# Public views of the Sustainable Development Goals across countries

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

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

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

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

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

59        While we have some information about the priorities assigned to SDGs on average[21],
60   we lack a deeper understanding of people's "mental maps" of sustainability. We use mental
61   map to denote a visual representation of cognitive associations between constructs, in this
62   case how people relate each SDG to the achievement of environmental, social, and economic
63   sustainability. For example, SDG7 (Affordable and Clean Energy) might be seen as primarily
64   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[12, 22, 23].
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[24], 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[5]; 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"[25]), which are known to influence
102  attitudes to environmental sustainability issues such as climate change[26]. 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[27, 28] (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[12].

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[29, 30]. 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[31] (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[32, 33]), 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[12, 22,
192 23].

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[22, 34, 35] (illustrated
206  by the title of a prominent journal "Environment: Science and Policy for Sustainable
207  Development"), especially for climate change[32, 36, 37].

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[30]) 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[38]) 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

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environmental, social or economic sustainability. Because people are more receptive of communication that fits their beliefs, sustainability communication could improve by moving beyond targeting the "obvious" elements (e.g., environmental sustainability for climate change, social sustainability for equality). For example, communication about SDG4 (Education) could highlight how it improves people's quality of life (social), increases economic productivity (economic), and helps people understand the importance of preserving the natural world (environmental). This study complements evidence from climate change communication demonstrating that a focus on social or economic outcomes can be as effective as focusing on its environmental effects[39, 40].

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

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

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

The findings highlight a particular challenge for explicitly "all-encompassing" sustainability programs such as the USA's proposed "Green New Deal"[48]. While its political opponents have claimed it will have devastating consequences for the economy[49], from our findings it appears that the largest challenge in public communication is not a proposal's economic sustainability, but to persuade people that it can deliver on both environmental and 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[13, 50]. 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[44, 45], 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**

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

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

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

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

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

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

**Data availability**

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

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**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.

543

**Competing Financial Interests**

545 The authors declare no competing financial interests.

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

| Sustainability element | Description |
| --- | --- |
| **Environmental** | Environmental sustainability refers to **maintaining the viability and health of the natural world** (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. |
| **Social** | Social sustainability refers to providing an **acceptable level of wellbeing and quality of life for all people** 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. |
| **Economic** | Economic sustainability refers to governments, businesses, and individuals **managing finances efficiently and responsibly to promote productive economic activity now and into the future**. 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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551  *Table 2. Descriptions of the Sustainable Development Goals used in the study (with short*
552  *labels used in the figures and text).*

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

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*Figure 1. The dominant mental map relating SDGs to Sustainability elements.*
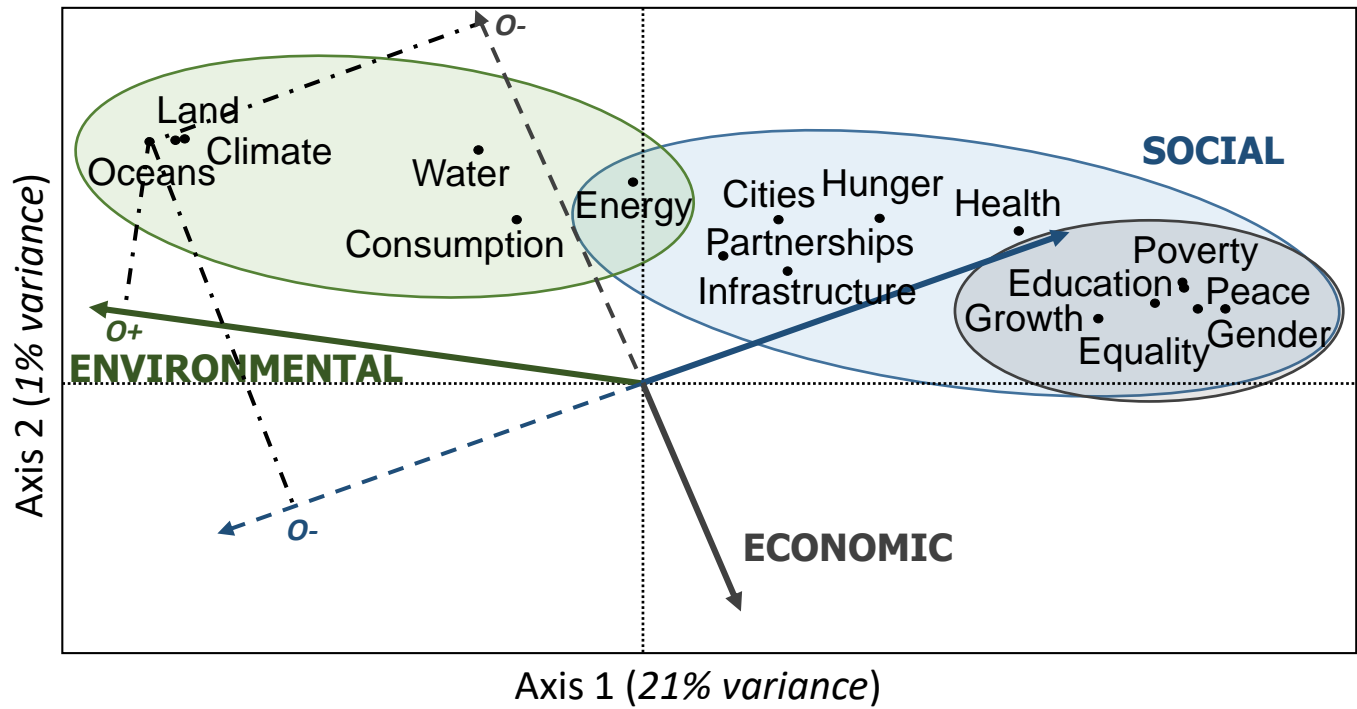
The plot is rotated so the maximum variance is explained on the horizontal axis. SDGs and
sustainability elements were transformed to have similar scales (symmetric scaling) so their
relationships can be seen more easily; hence axis values are not inherently meaningful and
were omitted. SDGs are shown as points and Sustainability elements as arrows (positive
direction: solid lines; negative direction: dotted lines). Projecting SDG points orthogonally
onto Sustainability element arrows shows their correspondence – intersecting with the solid
line means they are associated with a Sustainability element more strongly than average, and
with a dotted line more weakly than average (negative direction). This is illustrated for
SDG14: Oceans, which had the strongest association with environmental sustainability of all
SDGs and the weakest associations with social and economic sustainability. To help
interpretation, ellipses show where SDGs target a sustainability element more strongly than
average.

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

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

**SOCIAL**

**ENVIRONMENTAL**

**ECONOMIC**

Axis 2 (*1% variance*)

Axis 1 (*21% variance*)

Land
Climate
Oceans
Water
Consumption
Energy
Cities
Hunger
Health
Partnerships
Infrastructure
Poverty
Education
Peace
Growth
Gender
Equality

*O-*
*O+*
*O-*

**Primary contrast**

*Environmental ↔ Social*

*Economic ↔ Social/Environmental*

*Different elements*

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

Land
Climate
Oceans
Water
Consumption
Energy
Cities Hunger
Partnerships
Infrastructure
Health
Poverty
Education
Growth
Peace
Equality
Gender
SOCIAL
ENVIRONMENTAL
ECONOMIC
Axis 2 (1% variance)
Axis 1 (21% variance)

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

Oceans
Water
Energy
Land
Climate
Consumption
Cities Hunger
Infrastructure
Partnerships
Health Poverty
Education
Growth
Peace
Gender
Equality
SOCIAL
ECONOMIC
ENVIRONMENTAL
Axis 2 (<1% variance)
Axis 1 (4% variance)
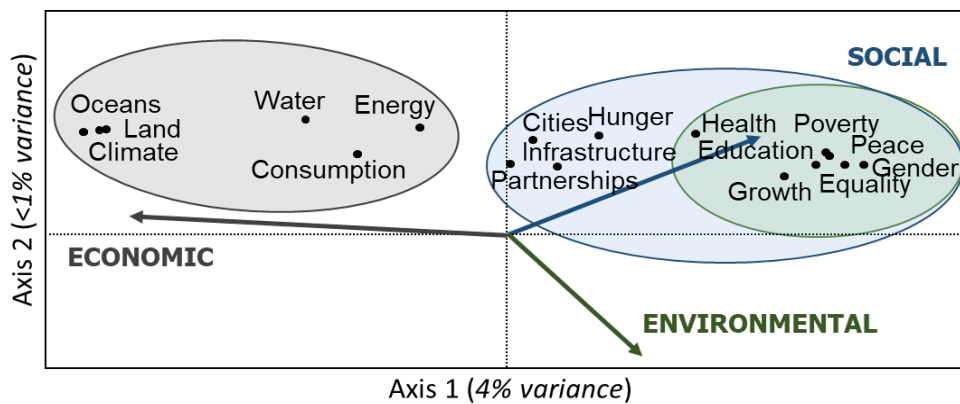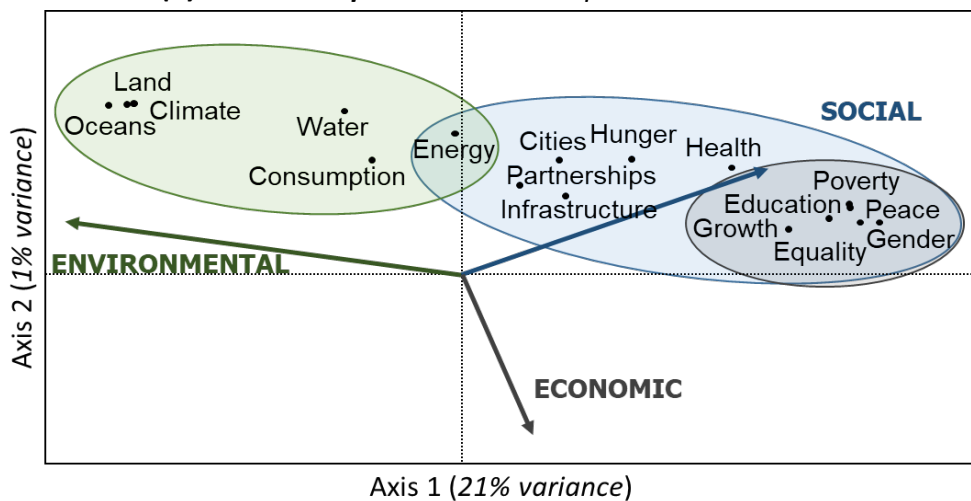
*(b) Mental map 1 – Negative component scores*

Land
Climate
Oceans
Water
Consumption
Energy
ECONOMIC
Cities Hunger
Partnerships
Infrastructure
Health
Poverty
Education
Growth
Peace
Equality
Gender
SOCIAL
ENVIRONMENTAL
Axis 2 (1% variance)
Axis 1 (21% variance)

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

Oceans
Land
Climate
Water
Energy
Consumption
ENVIRONMENTAL
Cities Hunger
Infrastructure
Partnerships
Health Poverty
Education
Growth
Peace
Gender
Equality
ECONOMIC
SOCIAL
Axis 2 (<1% variance)
Axis 1 (4% variance)

**SDG alignment**

*Same element(s)*
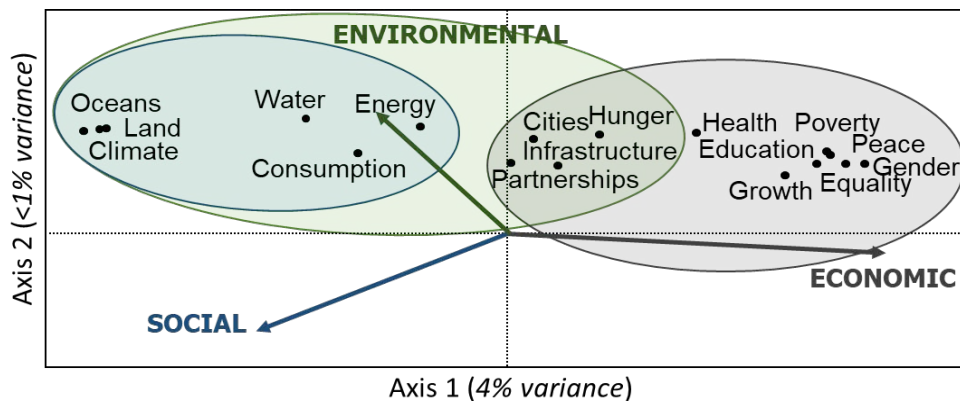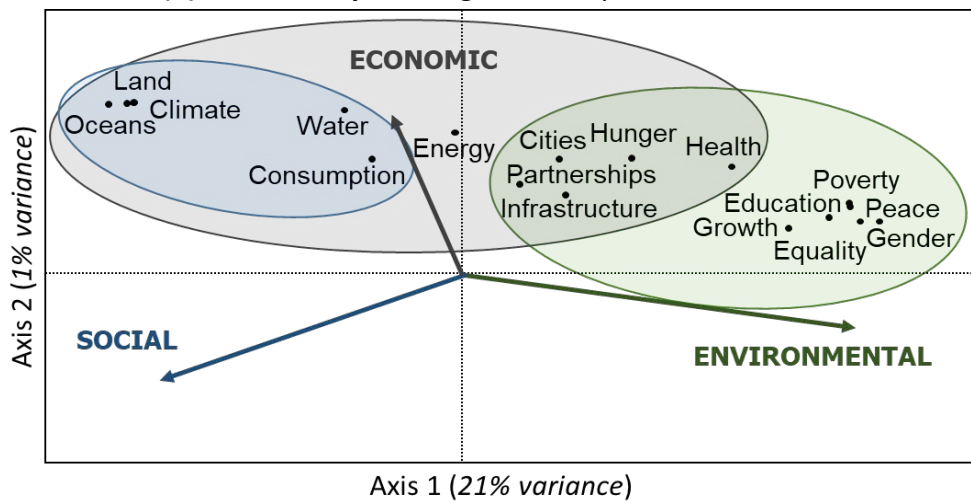
*(e) Mental map 3 – Positive component scores*

ENVIRONMENTAL
ECONOMIC
Consumption
Partnerships
Infrastructure
Poverty
Growth
Equality
Peace
Gender
Education
Health
Cities
Hunger
Climate
Energy
Land
Oceans
Water
SOCIAL
Axis 2 (<1% variance)
Axis 1 (8% variance)

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

SOCIAL
Oceans Land
Climate
Water
Consumption
Energy
Partnerships
Infrastructure
Cities
Hunger
Health
Growth
Poverty
Education
Peace
Gender
Equality
ECONOMIC
ENVIRONMENTAL
Axis 2 (<1% variance)
Axis 1 (9% variance)
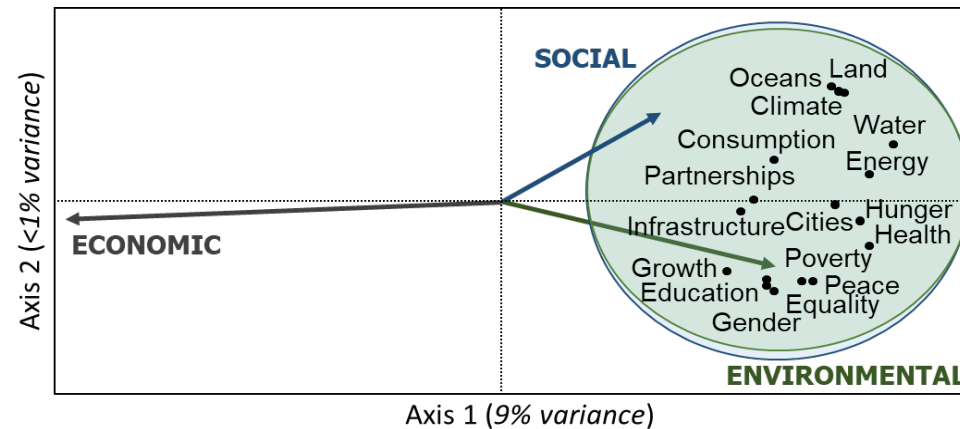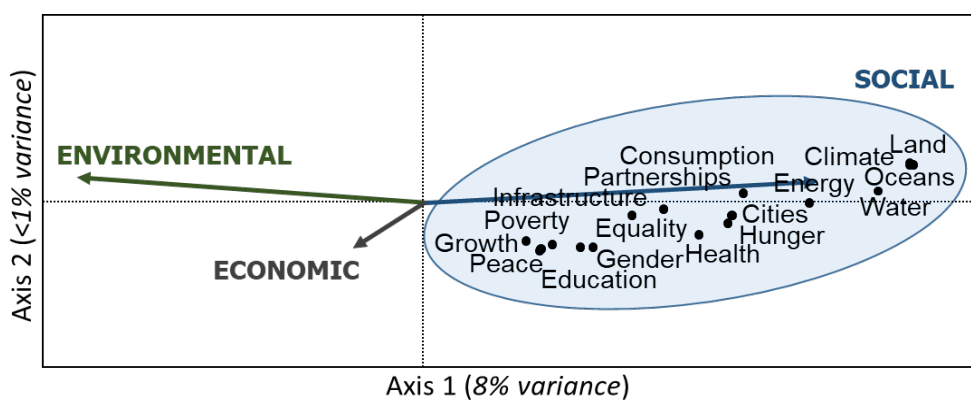
*(f) Mental map 3 – Negative component scores*

ECONOMIC
Consumption
Partnerships
Infrastructure
Poverty
Growth
Equality
Peace
Gender
Education
Health
Climate
Energy
Cities
Hunger
Land
Oceans
Water
SOCIAL
ENVIRONMENTAL
Axis 2 (<1% variance)
Axis 1 (8% variance)

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

ENVIRONMENTAL
Oceans Land
Climate
Water
Consumption
Energy
Partnerships
Infrastructure
Cities
Hunger
Health
Growth
Poverty
Education
Peace
Gender
Equality
SOCIAL
ECONOMIC
Axis 2 (<1% variance)
Axis 1 (9% variance)