although cross-cultural  
168 variation was identified – this mental map was held by more left-wing participants in the  
169 UK/France but by more right-wing participants in Russia. On values, this mental map was  
170 held more strongly by those with higher concern for others' welfare (Benevolence) and who  
171 value novelty and challenge (Self-direction), but was less prevalent for those who value  
172 control and dominance (Power), stability and the status quo (Tradition, Conformity), and  
173 excitement and pleasure (Hedonism, Stimulation).

174 This dominant mental map is shown with the other mental maps in Fig. 2. While there  
175 were only four participant components, this figure has eight panels to show the patterns for  
176 those with positive or negative scores for each component. For participants with negative  
177 component scores the associations between SDGs and sustainability elements are reversed,  
178 achieved in Fig. 2 by reversing the direction of the arrows for sustainability elements.

179 While each mental map tells an informative story, here we focus on the two simpler  
180 distinctions that differentiate these maps (for more detail on each mental map, see  
181 Supplementary Information, S3). The first distinction, which we label “primary contrast” in  
182 Fig. 2, involves how sustainability elements were contrasted (indicated by arrow directions).  
183 On the left side of Fig. 2 (Mental maps 1 and 3; accounting for almost 70% of explained  
184 variation), participants saw a tension between environmental and social sustainability – more  
185 focus on the health of the natural world means less focus on human wellbeing (and vice  
186 versa), with economic sustainability not strongly related to either of the other elements.

187 In contrast, the right side of Fig. 2 (Mental maps 2 and 4, accounting for about 30% of  
188 explained variation) shows a primary contrast between economic and social/environmental  
189 sustainability – more focus on sustained economic productivity means less focus on  
190 achieving a healthy natural world or human wellbeing. This minority view fits more closely  
191 with some expert models of sustainability that contrast the economy and the environment<sup>12, 22,</sup>  
192 <sup>23</sup>.

193 The second distinction is in how the SDGs were aligned with sustainability elements.  
194 In the top half of Fig. 2 (Mental maps 1 and 4; 60% of explained variation), different SDGs  
195 were seen to target different sustainability elements, but differ in which element is targeted.  
196 For example, in these mental maps SDG13 (Climate) was seen to target environmental

197 sustainability (Fig. 2a), economic sustainability (Fig. 2c), both social and economic  
198 sustainability (Fig. 2b), or both environmental and social sustainability (Fig. 2d).

199 In the bottom half of Fig. 2 (Mental maps 3 and 2, 40% of explained variation) all  
200 SDGs targeted the same element(s). Participants used one or two sustainability elements as a  
201 “lens” for all SDGs, but differed in the lens(es) used. These lenses showed a socio-centric  
202 focus, with all SDGs seen to target only social sustainability (Fig. 2e) or economic  
203 sustainability (Fig. 2h), but using environmental sustainability as a lens only in conjunction  
204 with social (Fig. 2g) or economic (Fig. 2f) sustainability. This is notable because there is a  
205 tendency to see sustainability issues mainly through an environmental lens<sup>22, 34, 35</sup> (illustrated  
206 by the title of a prominent journal “Environment: Science and Policy for Sustainable  
207 Development”), especially for climate change<sup>32, 36, 37</sup>.

208 Mental maps 2-4 showed no reliable demographic or value associations, and only one  
209 country difference. For Mental map 2, scores were more negative in Russia than in Brazil or  
210 the UK, indicating that Russians saw all SDGs as more focused on economic sustainability  
211 (reflecting a high priority on economic issues in sustainability noted by others<sup>30</sup>) and  
212 Brazilians/British saw all SDGs as more focused on social/environmental sustainability.  
213 While this study provided few indications about the characteristics associated with these  
214 mental maps, other demographics (e.g., education) or psychological factors (e.g.,  
215 worldviews<sup>38</sup>) may be relevant.

216 Participants could have high scores on more than one component, for whom the  
217 mental maps are building blocks for understanding these more complex beliefs. To illustrate,  
218 participants with high positive scores only on Mental map 1 (Fig. 2a) primarily distinguished  
219 SDGs on environmental or social sustainability and saw economic sustainability as less  
220 relevant, but those who also had high positive scores on Mental map 2 (Fig. 2h) showed the  
221 economic-social sustainability distinction but also believed the SDGs targeted economic  
222 sustainability.

223 To understand if these mental models were associated with the priority people give to  
224 achieving sustainable development, we introduced participants to the concept of Gross  
225 Domestic Product (GDP) as an indicator of national priorities, and asked participants to  
226 specify the percentage of their country’s GDP that should be devoted to achieving the SDGs.  
227 Responses ranged from 0-100%, and were lowest in Russia ( $M=27$ ,  $SD=22$ ) and highest in  
228 South Korea ( $M=45$ ,  $SD=19$ ). Meta-analyses showed no overall relationship between this  
229 measure and any mental map, with cross-country variation observed only for Mental map 2  
230 (see Supplementary Information, S5). While this broad measure assesses only one aspect of  
231 sustainability support, it suggests that these mental maps are alternative perspectives on  
232 sustainability rather than reflecting “pro-” or “anti-” sustainability views.

## 233 DISCUSSION

234 This mapping of cultural views of the SDGs and sustainability provides knowledge to  
235 improve public engagement with sustainability. Based on these findings we make the  
236 following recommendations, with the caveat that samples in each country were relatively  
237 small and would benefit from expanding the research to larger representative samples in these  
238 and other countries.

239 Our findings indicate a multifaceted strategy could engage people with a broader  
240 range of sustainability issues. For a substantial proportion of participants, each SDG targeted

241 environmental, social or economic sustainability. Because people are more receptive of  
242 communication that fits their beliefs, sustainability communication could improve by moving  
243 beyond targeting the “obvious” elements (e.g., environmental sustainability for climate  
244 change, social sustainability for equality). For example, communication about SDG4  
245 (Education) could highlight how it improves people’s quality of life (social), increases  
246 economic productivity (economic), and helps people understand the importance of preserving  
247 the natural world (environmental). This study complements evidence from climate change  
248 communication demonstrating that a focus on social or economic outcomes can be as  
249 effective as focusing on its environmental effects<sup>39, 40</sup>.

250 The findings also suggest which SDGs will work well together in public  
251 communication because they are both directed towards the same sustainability goals. For  
252 example, in the dominant mental map both SDG8 (Growth) and SDG5 (Gender) target social  
253 and economic sustainability, suggesting most people would accept the International Monetary  
254 Fund’s recent framing that links increased gender equality with stable economic growth<sup>41</sup>.  
255 However, it is important that policies and initiatives actually deliver on these outcomes (in  
256 this example policy success is equivocal<sup>42</sup>), to ensure policies do not undermine future  
257 communication efforts. Other political considerations are also important, such as how the  
258 political alignment of communicators could influence reactions (e.g. whether messages come  
259 from the political left or right).

260 Close consideration is needed when communicating environmental, social, and  
261 economic sustainability elements in combination<sup>43</sup>. One consideration is whether to present  
262 these elements with equal status and emphasis, or with the more obvious element as dominant  
263 and others as supplementary. The latter approach is common when communicating climate  
264 change, where social/economic outcomes are typically framed as “co-benefits”<sup>44, 45, 46</sup>. Yet  
265 this might be a less effective frame for people who see the primary outcomes of addressing  
266 climate change as social or economic rather than environmental.

267 A further consideration involves how using multiple elements could enhance or  
268 undermine persuasiveness. Communicating benefits for multiple sustainability elements  
269 could have additive effects through providing extra justifications to support policies.  
270 However, where people see these outcomes as in tension, the overall effect may be to  
271 undermine support by claiming they will achieve outcomes people view as incompatible.  
272 Some evidence from climate change communication suggests such undermining effects may  
273 be minimal because people tend to remember and pass on information familiar to them and  
274 filter out the rest<sup>20</sup>. Others have found that individual differences such as open-mindedness  
275 influence the persuasiveness of these types of messages<sup>47</sup>. The findings contribute to  
276 understanding both considerations through identifying public beliefs about which SDGS are  
277 seen as compatible or conflicting in achieving sustainability.

278 The findings highlight a particular challenge for explicitly “all-encompassing”  
279 sustainability programs such as the USA’s proposed “Green New Deal”<sup>48</sup>. While its political  
280 opponents have claimed it will have devastating consequences for the economy<sup>49</sup>, from our  
281 findings it appears that the largest challenge in public communication is not a proposal’s  
282 economic sustainability, but to persuade people that it can deliver on both environmental and  
283 social outcomes (e.g., addressing climate change *and* health or poverty).



284 Two approaches for overcoming this challenge warrant investigation. The first  
285 separates the communication of policies to diminish the salience of the tension. For example,  
286 policies to address SDG13 (Climate) and SDG1 (Poverty) could be communicated as separate  
287 programs even though they could be linked in policy development<sup>13, 50</sup>. A second approach is  
288 to ensure communication (and policies themselves) explicitly addresses this tension, e.g.,  
289 explaining how addressing climate change will help reduce poverty or create other social co-  
290 benefits<sup>44, 45</sup>, or how policies to address poverty will have minimal negative (or even positive)  
291 impacts on the environment.

292 For communication within specific countries, we recommend close consideration of  
293 the dominant beliefs within each country (see Supplementary Information, S4). However, to  
294 communicate SDGs to international audiences (where consistency and simplicity of  
295 communication may be higher priorities), we recommend working with the dominant model  
296 (Fig. 1). This means placing most emphasis on the environmental benefits of healthy  
297 ecosystems, the social benefits of infrastructure/innovation, improving health and reducing  
298 hunger, and the social and economic benefits of equality and peace.

299 While there are many considerations for what and how to communicate sustainability  
300 beyond audience reactions, understanding people's mental maps provides insights into what  
301 is most likely to resonate with the public in diverse societies. This informs efforts to improve  
302 public engagement with sustainability to gain the widest public support to address this crucial  
303 global issue.

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## Methods

308 This research was approved by the Psychology Research Ethics Committee at the  
309 Queensland University of Technology (QUT), Ethics Approval Number 1600000223.

310 An online survey was completed by 2671 community participants between February  
311 28 and March 19, 2018, using an online panel administered by Survey Sampling International  
312 (SSI) to its panel database in each country. We sampled from 12 countries (the maximum  
313 available within our budget), selected to include developing countries (“BRICS” countries:  
314 Brazil, Russia, India, China, South Africa; adding South Korea and Argentina to extend  
315 Asian/South American samples), developed anglophone countries (Australia, UK, USA), and  
316 developed non-anglophone countries (France, Sweden). SSI uses diverse methods to source  
317 their national panels, but the sample was self-selected by participants who chose to do the  
318 study (approx. 200 per country) and cannot be assumed to be fully representative of each  
319 country’s population. However, using a panel from a single company can reduce biases  
320 compared to using different recruitment methods. Surveys were in English for Australia,  
321 India, South Africa, UK, and USA, and for all other countries were translated into their major  
322 language using parallel or back-translation.

323 Participants read short definitions of environmental, social, and economic  
324 sustainability on separate pages (randomised order), and under each definition provided with  
325 short descriptions of the 17 SDGs (without the labels). Participants rated the extent to which  
326 each SDG was targeted at achieving that form of sustainability (see Table 1).

327 We also asked participants about the priority sustainability should be given in their  
328 country, introducing Gross Domestic Product (GDP) as a proxy measure of the resources in a  
329 country that can be used for different purposes. Participants indicated the percentage of their  
330 country’s GDP that should be directed towards achieving sustainability as a whole. They also  
331 were asked to indicate the proportion of their government’s budget to achieve the SDGs that  
332 should be allocated to each of the 17 SDGs (analyses for this measure is reported in  
333 Supplementary Information only, S5).

334 We also obtained ratings of values using the Short Schwartz Value Survey<sup>51</sup>, which is  
335 based on the most widely-used and cross-culturally validated psychological model of  
336 values<sup>25</sup>. Demographic information collected included age, gender, relative income, political  
337 orientation, religiosity, and rural/urban location. Additional measures not related to the study  
338 were included for a cross-cultural validation study (i.e., people’s worldviews about social  
339 change, ideal prize to win in a lottery).

340 For analyses, we excluded participants who showed clear evidence of “flatline”  
341 pattern responding – giving an identical rating for the relevance of all 17 SDGs in one or  
342 more sustainability elements (n=504). While it is possible that some participants could see all  
343 17 SDGs as relevant to a sustainability element to an identical degree, we took a cautious  
344 approach and reasoned that showing no variation at all across 17 SDGs was more likely to  
345 indicate inattention or disengagement with the task (further analyses of these responses is  
346 reported in Supplementary Information, S1). As the analyses requires a complete dataset with  
347 no missing values, participants with missing values for any SDG on any element were  
348 excluded (n=33). This resulted in a final sample of 2134. Demographic information by  
349 country is contained in Supplementary Information, S1.

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### **Data availability**

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Materials and data are publicly available on the Open Science Framework repository  
at <https://osf.io/c365a/>.

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535

### **Author contributions**

536 P.G.B. conceived and designed the study, developed the new measures, coordinated data

537 collection, analysed the data in conjunction with P.M.K, wrote the manuscript, and wrote

538 most of the Supplementary Information. P.M.K., L.J., T.L.M, C.R.C., and T.K. provided

539 input to the basic study design and measures. L.J., T.L.M, E.B., C.C, C.D., Y.G., and J.P

540 provided input into cultural considerations of the study and measures, and provided

541 translations of the survey. P.M.K. wrote part of the Supplementary Information. All authors

542 provided feedback on the results and the manuscript.

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### **Competing Financial Interests**

545 The authors declare no competing financial interests.

546

547 *Table 1. Definitions of sustainability elements used in the study (boldfaced parts of*  
 548 *descriptions were boldfaced in the survey).*

<b>Sustainability element</b>	<b>Description</b>
<b>Environmental</b>	Environmental sustainability refers to <b>maintaining the viability and health of the natural world</b> (including animals and plants) in wilderness, rural, and urban areas over time. This includes using renewable environmental resources, using non-renewable resources in ways that their use can continue until renewable substitutes are found, and controlling pollution to levels that the Earth can process.
<b>Social</b>	Social sustainability refers to providing an <b>acceptable level of wellbeing and quality of life for all people</b> in society over time. This includes governments and institutions acting to minimize destructive conflicts, to ensure there are acceptable levels of fairness, opportunity, and diversity in society, and providing support to meet people’s basic needs for health and wellbeing.
<b>Economic</b>	Economic sustainability refers to governments, businesses, and individuals <b>managing finances efficiently and responsibly to promote productive economic activity now and into the future.</b> This includes investing in activities likely to produce enduring positive results, avoiding activities that are likely to hamper long-term productivity (e.g., avoiding excessive debt and interest payments), and making optimal use of available resources.

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550

551 *Table 2. Descriptions of the Sustainable Development Goals used in the study (with short*  
 552 *labels used in the figures and text).*

<b>SDG</b>	<b>UN label</b>	<b>Short label</b>	<b>Description used in study</b>
1	No Poverty	<b>Poverty</b>	End poverty in all its forms everywhere
2	Zero Hunger	<b>Hunger</b>	End hunger, achieve food security and improved nutrition, and promote sustainable agriculture
3	Good health and well-being	<b>Health</b>	Ensure healthy lives and promote well-being for all, at all ages
4	Quality Education	<b>Education</b>	Ensure inclusive and equitable quality education and lifelong learning opportunities for all
5	Gender Equality	<b>Gender</b>	Achieve gender equality and empower all women and girls
6	Clean Water and Sanitation	<b>Water</b>	Ensure availability and sustainable management of water and sanitation for all
7	Affordable and Clean Energy	<b>Energy</b>	Ensure access to affordable, reliable, sustainable and modern energy for all
8	Decent Work and Economic Growth	<b>Growth</b>	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
9	Industry, Innovation and Infrastructure	<b>Infrastructure</b>	Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation
10	Reduced Inequalities	<b>Equality</b>	Reduce inequality within and among countries
11	Sustainable Cities and Communities	<b>Cities</b>	Make cities and human settlements inclusive, safe, resilient and sustainable
12	Responsible Consumption and Production	<b>Consumption</b>	Ensure sustainable consumption and production patterns
13	Climate Action	<b>Climate</b>	Take urgent action to combat climate change and its impacts
14	Life Below Water	<b>Oceans</b>	Conserve and sustainably use the oceans, seas and marine resources
15	Life on Land	<b>Land</b>	Protect, restore and promote sustainable use of ecosystems, including manage forests, combat desertification, reverse land degradation, and halt biodiversity loss
16	Peace, Justice and Strong Institutions	<b>Peace</b>	Promote peaceful and inclusive societies, including providing access to justice for all and building effective, accountable institutions
17	Partnerships for the Goals	<b>Partnerships</b>	Strengthen global efforts and partnerships for achieving sustainable development

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555 *Figure 1. The dominant mental map relating SDGs to Sustainability elements.*

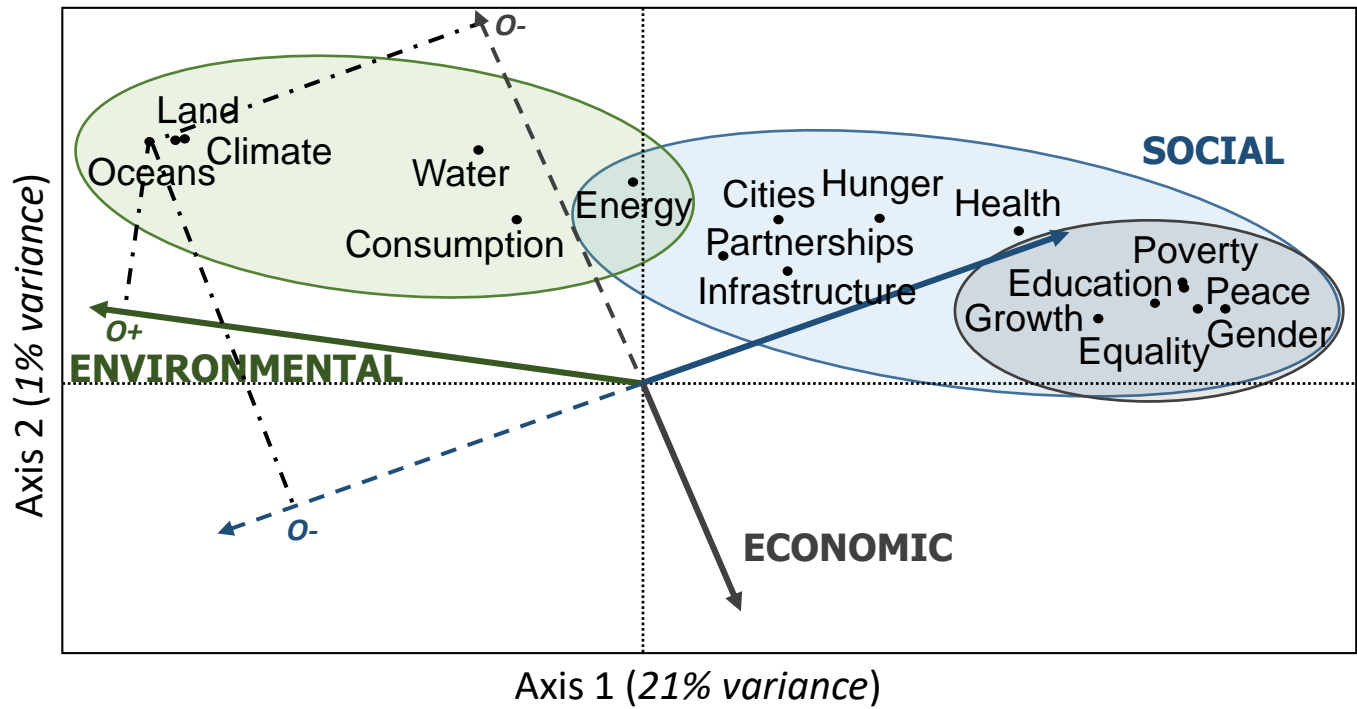
556 The plot is rotated so the maximum variance is explained on the horizontal axis. SDGs and  
557 sustainability elements were transformed to have similar scales (symmetric scaling) so their  
558 relationships can be seen more easily; hence axis values are not inherently meaningful and  
559 were omitted. SDGs are shown as points and Sustainability elements as arrows (positive  
560 direction: solid lines; negative direction: dotted lines). Projecting SDG points orthogonally  
561 onto Sustainability element arrows shows their correspondence – intersecting with the solid  
562 line means they are associated with a Sustainability element more strongly than average, and  
563 with a dotted line more weakly than average (negative direction). This is illustrated for  
564 SDG14: Oceans, which had the strongest association with environmental sustainability of all  
565 SDGs and the weakest associations with social and economic sustainability. To help  
566 interpretation, ellipses show where SDGs target a sustainability element more strongly than  
567 average.

568

569

570 *Figure 2. Mental maps relating SDGs to sustainability elements, showing relationships for*  
571 *those with positive and negative scores for each of the four participant components.*

572 Mental maps have been arranged to highlight commonalities and differences. Maps on the  
573 left and right reflect the primary contrast people made between sustainability elements – for  
574 mental maps on the left (Panels (a), (b), (e) & (f)) the primary contrast was between  
575 environmental and social sustainability, and for those on the right (Panels (c), (d), (g) & (h)  
576 the primary contrast was between economic and environmental/social sustainability. Maps in  
577 the top and bottom halves differed in how SDGs were aligned with sustainability elements  
578 (“SDG alignment”). In the top half (Panels (a), (b), (c) & (d)), different SDGs were seen to  
579 target different sustainability elements, e.g., in Fig. 2(a) SDG14: Oceans targets  
580 environmental sustainability and SDG3: Health targets social sustainability. In the bottom  
581 half (Panels (e), (f), (g) & (h)), all SDGs were seen to target the same element(s) but differed  
582 in which element(s) they targeted. Ellipses show where SDGs target a Sustainability element  
583 more strongly than average.



**Primary contrast**

*Environmental ↔ Social*

*Economic ↔ Social/Environmental*

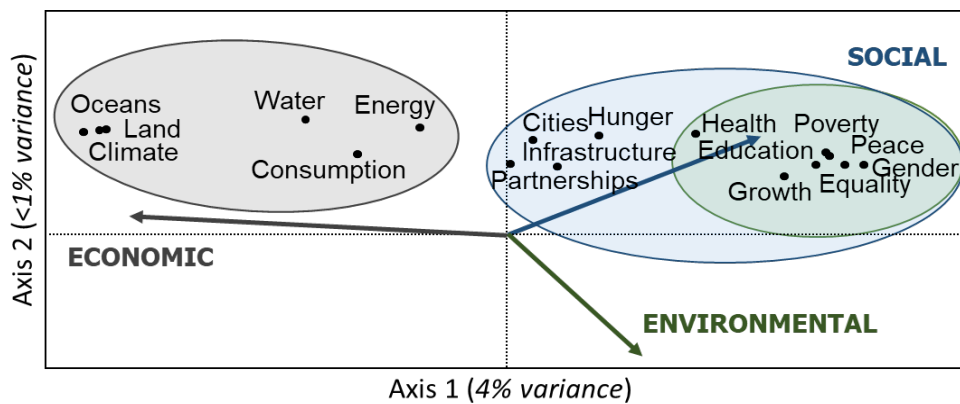
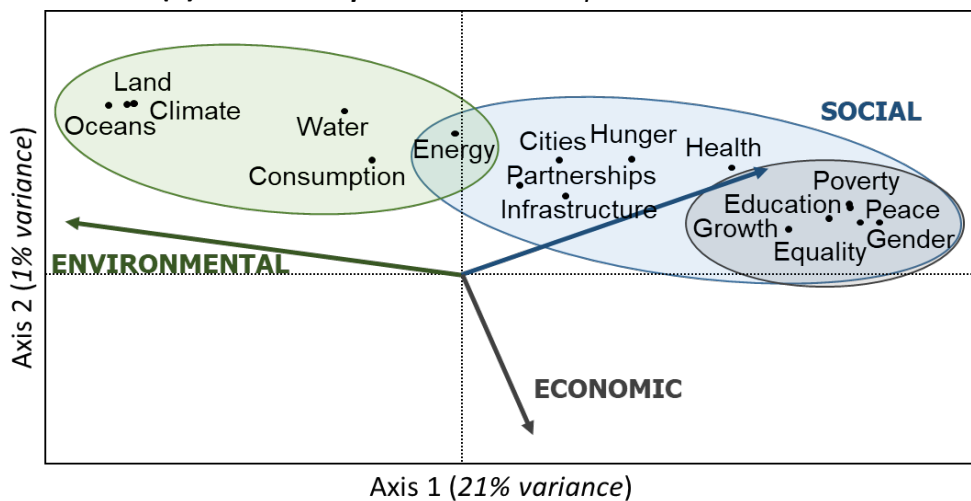
Different elements

SDG alignment

Same element(s)

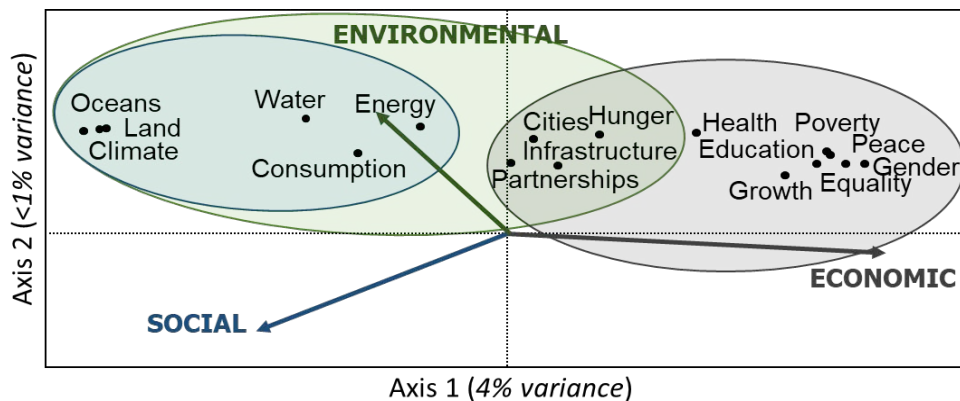
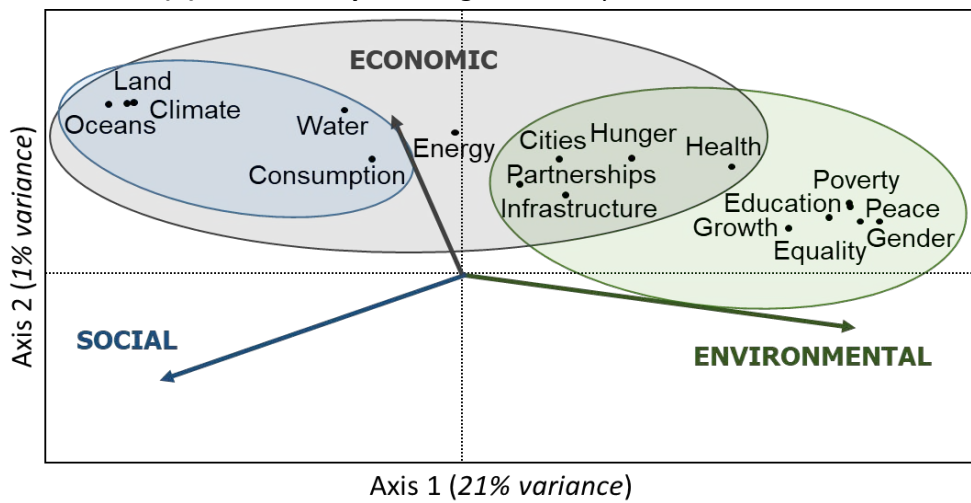
**(a) Mental map 1 – Positive component scores**

**(c) Mental map 4 – Positive component scores**



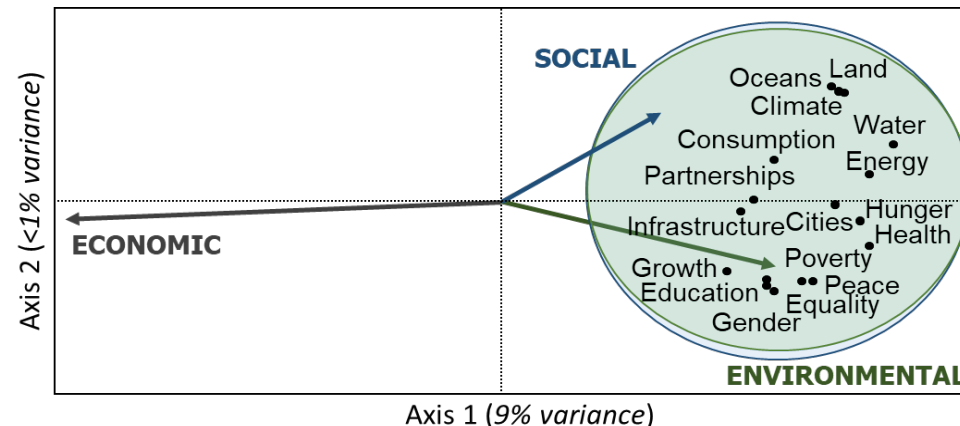
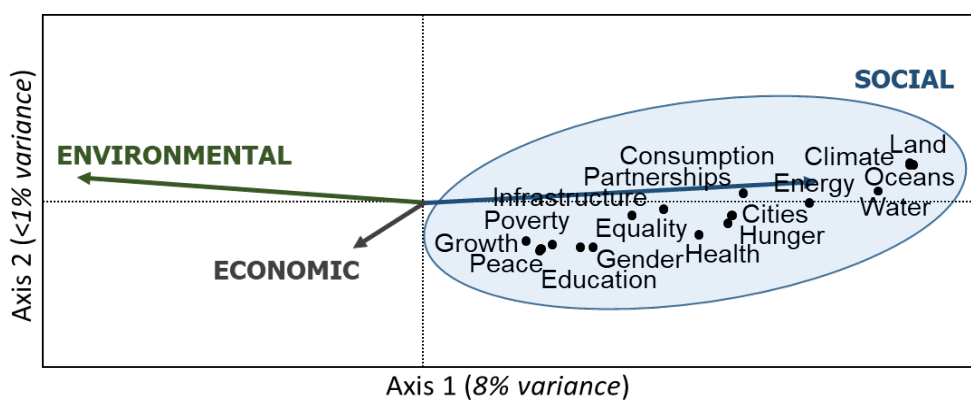
**(b) Mental map 1 – Negative component scores**

**(d) Mental map 4 – Negative component scores**



**(e) Mental map 3 – Positive component scores**

**(g) Mental map 2 – Positive component scores**



**(f) Mental map 3 – Negative component scores**

**(h) Mental map 2 – Negative component scores**

