

1 **Defining a Sustainable Development Target Space for 2030 and 2050**

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25 **Abstract**

26 By adopting the Sustainable Development Goals (SDGs), countries worldwide agreed to an agenda for
27 achieving a prosperous, socially inclusive and environmentally sustainable future for all¹. This ambition,
28 however, also exposes a critical knowledge gap since science-based insights on how to achieve the 17
29 SDGs simultaneously are lacking. Quantitative goal-seeking scenario studies could enable exploration of
30 the systems' transformations required to achieve the SDGs, but this requires a clear definition of the
31 "target space". The 169 targets and 232 indicators defined by the international community for monitoring
32 SDG implementation cannot be directly used for this purpose. Here, we define a streamlined set of well-
33 defined, science-based indicators and associated target values that is *quantifiable* and *actionable* to make
34 quantitative scenario analysis meaningful, *relevant* (i.e. reflecting societal goals), and yet simple enough
35 to keep analysis *transparent* and communicable. The set of 36 targets is based on the UN 2030 Agenda,
36 other existing multilateral agreements and insights from sustainability science and expert assessment,
37 and it includes 2050 as an additional longer-term reference point. Thus, this target space provides a
38 strategic focus to guide the scientific community in developing new global sustainable development
39 pathways.

40

41 **1. Introduction**

42 The *2030 Agenda for Sustainable Development*¹, adopted in 2015 by the UN General Assembly, sets an
43 ambitious agenda for the universal pursuit of economic, social, environmental, and institutional
44 objectives, concretized in 17 Sustainable Development Goals (SDGs) and 169 associated targets. Together
45 with other international agreements (such as the Paris Climate Agreement and the Aichi biodiversity
46 targets^{2,3}), the 2030 Agenda aims to ensure that development patterns lead to wellbeing and social
47 inclusion while maintaining the stability of the earth's biophysical life support systems. Achieving the SDGs
48 will require a fundamental transformation of today's societies⁴⁻⁷. Still, it is not easy to understand exactly
49 what is needed. While for some goals (e.g. climate, SDG13), literature exists showing how to achieve them,
50 for many others, such literature is sparse or lacking. More importantly, hardly any information exists on
51 what is needed for achieving all SDGs together⁵, accounting for the linkages between SDGs and possible
52 synergies or trade-offs^{4,8-12}. For example, pursuing food security for all (SDG2) could foster water
53 shortages (SDG6) that could cause social conflict (SDG16). Recent studies have looked at achieving
54 multiple SDGs at the national level¹³ or specific groups of SDGs^{6,14-16}. Still, no study looks at all 17 SDGs
55 simultaneously or the longer-term implications, which is critical for genuinely sustainable planning as
56 expressed by various policy reports and science programs (e.g., the Science-based Targets Initiative¹⁷ and
57 the UN Global Sustainable Development Report)¹⁸. The current situation caused by the COVID-19
58 pandemic and the recovery process (which could enable or impede pathways towards implementing the
59 SDG has made this even more important^{19,20}. Scenarios showing how SDGs can be met could play a similar
60 role as emission, and climate scenarios have in the climate realm, i.e., spur scientific research and help
61 policymakers translating ambitions into concrete action. Identifying pathways to implement the SDGs has
62 become even more urgent due to the slow implementation record in the past five years.

63 Any exercise aiming to provide a quantitative analysis of pathways towards meeting the SDGs would need
64 a precise formulation of the "target space"^{9,21-24}: i.e., a limited set of targets formulated unambiguously
65 and providing comprehensive coverage of the ambition of the SDGs. While the current 169 targets and
66 232 indicators allow tracking global and country-level progress on implementing the 2030 Agenda²⁵, they
67 are too broad, unstructured, and complex to support quantitative analyses of transformation trajectories.

68 As a result, progress on scenario development at all scales (global, national, or city level) is slowed down
69 by the lack of a relatively simple framework that includes all relevant, sustainable development
70 dimensions. This paper proposes a new set of targets that are the first systematic framework guiding
71 sustainable development scenarios. These targets allow the representation of all the SDGs and their long-
72 term explorations. Based on this new set of targets, research will move beyond the more topic-oriented
73 scenario exercises done so far (e.g. climate – IPCC, biodiversity – IPBES, food – FAO) towards integrated
74 analyses of the people-planet framework.

75 Defining such a target space is not easy. For instance, quantitative projections are only in their beginnings
76 in several science areas relevant to the SDGs^{26,27}. Moreover, any selection automatically leaves out
77 important topics. Based on the criteria described here, below and in the Supplementary Information (SI),
78 we explain why the targets were chosen. At the same time, it should be noted that the formulation of this
79 target space intends to provide the scientific community with a first standardized set that can be tested
80 and evaluated in scenario studies. No single model will be able to address all aspects of the target space
81 meaningfully. As such, we expect and encourage the community to work together with sets of (coupled)
82 models to provide a more comprehensive analysis²⁸. In addition to the target space, transformation
83 narratives will be critical for improving comparability and consistency across quantitative studies on the
84 SDGs. We illustrate the use of this set of targets by applying it to available information for a middle-of-
85 the-road scenario²⁹. With increasing experience and scenario applications, the target space is expected to
86 be adapted and improved over time. Future studies could contribute to this exercise by using it, engaging
87 in further refinement of indicators or targets and contributing to improved modelling of individual
88 indicators or linkages.

89

90 **2. Defining a sustainable development target space**

91 The formulation of the target space draws upon expert discussions as part of the "The World in 2050"
92 (TWI2050) initiative, which convenes scientists involved in scenario modelling, social and natural scientists
93 and policy analysts from around the world for collaboration and deliberative consultation for the
94 development and use of sustainable development pathways⁵ (see for further information and
95 participating institutions the website). TWI2050 has identified six fundamental transformations,
96 describing a set of interventions for simultaneously achieving the SDGs and extending sustainable
97 development beyond 2030: i) advancing human capacities, ii) establishing responsible consumption and
98 production patterns, iii) decarbonizing the energy system and providing access to energy services, iv)
99 establishing sustainable land use management and access to food while safeguarding biodiversity, iv)
100 developing sustainable cities and vi) aligning the digital revolution with the SDGs⁵ (Sachs et al. ⁷ provided
101 a slightly adapted variant). These transformations were kept in mind in selecting the target space
102 indicators. Around 60 scientists involved in TWI2050 assisted in formulating the target space. This involved
103 the selection of indicators, as well as the associated target values. There were several steps in the process
104 (Fig 1): 1) formulation of key principles for the target space and selection criteria, 2) the review of existing
105 sets of indicators and targets in the literature, international agreements and associated with the SDGs,
106 and 3) the final selection of a set of indicators and targets.

107

108 *Target space design: principles and criteria for indicator selection*

109 As a starting point, a list of principles for selecting indicators and setting targets was developed (Table 1).
110 A first principle is to ensure that the indicators are *relevant for society*, i.e. link to the societal agenda as
111 expressed in the SDGs, which are the outcome of a global political consultation process. The set also needs
112 to be *science-based*, i.e. it should be consistent with the insights of global sustainability science. This leads
113 to the third principle that a longer-term perspective needs to be included (*valid for 2030 and beyond*). The
114 fourth principle emphasizes that indicators need to be *robustly quantifiable* to enable quantitative
115 analysis. Finally, the fifth principle of *operational simplicity, transparency and usability* aims to ensure the
116 relevance of the quantitative analysis for policymakers (Table 1). This, for instance, means that the
117 number of targets needs to be limited.

118 Our ambition to keep the Sustainable Development target space analytically tractable and transparent
119 subsequently translated into a criterion to choose only 2-3 targets per SDG. One way to do so was (if
120 relevant) prioritizing those targets that represent endpoints in terms of the actual desired state and not
121 the means of achieving this state. Another way is to avoid overlap between target indicators. As the SDGs
122 are interlinked, an indicator selected for a given SDG can also cover aspects of other SDGs (for example,
123 access to the internet and financial institutions relates to SDG9 on innovation and covers aspects of SDG10
124 on reducing inequality). Each target should also be suitable for quantitative analysis and sensitive to policy
125 choices. Regarding the choice of the specific numerical target values, we used three key criteria: 1)
126 preferably, values are directly taken from the 2030 Agenda and other international agreements; 2) as an
127 alternative, the values of top-performing countries are used; or 3) values assessed to be consistent with
128 the basic principles underlying the SDGs.

129

130 *Selection of targets and target values*

131 The expert deliberations proposed a set of targets³⁰ that has been iteratively refined based on the above
132 criteria and existing literature (Table 2). Given the first principle, we started with an initial list of targets
133 as part of the 2030 Agenda and multilateral agreements, complemented with the (scientific) literature³¹⁻
134 ³³ (more specific references are provided in the paragraphs describing indicator choice). In some cases,
135 the targets needed to be defined more precisely to allow quantitative evaluation (e.g. the notion of
136 "hunger" needs a specification of a number of kilocalories per person per day). Finally, our final set also
137 includes examples for which target values could not yet be provided, such as quantifying peace by
138 measuring the reduction of conflict-related deaths until 2030 and 2050. Two challenges have to be kept
139 in mind when applying the target space. First, the targets are interlinked^{11,12}. Synergies between SDGs
140 reinforce the achievement of different targets (e.g. access to drinking water improves health) while trade-
141 offs may limit or hinder the achievement of other goals^{5,7}. Second, while several targets are universal and
142 can be applied at different geographic scales, others are currently focused on the global scale. We assume
143 that in quantitative analysis, model teams will find ways to deal with these challenges and encourage the
144 international community to explore further elaboration in future applications of the proposed target
145 space³⁴.

146

147 3. The selected indicators and target values

148 We discuss the target and indicator selection in five clusters and provide additional information on the
149 choices in the SI. The clusters are based on the key elements of sustainable development introduced in
150 the preamble of the 2030 Agenda¹, i.e. i) mobilizing *people's* potentials in dignity and equality, above all
151 requiring the end of poverty (*people*); ii) ensuring that all human beings can enjoy prosperous and fulfilling
152 lives (*prosperity*); iii) protecting the *planet* from degradation, including ensuring more sustainable
153 management of key resources (*planet*), and iv) ensuring the development of well-governed, *peaceful*, just
154 and inclusive societies which are free from fear and violence (*peace*). We have split the 'planet' element
155 into two clusters on *planetary integrity* and *sustainable resource management*. The resulting clustering of
156 targets and indicators serves as an accessible, yet meaningful, form of presenting the high number of
157 indicators in a readable way. These clusters and the sequence of our discussion do not imply any form of
158 hierarchy and do not consider interactions between SDGs yet. Use of the indicators in model-based
159 scenario analyses will do so (and could be combined with the six transformations^{5,7}). Table 2 summarizes
160 the target space organized by SDG. More information about alternative indicators and why we opted for
161 our selection can be found in the SI.

162

163 *People (SDGs 1, 3, 4 and 5)*

164 The SDGs addressing poverty eradication, health, education, and gender equality together represent a
165 concept of human development. Several indices have previously been used to capture the multi-
166 dimensional nature of human development, aiming to assess progress over time beyond economic
167 growth. The UNDP's Human Development Index (HDI) encapsulates three dimensions of development:
168 leading a long and healthy life, acquiring knowledge and achieving a decent standard of living³⁵. In
169 selecting indicators, we included the *number of people suffering from extreme poverty* for SDG1, the
170 *healthy life expectancy* and *under-5 mortality rate* for SDG3, the *completion of secondary education* for
171 SDG4, and *gender gaps in education and income* for SDG5.

172 For SDG1, it is clear that one indicator needs to be related to the objective of no one living in extreme
173 poverty by 2030. A key question is how to define extreme poverty. The World Bank global poverty line³⁶,
174 is chosen as the threshold for 2030. The global poverty line has been periodically updated to reflect these
175 changes. Where Target 1.1 specifically mentions \$1.25 per day, the World Bank has updated the absolute
176 poverty line to \$1.90 per day (US\$ 2011). We use 2 US\$ (US\$ 2015) per capita per day for 2030 and 2050
177 for practical reasons – and kept it constant over the time period (given the correction for inflation).
178 Relative poverty is also included under SDG10 and discussed in the *Prosperity* cluster. SDG3 aims at
179 ensuring healthy lives. Healthy life expectancy at birth is often proposed as a summary indicator³³. The
180 set of SDG targets includes several other indicators, including maternal mortality rates, and many other
181 indicators are also used in the literature. However, the advantage of the healthy life expectancy indicator
182 is that it is all-encompassing. The SDG target on under 5 mortality rate is used to track progress in
183 developing countries. The SDG target level of 25 deaths per 1,000 live births is taken for 2030, further
184 halved by 2050 to increase progress. Finally, alternative indicators that were considered include, among
185 others, normal life expectancy at birth, a goal of avoiding 40% of premature deaths³⁷ and the median
186 health-related SDG index used by the Global Burden of Disease study³⁸. The latter, however, will require

187 a much more comprehensive set of underlying indicators to be modelled. SDG4 aims for quality education.
188 The addition of universal secondary education expanded the Millennium Development Goals (MDGs)
189 ambition, which targeted universal primary education only. This addition is based partly on recent insights
190 that, for poor countries to come out of poverty, universal primary education is not enough and must be
191 complemented by secondary education for broad segments of the population³⁹. We chose the share of
192 young people achieving lower secondary education as this covers the compulsory schooling time in most
193 countries. Considering current enrollment rates in primary education, achieving 100% completion of
194 lower secondary education by 2030 is practically impossible, so the target values proposed are 80% in
195 2030 and 100% in 2050. Alternative indicators may include literacy rates, expected years of schooling,
196 participation in early childhood education, the share of the total population with lower secondary
197 education, a measure of the quality of education through graduate employment and mean years of
198 schooling. SDG5 aims for gender equality. Out of the broad domains covered by this SDG, we chose
199 education and income to track female empowerment. The target values aim at full equality in 2030, as
200 called for by SDG5. While some models cover differences in education, the wage gap is currently
201 addressed in very few models – and might be a future alternative indicator. The advantage of the
202 education-gap indicator is that it is directly related to future capacity and has an established link with
203 other indicators such as fertility levels. Other indicators that are used to track current progress regarding
204 gender equality include the female to male labor force participation rate, proportion of women in national
205 parliaments, share of women in management roles, legal gender discrimination and rates of sexual
206 violence. However, none of these are currently captured by integrated assessment models.

207

208 *Prosperity (SDGs 8, 9, 10, and 11)*

209 The SDGs on decent work and economic growth, industry, innovation and infrastructure, reduced
210 inequalities and sustainable cities and communities are closely interlinked and relate to the socio-
211 economic configuration of society as a whole.

212 SDG8 aims for sustained and inclusive economic growth and full and decent employment. As prosperity
213 in high-income countries is no longer driven by economic growth per se⁴⁰, a focus is placed on sufficient
214 economic growth in low and lower-middle-income countries, eventually leading to a convergence of living
215 standards. We, therefore, propose an indicator of economic convergence as measured by the ratio of
216 GDP/capita in the target country to the average OECD GDP/capita (both measured in PPP). Our
217 quantitative targets are based on historical examples of rapid GDP/capita growth and income
218 convergence, particularly the Asian “tiger economies” in the period 1960-1995 and China post-1990. In
219 these cases, GDP/capita relative to the developed economies multiplied by a factor of ≥ 4 in a few
220 decades, with per capita growth rates of $\sim 7\%$ ⁴¹ (see further SI). As an aside, we note that for many
221 countries, these targets will be met under an SSP1 GDP and population scenario⁴². The second proposed
222 indicator for SDG8 is related to employment and decent work (targets 8.5-8.8). Work serves two crucial
223 purposes. It gives individuals access to financial income for entertaining a life of their choosing, and it
224 provides meaning and organizing structure to life. In addition to a decent income, there needs to be a
225 sufficient supply of meaningful activities, i.e. decent employment opportunities or other activities of
226 societal value such as caretaking or community service. We focus on employment as indicator but
227 acknowledge that the future of work is likely to change substantially with increasing digitalization and
228 automation⁴³. We, therefore, may eventually require a broader notion of activities with economic or
229 societal value to cover the goal of decent work. Following O'Neill et al. ³³, we set a target of less than 6%
230 of the labour force being unemployed (or more broadly being without valued activity). SDG8 also contains

231 the fundamental goals of eradicating forced and child labour (target 8.7), protecting labour rights, and
232 promoting a safe working environment (target 8.8). These fundamental goals are not singled out explicitly
233 in our set of indicators. However, they are implied by a range of indicators relating to poverty eradication
234 (SDG1), universal education (SDG4), broad access to socio-economic activities (SDG9), decent income
235 (SDG10) and living conditions (SDGs 3, 6, 7, 11), and gender equality (SDG5).

236
237 The indicators proposed for SDG9 aim to capture multiple aspects of infrastructure (both physical and
238 non-physical) and innovation, focusing on technologies and services that can serve as critical enablers.
239 Following the proposal in the literature, we select a country's *R&D intensity* as a proxy for innovation and
240 the fractions of the *population with access to the internet*, *access to financial services*, and *access to*
241 *economic hubs* represented by travel time to the nearest major city⁴⁴ as proxies for infrastructure. SDG10
242 calls for reducing inequality both across and within countries. The inequality dimension across countries
243 is already covered by the income convergence indicator proposed for SDG8. For inequality within
244 countries, we focus on relative poverty and use the OECD definition⁴⁵ of people living below half of the
245 national median income (cf. target 10.2.1). To derive a quantitative target for this indicator, we examine
246 national statistics for the Gini index taken from the World Development Indicators⁴⁶. In recent years the
247 lowest measured Gini indices are around 25, with around 15-20% of the countries with available data
248 having Gini indices below 30. We, therefore, take a value of ≤ 30 as an ambitious but still realistic target
249 to be reached by 2050. Under the assumption of a lognormal income distribution, we can analytically
250 relate the Gini coefficient to our proposed indicator. This yields a target of at most 10% of the population
251 living below half of the median income (independently of the average income level) in 2050. We propose
252 an intermediate target of at most 15% of the population in relative poverty by 2030. Finally, for SDG11,
253 we focus on two central aspects of sustainable cities: adequate and safe housing, represented by the
254 *number of people living in slums*, and a healthy environment represented by the *share of people exposed*
255 *to an annual average pollution level of particulate matter (PM2.5)*. The threshold for PM2.5 follows the
256 upper value (24-hour mean) of the WHO guideline⁴⁷ (WHO, 2018) and coincides with the annual average
257 threshold value used by the EU. As targets, we propose that less than 10% of the urban population is
258 exposed to higher annual average levels of PM2.5 by 2050 and less than 20% by 2030. These values are
259 comparable to current values in the EU⁴⁸. Taken together, the selected indicators provide a robust proxy
260 for the ability of an economy to deliver equal access to decent work, income, and living conditions⁴⁰.

261

262 *Planet integrity (SDGs 13, 14, and 15)*

263 The SDGs on climate action and aquatic and terrestrial biodiversity relate to the condition of the natural
264 environment and the planetary boundaries^{31,49}. Given the ongoing work on the Planetary Boundary
265 framework, we have decided to look for synergy for some of the indicators and goals. For SDG13, we
266 follow the target of the Paris Agreement, i.e. well below 2°C and pursue efforts to stay below 1.5°C. Global
267 IAMs models can use this target directly. However, other models (e.g. at the national scale) need derived
268 information, such as existing IAM *emission profiles*⁵⁰ or national carbon budgets over a specific period.
269 We have selected a greenhouse gas emission target – but did not specify the downscaling method given
270 the difficult (political) choices involved. Moreover, we also left it up to the user to interpret the Paris
271 Agreement for the temperature goals and only set an upper bound. Future work could further specify this
272 target. The target for ocean acidification (SDG14) is also related to CO₂ emissions and is assumed to be
273 covered by the climate target. In addition, for SDG14, eutrophication can be covered by the phosphorous
274 flow from freshwater systems into the ocean (based on the planetary boundaries) or the index of coastal
275 eutrophication (selected from the SDGs)⁵¹. The latter is more refined but does need further modelling of

276 coastal systems. Further, the fraction of fish stocks within safe biological limits⁵² represents the
277 sustainable use of fish resources³¹. We also considered the Ocean Health index – or other work on
278 biodiversity indicators for aquatic systems (such as the mean species abundance), but considered work
279 not advanced enough to add them at this stage, given the relatively complicated calculation schemes. For
280 terrestrial biodiversity, in principle, multiple dimensions of biodiversity would need to be covered⁵³. In
281 order to limit the number of targets, however, the planetary boundary indicators are proposed, i.e. the
282 minimum extent of forest cover in different forest biomes, the balance of nitrogen into soils, and the
283 biodiversity intactness index (BII)⁵⁴. For the latter, also alternative aggregated biodiversity indicators exist
284 and possibly a comparison project can show whether these can be used as a replacement (if applied
285 relative to reference year).

286

287 *Sustainable resource management (SDGs 2, 6, 7 and 12)*

288 The consumption and production of food, energy and water (nexus resources) play a crucial role in many
289 sustainable development challenges, while large parts of society still lack sufficient access⁵⁵⁻⁵⁷. The
290 relevant SDGs aim to ensure access to these critical resources for all people while also limiting possible
291 negative consequences of their production and use.

292 The first indicator is the number of undernourished people (proposed by many other publications,
293 including³³). The target of 0 people undernourished³³ by 2030 is taken from the SDG and needs to be
294 sustained beyond 2050. As the threshold for undernourishment, we apply the minimum daily energy
295 requirement (MDER, kcal/cap/day) suggested by FAO (2017). FAO (2017) calculates country-specific
296 minimum daily energy requirements. The 2030 and 2050 global average minimum thresholds are based
297 on calculations by Hasegawa for SSP1⁵⁸. The future mean MDER is calculated for each year and country
298 using the mean MDER in the base year at the country level²⁶ and allowing for an adjustment coefficient
299 for the MDER in different age and sex groups²⁷. This can be done using future population demographics²⁸
300 to reflect differences in the MDER across age and sex⁵⁸. As SDG2 also covers malnourishment, the
301 prevalence of malnourishment and stunting and wasting could also have considered as alternative
302 indicators, but the proposed indicator is assumed to be more encompassing. In the future, it might be
303 interesting to include an indicator going beyond the mere energy content of diets (kcal) and include
304 aspects related to health^{59,60}. We also added an indicator related to obesity. Obesity is on the rise globally,
305 also in developed countries, and has severe health impacts (linked to SDG3), but also clear links to
306 consumption patterns (SDG12) and the overall impact of the agriculture system on the environment (also
307 given the role of animal products). Work on diets in relation to sustainable development (e.g. EAT-Lancet
308 Commission) and as well as health impacts (non-communicable diseases) is evolving⁶¹ but setting target
309 values and related thresholds still poses a challenge as it closely connected with lifestyle. SDG2 also covers
310 agriculture and food production. We considered an indicator focusing on sustainable agriculture, but it
311 should also be noted that it also links to the nutrient, energy, water, and climate indicators proposed
312 under the environmental and resource SDGs (6, 7, 13, 14 and 15). For that reason, no additional indicator
313 was added here.

314 SDG6 covers water demand by human beings and the environment. The first indicators look at access to
315 clean water. We use a threshold of sufficient access 50l/per/capita/day recommended as a basic water
316 requirement⁶². This is proposed as a universal threshold focusing on meeting basic needs, including water
317 for drinking, basic sanitation, plus some water for cooking and bathing. The second indicator is access to

318 sanitation services. Finally, for water scarcity, we use the proportion of an area or region under water
319 stress. Here, water stress is defined as the ratio between total water use and availability. A value above
320 40% is defined as areas suffering from severe water stress.

321 SDG7 calls for both access to energy for all and the sustainable use of energy. We propose to focus on
322 energy service levels (final energy demand), including heating/cooling and mobility service per household
323 per day that allows a decent life (see ⁶³), going beyond mere access. What is deemed “decent” is subject
324 to national circumstances (e.g. also related to climate zone). Because of advances in technology and living
325 standards, energy requirements in 2050 are subject to change.

326 For SDG12, a range of indicators can be considered. Our selected indicators – Food loss and waste and
327 Municipal material recovery – only cover a subset of the relevant resources involved in society’s processes
328 of production and consumption, and target values will have to be even more ambitious in the long run.
329 However, they can be regarded as illustrative of the capabilities of society to manage and recycle resource
330 flows. These indicators are also well established - at least in industrialized countries - in statistical
331 reporting and can be captured in a modelling framework in a stylized way (technologies, economic
332 incentives). Suitable alternatives could be more comprehensive indicators and indices such as the human
333 appropriation of natural primary productivity (HANNP)³³, the ecological footprint, the material footprint,
334 the global food loss index or recycling rates, but these indicators are hardly covered by models yet. Further
335 development could also focus more on circular economy indicators and overall efficiency.

336

337 *Peace, political institutions and means of implementation (SDGs 16 and 17)*

338 Peaceful, just and inclusive societies and global partnership are not only desired outcomes of the 2030
339 Agenda but also serve as essential enablers to achieve all other SDGs⁶⁴⁻⁶⁶. The number of battle-related
340 deaths⁶⁷ can be used to gauge progress towards more peaceful societies. In contrast, the *equality before
341 the law and individual liberty index*⁶⁸ and the *equal access Index*⁶⁸ can be used to measure the
342 development of robust and inclusive political institutions. For SDG17, the inclusiveness of the
343 international civil society (data provided by the Yearbook of International Organizations⁶⁹) can be used to
344 assess viable societal partnerships. As also the availability of an adequate set of financial means will be
345 crucial ⁷⁰, we propose to measure the role of governments with the indicator *total revenue as a percentage
346 of GDP*^{24,71}, excluding revenues earned from natural resources ". This last aspect is key to avoid goal
347 conflict and trade-off with other SDGs. Finally, we propose the source data dimension of the *Statistical
348 Capacity Indicator*⁷² to capture the availability of crucial data for designing, implementing and evaluating
349 policies towards the achievement of the SDG.

350

351 **4. Example application based on current scenarios**

352 In order to show the relevance of the targets, we use the target space to evaluate the projected trends in
353 the so-called SSP2 scenario, the "middle of the road pathway" among the Shared Socioeconomic Pathways
354 (SSPs), which describe different trajectories for socio-economic development and consequences for the
355 earth system²⁹. SSP2 represents a scenario describing median trends for population and economic growth,
356 technology, lifestyle, and other variables within the set. Here, we use the SSP2 scenario to illustrate how
357 the target space can be used within the broader range of values across other SSPs (see SI for a brief

358 description of the SSPs). The SSP2 scenario has been elaborated in multiple studies by different models
359 but using the same storyline and key assumptions. The SSP values are illustrative as they are not based on
360 a single model but have been derived from several publications elaborating on these scenarios.

361 The results (Table 3) highlight that the SSP2 scenario depicts some improvements over time for most
362 targets. However, these improvements are insufficient to meet all targets that were set for 2030 or 2050.
363 For many environmental targets, developments even continue to go in the wrong direction (i.e. away from
364 the target) even in the scenario among the SSPs that moves most in the direction of sustainable
365 development (SSP1). We conclude that the implementation of sustainability policies needs to be
366 enhanced significantly across the socio-economic and environmental domains to reach the sustainable
367 development goals. The quantitative scenarios literature does not include any Sustainable Development
368 Pathways (SDPs) that manage to meet all SDGs. Hence, the SSPs serve as a useful starting point that can
369 be extended by additional elements to cover the full target space and thus enable a comprehensive
370 assessment of SDG interactions and long-term sustainability⁷³.

371

372 **5. The way forward**

373 The target space formulation presented above is critically important to provide a consistent analytical
374 framing for quantitative analysis of the required transitions towards sustainable development. It provides
375 an initial framework to guide the analyses of how to achieve the SDGs simultaneously. Using a common,
376 transparent, and science-based definition of the targets permits the scientific community to work
377 together on this endeavour and to start from a set of comparable and internally consistent assumptions.
378 In many ways, the proposed approach for the SDGs is similar to how the climate research community has
379 formulated pathways for meeting the goals of the Paris Agreement, and which were subsequently used
380 in the scientific assessments of the IPCC for the formulation of consistent messages for policymakers.
381 Developing a set of Sustainable Development Pathways requires organizing a comprehensive program for
382 model-based scenario analysis focusing on systems transformations towards the quantitative goals of the
383 target space. This, in turn, requires the pursuit of model improvements to deal better with sustainable
384 development needs⁷⁴. The current formulation of the target space should be understood as the first step
385 of an iterative process among the worldwide scientific community and the policymakers and other
386 stakeholders with interests in these pathways.

387 Critical issues for further refinement are related to evaluating the indicators and target values, the
388 treatment of non-linearities and interdependences within the target space as it evolves to 2050 and
389 beyond, and the coherent use of indicators at different geographical scales³⁴. In several cases, we have
390 not yet formulated concrete targets. In other cases, we indicated that our current initial proposals could
391 be improved, for example, due to limitations of data and modelling capacity. All these improvements will
392 require more interdisciplinary engagement across sustainability science communities. Especially social
393 science communities interested in modelling need to be engaged to advance the target space further. We
394 see the need for an SDG-focused science-policy network, facilitating regular meetings to compare results
395 and to exchange experiences with the target space framework. Ultimately, it will thus be up to societal
396 actors, policymakers, and scientists to refine this target space by developing a tractable set of indicators
397 and targets that can be used realistically in integrated policy and impact assessments that are still
398 consistent with the spirit goals of the original 2030 Agenda.

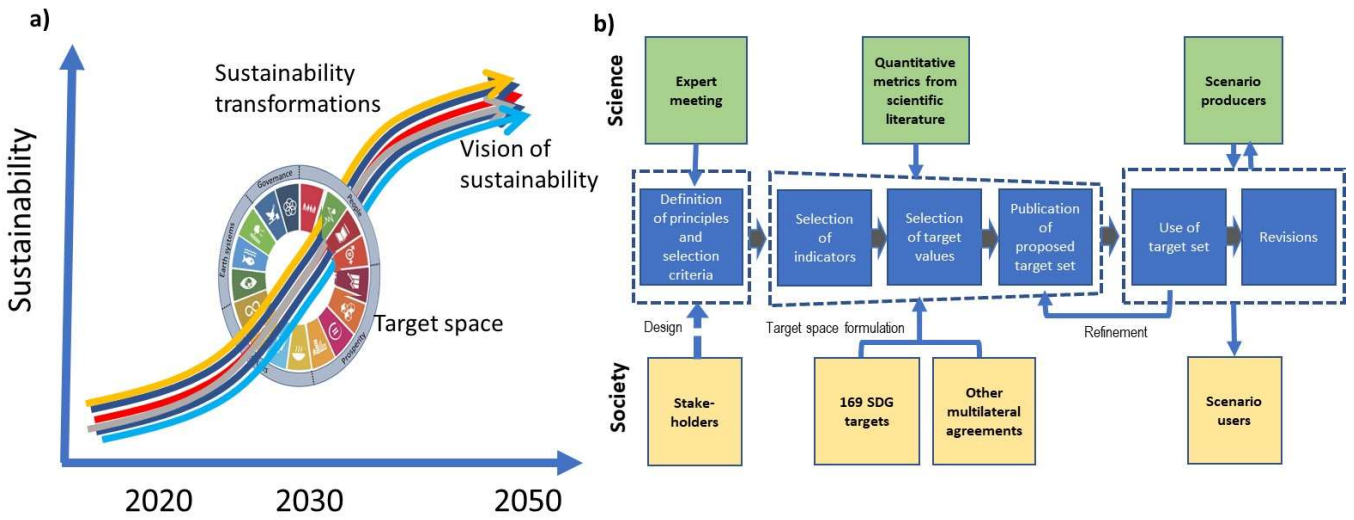
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415

416 *Figure 1 Defining a sustainable development target space for Sustainable Development Pathway*
417 *analysis. a) Conceptualization of the target space, showing how it relates to the required societal*
418 *transformations (such as the six transformations described by TWI2050) and the long-term sustainability*
419 *vision and b) The process for defining and applying the target space.*

420

421 **Table 1 Criteria for defining the sustainable development target space.**






<i>Key principles underlying the target space Target indicators should be:</i>	<i>Derived criteria for selection of targets</i>	<i>Derived criteria for target values</i>
Societal relevance	The target space addresses areas of sustainable development organized around the 17 SDGs. Wherever possible, indicators and target values directly relate to SDG Targets or objectives from other international agreements.	
Science-based	The indicators need to address the most pressing dimensions of human development (People), socio-economic wellbeing (Prosperity), national and international security (Peace) and global environmental change (Planet) as discussed in the scientific literature, such as the processes prioritized in the Planetary Boundaries framework ³¹ .	Where consensus exists on science-based targets that must be achieved by 2030 or later, these should be used.
Valid for 2030 and beyond	The indicators should be able to relate to both the SDG timeframe (2030) and the long-term (2050 and beyond) and account for path-dependency.	For 2050, target values either retain absolute 2030 measures (e.g., zero hunger, energy access for all), or even improve upon these values. In the latter cases, the values are set to achieve a decent life for all.
Quantifiable	The targets should be well suitable for inclusion in quantitative analyses, capturing as many features as possible in state-of-the-art integrative models. They also need to be unambiguous and measurable	Target values need to be specified clearly and with appropriate precision, in order to be suitable for quantitative analysis
Transparent:	The set should be clearly defined, and individual indicators should be easy to understand (e.g. avoiding multi-dimensional indices). The number of indicators per issue should be as low and complementary as possible while capturing global features of Agenda 2030. We therefore aim to have at most 2 or 3 indicators per SDG, and some indicators assigned can be relevant for multiple SDGs. We prioritize the selection of indicators that describe end-values of system transformation rather than the means to achieve them.	Target values should ensure consistency across the indicators for the different SDGs and should be linked to the principles underlying the SDGs, and the objectives of other international agreements.
Actionable	The indicators should be actionable, and sensitive to policy initiatives (and thus link to system transformations)	The target values are derived from existing agreements. Targets should be reachable, for instance demonstrated by the fact that some countries have reached the target.

422

423

424 **Table 2 Targets and indicators for the 2030 and 2050 target space. Most targets can be applied at the**
 425 **regional or national level.**

SDG	TW2050 normative goal	Indicator	Current Situation (around 2015)	2030 Target	2050 Target
	End extreme poverty	Number of people below international poverty line	889 million (13%) ⁴⁶	0	0
	End hunger	Number of people undernourished (below minimum daily energy requirement)	795 million (11%) people undernourished ⁷⁵	0	0
	Healthy diets for all	Number of people with obesity (BMI > 30) ⁷⁶	636 (9%) million in 2010 ⁷⁷	0	0
	Achieve adequate health care for all	Healthy Life expectancy at birth (years)	global mean 63.12 years country range [45.6-75.2] ³⁸	> 65 ³³	> 70
		Under 5 mortality rate (deaths per 1,000 live births)	global mean 43; 99 in sub-Saharan Africa ⁷⁸	25	12
	Universal lower secondary education	Share of leaving cohort completing lower secondary education	90% primary and 76.7% lower secondary completion rate ⁴⁶	80% secondary; 100% primary	100% secondary
	End gender discrimination in education	Gender gap in mean years of schooling of population aged 15 years+	global mean: 0.79 ⁷⁹	0	0
	Achieve gender pay parity	Female estimated earned income over male	52-87% ⁸⁰	1	1
	Universal access to clean water	Population without access to improved water source, piped	660 million (9%) ⁴⁶	0	0
	Universal access to sanitation	Population without access to improved sanitation facility	2.4 billion (32%) ⁴⁶	0	0
	End water scarcity	Area under water stress (water stress index for most water scarce month/season)	11% ⁸¹	no increase	no increase
	Universal modern energy services for all	Population cooking with traditional biomass	2.8 billion (37%) ⁸²	0	0
		Population without basic electricity access	1.1 billion (13%) ⁸²	0	0
	Work for all	Unemployment rate (formal economy)	6% ⁷⁵	6% ³³	6%
	Global economic convergence	Ratio of GDP per capita of a country to the average OECD GDP per capita (both in PPP) ⁴⁶ ; (can also be expressed as gini)	Avg low income countries: 5.0%; Avg lower-middle income countries: 16.7% (both 2018)	Low income countries: 2-fold increase; Lower-middle income countries: increase by 50%	Low income countries: 4-fold increase (reaching at least 15%); Lower-middle income countries: 3-fold increase
	R&D	R&D intensity, i.e. private and government-financed gross domestic R&D expenditure (GERD) in percent GDP	1.7% ⁸³	3% ⁸⁴	3%
	Universal access to ICT	Proportion of population using the internet (%)	46% ⁸⁵	95%	95%
	Universal access to finance	Proportion of adult population with account at financial institution (%) ⁸⁶	69%	Middle & high income countries: 90% Low income countries: 80%	95%
	Fast access to economic hub	Travel time to nearest city with at least 50000 inhabitants ⁴⁴	High income countries: less than one hour for 90% of population Low income countries: 20% have to travel for more than three hours	Middle & high income countries: less than one hour for 90% of population Low income countries: less than three hours for 90% of population	All countries: less than one hour for 90% of population
	Decrease relative poverty	Number of people below 50% of median national daily income (% of population) ⁴⁵	> 1.4 billion (~20%) people	15%	10%
	Decent housing for all	Population living in slums (urban)	880 million (30% of urban population) ⁷⁵	10%	0
	Improve air quality in cities	Population exposed to annual average PM2.5 >25µg/m ³ ⁴⁷	65% ⁴⁶	20%	10%
	Reduce waste & pollution	Food loss and waste	33% ⁸⁷	<15%	<15%
		Municipal material recovery	34% in OECD ⁸⁸	59% (top5 countries2015)	-

	<i>Limit global warming</i>	well below 2°C above preindustrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels	55 GtCO ₂ -eq ²⁹	Pathway towards long-term goal: or globally at least below <31-45 GtCO ₂ -eq ⁵⁰ (1.5 and well below 2°C, 75 th percentile)	Pathway towards long-term goal: or globally at least below <10-20 GtCO ₂ -eq ⁵⁰ (1.5 and well below 2°C, 75 th percentile)
	<i>Balance phosphorus in oceans</i>	P flow from freshwater systems into the ocean	~22 Tg P yr ⁻¹ ³¹	11 Tg P yr ⁻¹ ³¹	11 Tg P yr ⁻¹ ³¹
	<i>Sustainably manage marine resources</i>	Proportion of fish stocks within biologically sustainable levels ⁵²	65 ⁵²	90 ⁸⁹	100 ⁸⁹
	<i>Halt Land-system change (deforestation)</i>	<u>Global</u> : area of forested land as % of original forest cover <u>Biome</u> : area of forested land as % of potential forest	~4,000 ha ⁹⁰	No further loss of primary forest	Global: 75% (75-54%) – specified by forest type ³¹
	<i>Balance nitrogen in soils</i>	Industrial and intentional biological fixation of N	~150 Tg N yr ⁻¹ ³¹	62 Tg N yr ⁻¹ ³¹	62 Tg N yr ⁻¹ ³¹
	<i>Protect biodiversity</i>	Biodiversity Intactness Index (BII)		no degradation from 2020 onwards	no degradation from 2020 onwards
	<i>Reduce violence and related deaths</i>	Battle-related deaths and fatalities from one-sided violence	>93,000 ⁹¹	0 per country/year*	0 per country/year*
	<i>Promote the rule of law and ensure equal access to justice for all</i>	Equality before the law and individual liberty index ‡	Global: 0.69 (based on ⁶⁵)	increase all individual country scores, at least >0.9*	increase all individual country scores, at least >0.9*
	<i>Ensure responsive, inclusive, participatory and representative decision-making</i>	Equal access index ‡	Global: 0.63 (based on ⁶⁵)	increase all individual country scores, at least >0.9*	increase all individual country scores, at least >0.9*
	<i>Increase statistical capacities</i>	Statistical Capacity score- Source Data (Second dimension of the Statistical Capacity Indicator by the World Bank)	62.0 (global average for 149 countries) ⁹²	increase up to 100 for all countries"	increase up to 100 for all countries"
	<i>Strengthen domestic resource mobilization</i>	Total government revenue	Global average: 24-28% (w/o, natural resources) for 2011- 2015 (based on ⁷¹)	increase to 20 % for countries currently below this threshold, otherwise maintain	maintain the level of 2030 the threshold without revenue generated by exploitation of natural resources
	<i>Enhance interconnection with global civil society</i>	Number of international NGOs of which a country is a member, whether directly or through the presence of members in that country.‡	Average 386 (countries>500.000) based on ⁹³	increase value above the 25th percentile based on data of 2017 for countries below this threshold, otherwise maintain	increase value above the 25th percentile based on data of 2030 for countries below this threshold, otherwise maintain

426 ‡ indicators where we are unaware of model-based long-term projections; * indicators for which we are unaware of model-
427 based thresholds.

428

429 *Table 3: Example of use of the target space using data published for the SSP scenarios in various studies.*
 430 *The colours show evaluation of the scenario against the target values (red: situation becomes worse*
 431 *compared 2015, orange: situation improves but target is not met; light orange: situation improves and*
 432 *approaching target; green: target is met). The SSP2 scenario currently only provides information for a*
 433 *subset of the indicators of the target space.*

		Target 2050	2015	2030		2050		Reference
				SSP2	SSP range	SSP2	SSP range	
SDG1: #People in absolute poverty	Millions	0	886	441	[286-655]	119	[22-563]	94
SDG2: #People suffering from hunger	Millions	0	837	295	[188-560]	92	[13-585]	95
SDG3: <5 mortality	Per 1000	12	43	45	[31-71]	32	[15-70]	96
SDG4: #People w/o. sec. education	Millions	0	1687	2396	[1839-3826]	2108	[1607-4875]	97
SDG5: Schooling gender gap	Years	0	1	0.5	[0.5-0.7]	0.3	[0.2-0.6]	97
SDG6: Water stress	% area	0	7	7.0	[7-7.1]	8.3	[7-8]	98
SDG6: #People w/o san/clean water	Millions	0	4127	3636	[79-4251]	2199	[84-3979]	99
SDG7: #people w/o acc clean. cooking	Millions	0	2590	3240	[1232-3742]	2323	[574-3904]	100
SDG7: #people w/o access electricity	Millions	0	1810	845	[144-1080]	471	[89-1015]	100
SDG10: #people in relative poverty	Millions	0	2232	2621	[2326-2909]	2816	[2055-3621]	94
SDG11: #people poor air quality	Millions	0	4684	4825	[4683-5184]	4966	[4683-5685]	101
SDG13: CO ₂ emissions	GtCO ₂ /yr	18	42	47	[42-55]	57	[42-64]	29
SDG15: Loss of forest cover	Mkm ²	1500	2206	2232	[2211-2332]	2253	[2122-2429]	102

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653

654

655 **Supplementary information**

656

657 *People (SDGs 1, 3, 4 and 5)*

658 SDG1 (no poverty), SDG3 (good health and well-being), SDG4 (quality education) and SDG5 (gender
659 equality) all form fundamental building blocks for human development. Clearly, the issue of human
660 development is also directly related to the SDGs in other clusters. Several indices have previously been
661 used to capture the multi-dimensional nature of human development, aiming to assess progress over time
662 beyond economic growth. The UNDP's Human Development Index (HDI) encapsulates three dimensions
663 of development, concerned with the abilities of leading a long and healthy life, acquiring knowledge and
664 achieving a decent standard of living¹. The focus here is on tracking advances towards improving basic
665 aspects of human development. Through complementary indices, such as the gender development index
666 and inequality adjusted HDI, which both built on the general HDI, UNDP seeks to further shed light on
667 gender differences and prevalent conditions of inequality in the context of advancing human
668 development. Other indicators aim to present a more comprehensive assessment of conditions of
669 poverty, which are linked to various forms of deprivation. This includes for example the multi-dimensional
670 poverty index (MPI), which was developed by the Oxford Poverty and Human Development Initiative and
671 further modified in collaboration with UNDP (see ¹). While being cognizant of this complexity of human
672 development indicators, we wanted to select a limited number of targets that are representative of the
673 SDGs contained in this cluster, and that are quantifiable and suited for modeling.

674 For SDG1, it is clear that one indicator needs to be related to the objective of no one living in extreme
675 poverty by 2030. Obviously, a key question is how to define extreme poverty. The World Bank global
676 poverty line² as suggested in the SDG target is chosen as the threshold for 2030. As differences in the cost
677 of living across the world evolve, the global poverty line has been periodically updated to reflect these
678 changes. Where Target 1.1 specifically mentions \$1.25 per day, the World Bank has updated the absolute
679 poverty line to \$1.90 per day (US\$ 2011). We use 2 US\$ (US\$ 2015) per capita per day for 2030 and 2050
680 for practical reasons – and kept it constant over the time period (given the correction for inflation).
681 Relative poverty is also included under SDG10 and discussed in the *Prosperity* cluster.

682 SDG3 aims at ensuring healthy lives. We view healthy life expectancy at birth as a summary indicator³.
683 The set of SDG targets includes several other indicators including maternal mortality rates and many other
684 indicators are also used in the literature, but the advantage of the healthy life expectancy indicator is that
685 it is all-encompassing. On country level, an additional indicator is included of a minimum increase in
686 healthy life expectancy at birth of 3 years per decade³, which would be non-linear: countries with very
687 low life expectancy at birth gain a lot of years by saving infants' and children's lives, while countries with
688 higher life expectancies show smaller gains as the lives saved postpone age at death. The SDG target on
689 under 5 mortality rate is used to track progress in developing countries. The SDG target level of 25 deaths
690 per 1,000 live births is taken for 2030, which is further halved by 2050 to increase progress. Finally,
691 alternative indicators that were considered include, among others, normal life expectancy at birth, a goal
692 of avoiding 40% of premature deaths⁴ and the median health-related SDG index used by the Global Burden
693 of Disease study⁵. The latter, however, will require a much wider set of underlying indicators to be
694 modelled.

695 SDG4 aims for quality education. The addition of universal secondary education expanded the ambition
696 of the Millennium Development Goals (MDGs), which targeted universal primary education only. This
697 addition is based partly on recent insights that, for poor countries to come out of poverty, universal
698 primary education is not enough and must be complemented by secondary education for broad segments
699 of the population⁶. We chose the share of young people achieving lower secondary education as this
700 covers the compulsory schooling time in most countries. Considering current enrollment rates in primary
701 education, achieving 100% completion of lower secondary education by 2030 is practically impossible, so
702 the target values proposed are 80% in 2030 and 100% in 2050. A supporting threshold is introduced of
703 100% primary completion rate in 2030. Alternative indicators may include literacy rates, expected years
704 of schooling, participation in early childhood education, share of total population with lower secondary
705 education, measure of the quality of education through graduate employment and mean years of
706 schooling.

707 SDG5 aims for gender equality. Out of the wide domains covered by this SDG, we chose education and
708 income to track female empowerment. The target values aim at full equality in 2030 as called for by SDG5.
709 While differences in education are covered by some models, the wage gap is addressed in very few models
710 – and might therefore only be a future alternative indicator. The advantage of the education-gap indicator
711 is that it directly related to future capacity and also has an established link with other indicators such as
712 fertility levels. Other indicators that are used to track current progress regarding gender equality include
713 the female to male labor force participation rate, proportion of women in national parliaments, share of
714 women in management roles, legal gender discrimination and rates of sexual violence. However, none of
715 these are currently captured by integrated assessment models.

716

717 *Prosperity (SDGs 8, 9, 10, and 11)*

718 The cluster of SDGs 8, 9, 10 and 11 is envisaging societies and economies that offer a prosperous and
719 fulfilling life for all.

720 SDG8 aims for sustained and inclusive economic growth and full and decent employment. As prosperity
721 in high income countries is no longer driven by economic growth per se⁷, a focus is placed on sufficient
722 economic growth in low and lower-middle income countries, eventually leading to a convergence of living
723 standards. We therefore propose an indicator of economic convergence as measured by the ratio of
724 GDP/capita in the target country to the average OECD GDP/capita (both measured in PPP). This indicator
725 reflects SDG target 8.1 (sustained per capita economic growth in accordance with national circumstances,
726 including high growth rates in least developed countries) as well as the overarching goal of inclusive
727 growth across countries. Our quantitative targets are based on historical examples of rapid GDP/capita
728 growth and income convergence, in particular the Asian “tiger economies” in the period 1960-1995 and
729 China post-1990. In these cases GDP/capita relative to the developed economies multiplied by a factor of
730 ≥ 4 in a few decades, with per capita growth rates of $\sim 7\%$ ⁸.

731 As a 2050 target for our convergence indicator we therefore suggest a fourfold increase for low-income
732 countries (translating the World Bank income classification thresholds into \$ 2011 PPP, these are countries
733 with a GDP/capita below $\sim 6.5\%$ of the average OECD value). As some countries start from around 2% of
734 the OECD value, we supplement this with an additional threshold of reaching at least 15% of the OECD
735 value in 2050. For lower-middle income countries (in PPP below $\sim 21\%$ of the average OECD GDP/capita)

736 we propose a threefold increase as a target for 2050. Assuming an average GDP/capita growth rate of
737 1.5% in OECD countries, these targets translate to annual GDP/capita growth rates of 6% in low-income
738 and 5% in lower-middle income countries over the period 2019-2050. For calculating the intermediate
739 2030 targets we assume 7% growth rate until 2030 declining by 1 percentage point each additional decade
740 until 2050 in low income countries and the same growth rate of 5% in lower-middle income countries,
741 leading to 2030 convergence factors of two for low-income and 1.5 for lower-middle-income countries.
742 As an aside, we note that for many countries these targets will be met under an SSP1 GDP and population
743 scenario⁹.

744 The second proposed indicator for SDG8 is related to employment and decent work (targets 8.5-8.8).
745 Work serves two important purposes. It gives individuals access to financial income for entertaining a life
746 of their choosing, and it provides a meaning and organizing structure to life. Possible changes in the future
747 of work could mean that these two dimensions do not necessarily need to coincide in the same activity
748 anymore. Therefore, for the achievement of SDG8, it will be essential to provide every human with a
749 stable income stream that will be the accumulation from different sources (labor income, capital income,
750 transfer income). In our target set, access to decent income is covered by a combination of per capita GDP
751 convergence between countries (see above) and reduced income inequality within countries (see our
752 choice of indicator for SDG10). In addition to a decent income, there needs to be sufficient supply of
753 meaningful activities, i.e. decent employment opportunities or other activities of societal value such as
754 caretaking or community service. For the time being we focus on employment as indicator, but
755 acknowledge that the future of work is likely to change substantially with increasing digitalization and
756 automation¹⁰. We therefore may eventually require a broader notion of activities with economic or
757 societal value to cover the goal of decent work. Following O'Neill et al³ we set a target of less than 6% of
758 the labor force being unemployed (or more broadly being without valued activity). SDG8 also contains the
759 fundamental goals of eradicating forced and child labor (target 8.7) and protecting labour rights and
760 promoting a safe working environment (target 8.8). These fundamental goals are not singled out explicitly
761 in our set of indicators, but are implied by a range of indicators relating to poverty eradication (SDG1),
762 universal education (SDG4), broad access to socio-economic activities (SDG9), decent income (SDG10) and
763 living conditions (SDGs 3, 6, 7, 11), and gender equality (SDG5). Likewise, other targets of SDG8 relating
764 to innovation (targets 8.2 and 8.3) and access to finance (targets 8.3. and 8.10) are largely covered by our
765 choice of indicators for SDG9, and the target 8.4 on global resource efficiency is covered by SDG12 on
766 sustainable production and consumption.

767 The indicators proposed for SDG9 aim to capture multiple aspects of infrastructure (both physical and
768 non-physical) and innovation, with a focus on technologies and services that can serve as key enablers.
769 SDG 9.1 emphasizes access to transport infrastructure to support economic development and human
770 well-being. We adopt a broader concept of access to markets, knowledge and culture, both physically in
771 terms of travel time to the nearest city and non-physically in terms of access to information and
772 communications technologies (ICTs). As highlighted in SDG9, ICTs such as mobile phones and the Internet
773 are key enabling technologies. We focus on Internet use (beyond mere access) here and adopt a target of
774 near universal internet use among adults and teenagers, i.e. ca. 95% of the population, for 2030 and
775 beyond (cf. SDG9). The target for physical access to market places and knowledge and culture hubs is
776 based on the global map of travel time to the next city¹¹. Following their definition of a city (a contiguous
777 area with population density above 1,500 km⁻² or built-up area with at least 50,000 inhabitants) we use
778 the typical values in high-income countries as a motivation for setting our target for 2050: less than one

779 hour for 90% of the population. This can be compared with the current situation in low income countries
780 where less than half of the population lives within one hour of the next city and 20% of the population
781 has to travel for more than three hours to the next city. For 2030 we propose intermediate target of less
782 than 3 hours travel time to the next city for 90% of the population in low income countries while middle
783 and high income countries should already have reached the long term target by 2030.

784 Another important element for economic access is access to financial services. SDGs 9.3 and 8.3 focus on
785 access of small and medium enterprises (SME) to such services as well as their market integration. Here
786 we widen the consideration of financial service access to individuals in order to cover also the related SDG
787 8.10. As a simple proxy for broad access to financial services, we use the share of the population with an
788 account at a financial institution, including access to mobile-money-services¹². We choose a mid-century
789 target of 95% account ownership among the adult population reflecting near universal access to financial
790 services. For 2030, we suggest a target of 90% in middle and high income countries which mirrors current
791 values in OECD countries, and a target of 80% of the adult population in low income countries. The target
792 should be reached in 2030 in middle and high income countries and 2050 in low income countries. Account
793 ownership is a proxy indicator that focuses particular on financial inclusion. Financial development is a
794 broader concept that also takes into account the depth and efficiency of financial markets. We
795 acknowledge that those factors are relevant for the availability of credit as highlighted in SDGs 8.3 and
796 9.3, but suitable and easily accessible indicators are hard to come by. There are attempts to include macro-
797 level indicators such as credit to GDP ratio and other indicators into compound indices for financial
798 development¹³ but their direct relevance to the SDGs less clear and data availability is limited. In the SDG
799 context, the finance gap for micro/small/medium enterprises (MSME) is a potentially relevant indicator
800 for SDG9.3, but it is only available for emerging economies to date¹⁴. More work on SDG-oriented
801 indicators for access to financial services is needed.

802 Besides infrastructure and services, a key focus of SDG9 is innovation as captured in SDG9.5 which calls
803 for enhancing scientific research and increasing public and private research and development (R&D)
804 investments. We adopt private and government-financed gross domestic R&D expenditure (GERD) in
805 percent GDP as central indicator for R&D investments (cf. target 9.5.1). The target is set to 3% of GDP in
806 2030. This value is often used as a benchmark in country comparisons of R&D spending and was adopted
807 as target by the European Union¹⁵. Currently, OECD countries spend around 2.5% of their GDP on R&D.

808 Other elements of SDG9 such as specific goals for industry (target 9.2) have not been targeted explicitly
809 as both industry and services will be nurtured by increased innovation and improved access to markets,
810 knowledge and finance. Likewise, SDG target 9.4 which calls for increased resource efficiency and
811 environmental soundness of industrial production is largely covered by SDG12. This allows us to limit the
812 number of indicators for SDG9 to four, covering also aspects of SDG8. We note, however, that it remains
813 a research challenge to better represent these indicators in future modelling efforts.

814 SDG10 calls for reducing inequality both across and within countries. The inequality dimension across
815 countries is already covered by the income convergence indicator proposed for SDG8. For inequality
816 within countries we focus on relative poverty and use the OECD definition¹⁶ of people living below half of
817 the national median income (cf. target 10.2.1). To derive a quantitative target for this indicator we
818 examine national statistics for the Gini index taken from the World Development Indicators¹⁷. In recent
819 years the lowest measured Gini indices are around 25, with around 15-20% of the countries with available
820 data having Gini indices below 30. We therefore take a value of ≤ 30 as an ambitious but still realistic target

821 to be reached by 2050. Under the assumption of a lognormal income distribution we can analytically relate
822 the Gini coefficient to our proposed indicator. This yields a target of at most 10% of the population living
823 below half of the median income (independently of the average income level) in 2050. We propose an
824 intermediate target of at most 15% of the population in relative poverty by 2030. These targets mandate
825 a pathway of decreasing relative poverty for all countries which fulfills SDG10.1 calling for sustained
826 income growth of the bottom 40% of the population at a rate higher than the national average. There are
827 also other relative poverty concepts¹⁸, e.g., based on consumption patterns. Here we use relative income
828 as proxy for relative poverty and inequality within countries as it is most widely used and easily accessible.
829 Absolute poverty is targeted by SDG1. SDG10 includes a set of other goals on inclusion and equal
830 opportunities for societal groups. Those are not explicitly mapped to indicators here as root causes are
831 addressed by other SDGs, including the access indicators defined for SDG9.

832 SDG11 deals with sustainable cities and communities. Our selected indicators focus on two key aspects:
833 adequate housing and a healthy urban environment. We represent the former by the fraction of the urban
834 population living in slums, with a target of zero by 2050 and an intermediate target of less than 10% in
835 2030. While this intermediate target would not completely eliminate slums by 2030, it is nonetheless
836 ambitious given recent trends¹⁹. The number of people living in slums is a useful composite indicator that
837 already captures several important aspects of life in cities. Some of these dimensions are also cross-cutting
838 with indicators from other SDGs, e.g. poverty (see SDG1), access to piped water (SDG6) or energy (SDG 7).
839 Access to piped water and electricity can also serve as proxy indicators for quality of housing and
840 municipal planning and infrastructure services.

841 Our second indicator is the fraction of the urban population exposed to hazardous levels of air pollution,
842 quantified by a threshold on the concentration of fine particulate matter (PM_{2.5}) of 25 µg/m³. The
843 threshold follows the upper value (24-hour mean) of the WHO guideline²⁰ (WHO, 2018), and coincides
844 with the annual average threshold value used by the EU. As targets we propose less than 10% of the urban
845 population exposed to higher annual average levels of PM_{2.5} by 2050, and less than 20% by 2030. These
846 values are comparable to current values in the EU²¹. Similar fractions are also obtained in SSP1-2.6W/m²
847 projections²², note however that the latter refer to the total population and not the urban population
848 used here (making them less ambitious).

849 Clearly, two indicators can never fully capture the multi-faceted nature of life in cities. However, we argue
850 that our selection, in combination with those aspects already covered in other SDGs, captures many of
851 the important dimensions. We further note that data on these indicators are readily available, making it
852 easy to track progress.

853

854 *Planet integrity (SDGs 13, 14, and 15)*

855 The SDGs on climate action and aquatic and terrestrial biodiversity relate to the condition of the natural
856 environment and the planetary boundaries^{23,24}. Given the ongoing work on the Planetary Boundary
857 framework we have decided to look for synergy for some of the indicators and goals. For SDG13, we follow
858 the target of the Paris Agreement, i.e. well below 2°C and pursue efforts to stay below 1.5°C. Global IAMs
859 models can use this target directly, but others models (e.g. at the national scale) need derived information,
860 such as existing IAM *emission profiles*²⁵ or national carbon budgets over a certain time period. We have
861 selected a greenhouse gas emission target – but did not specify exactly the downscaling method.

862 Moreover, we also left it up to the user at this stage how interpret the Paris Agreement with respect to
863 the temperature goals and only set an upper bound. Future work could further specify this target. The
864 target for ocean acidification (SDG14) is also related to CO₂ emissions, and is for that reason assumed to
865 be covered by the climate target. In addition, for SDG14, eutrophication can be covered by the
866 phosphorous flow from freshwater systems into the ocean (based on the planetary boundaries) or
867 alternatively, the index of coastal eutrophication (selected from the SDGs)²⁶. The latter is more refined
868 but does need further modelling of coastal systems. Further, the fraction of fish stocks within safe
869 biological limits²⁷ represents the sustainable use of fish resources²³. We also considered the Ocean Health
870 index – or other work on biodiversity indicators for aquatic systems (such as the mean species abundance),
871 but considered work not advanced enough to add them at this stage, given the rather complication
872 calculation schemes. For terrestrial biodiversity, in principle multiple dimensions of biodiversity would
873 need to be covered²⁸. In order to limit the number of targets, however, the planetary boundary indicators
874 are proposed, i.e. the minimum extent of forest cover in different forest biomes, the balance of nitrogen
875 into soils, and the biodiversity intactness index (BII)²⁹. For the latter, also alternative aggregated
876 biodiversity indicators exist and possibly a comparison project can show whether these can be used as
877 replacement (if applied relative to reference year).

878

879 *Key resources (SDGs 2, 6, 7 and 12)*

880 Access to resources forms an important aspect of sustainable development, while at the same time these
881 resources need to be properly maintained. Key resources include energy, food and water – while SDG12
882 deals with consumption and production of resources in general. SDG2 focuses on both ending hunger and
883 promoting sustainable agriculture practices. The first indicator is the number of undernourished people
884 (proposed by many other publications, including ³). The target of 0 people undernourished by 2030 is
885 taken from the SDG and needs to be sustained beyond 2050. As the threshold for undernourishment, we
886 apply the minimum daily energy requirement (MDER, kcal/cap/day) suggested by FAO (2017). FAO (2017)
887 calculates country specific minimum daily energy requirements. The 2030 and 2050 global average
888 minimum thresholds are based on calculations by Hasegawa for SSP1 ³⁰. The future mean MDER is
889 calculated for each year and country using the mean MDER in the base year at the country level²⁶,
890 adjustment coefficient for the MDER in different age and sex groups²⁷ and the future population
891 demographics²⁸ to reflect differences in the MDER across age and sex ³⁰. As SDG2 also covers
892 malnourishment, the prevalence of malnourishment, and stunting and wasting could also be included. In
893 general, reflecting the nutrient value of diet, beyond mere energy content (kcal), moving towards
894 reflecting healthy diets for all should be a goal for modelling, and this is an active area of international
895 research^{31,32}. We also added an indicator related to obesity. Obesity is on the rise globally, also in
896 developed countries, and has severe health impacts (linked to SDG3), but also clear links to consumption
897 patterns (SDG12) and the overall impact of the agriculture system on the environment (also given the role
898 of animal products). Work on diets in relation to sustainable development (e.g. EAT-Lancet Commission)
899 and as well as health impacts (non-communicable diseases) is evolving³³ but setting target values and
900 related thresholds still poses a challenge as it closely connected with lifestyle and the goal would be to
901 avoid diseases. SDG2 also covers agriculture and food production. An indicator on sustainable agriculture
902 is desired but also links to indicators proposed under the environmental SDGs (13, 14 and 15) that can
903 provide guardrails relevant to sustainable agriculture practices and therefore do not have to be added
904 here.

905 SDG6 covers water demand by human beings and the environment. The first indicators look at access to
906 clean water. We use as threshold of sufficient access 50l/per/capita/day recommended as basic water
907 requirement³⁴. This is proposed as universal threshold focusing on meeting basic needs, including water
908 for drinking, basic sanitation, plus some water for cooking and bathing. The second indicator is access to
909 sanitation services. Finally, for water scarcity we use the proportion of an area or region under water
910 stress. Here, water stress is defined as the ratio between total water use and availability. A value above
911 40% is defined as areas suffering from severe water stress. It is important to calculate a full balance
912 (include water use from groundwater and environmental water needs) and the same for water availability
913 (include sustainable groundwater availability, lakes but also technical solutions like desalination). This is
914 pointing at groundwater over-use particularly but also some lakes and surface waters which are
915 contracting in size/volume. It should be noted that the indicator is also strongly dependent on natural
916 attributes. Other indicators considered include total water use (as in the planetary boundaries
917 framework²³), the number of people living in water scarce areas, environmental flows in freshwater
918 ecosystems and water quality. However, these indicators either contain less actionable information or are
919 more difficult to model in an integrative assessment framework.

920 SDG7 calls for both access to energy for all and the sustainable use of energy. We propose to focus on
921 energy service levels (final energy demand) including heating/cooling and mobility service per household
922 per day that allow a decent life (see ³⁵), going beyond mere access. What is deemed “decent” is subject
923 to national circumstances (e.g. also related to climate zone). Because of advances in technology and living
924 standards, energy requirements in 2050 are subject to change.

925 For SDG12 a range of indicators can be considered. Our selected indicators – Food loss and waste and
926 Municipal material recovery – only cover a subset of the relevant resources involved in society’s processes
927 of production and consumption, and target values will have to be even more ambitious in the long run.
928 They can however be regarded as illustrative of the capabilities of a society to manage and recycle
929 resource flows. These indicators are also well established - at least in industrialized countries - in statistical
930 reporting and can be captured in a modeling framework at least in stylized way (technologies, economic
931 incentives). Suitable alternatives could be more comprehensive indicators and indices such as the human
932 appropriation of natural primary productivity (HANNP)³, the ecological footprint, the material footprint,
933 the global food loss index or recycling rates, but these indicators are hardly covered by models yet. Further
934 development could also focus more on circular economy indicators and overall efficiency.

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936 *Peace, Political Institutions and Means to Implement (SDGs 16 and 17)*

937 Compared to other SDG areas, the definition of lean and evidence based benchmarks for SDGs 16 and 17
938 seems to be more challenging because of the contingent nature of governance, politics and peace.
939 However, measuring these issues is not only possible but quite common. The use of quantified and
940 standardized measures of governance, political institutions and violent conflict has become ubiquitous in
941 political sciences and conflict research. We propose a series of numeric targets based on the insights from
942 empirical studies and normative considerations of what we consider minimal quantifications of the
943 political goals enshrined in the SDGs. Improving a list of indicators for SDGs 16 and 17 is a challenge, which
944 has been acknowledged by the broader social science community since 2015. However, quantitatively
945 projecting long-term scenarios of governance^{36,37} and political events such as violent conflict³⁸⁻⁴⁰,
946 coups^{41,42} and regime change⁴³ are on the rise. It will require more engagement with social science

947 communities interested in future scenarios to further advance the indicators and their application for
948 integrated modelling.

949 The proposed indicators for the target space approximate the larger set of targets in both SDG16 and 17,
950 while being sufficiently narrow to allow quantitative modeling of pathways. They address some of the
951 most important interlinkages to other goals, in particular SDG4, 5, and 10. We focus on measurable
952 political and financial outcomes of institutions instead of the latter's procedural attributes as proposed in
953 some of the targets. This is based on the assumption that there is a significant correlation between
954 institutions and outcomes linked to institutions. For instance, participatory political institutions are more
955 likely to provide inclusive policies. In addition, political institutions are better to predict because they are
956 more stable over time than contingent political events.

957 Peaceful, just and inclusive societies (SDG16) as well as global partnership (SDG17) are not only desired
958 outcomes of the 2030 Agenda but also serve as important enablers to achieve the remaining SDGs^{44,45}.
959 SDG16 and 17 describe the political goals defined by the Agenda 2030. SDG16 calls to significantly reduce
960 all forms of violence, promote peace and build effective, accountable and inclusive institutions. Armed
961 conflicts with high fatality numbers are known to perpetuate underdevelopment⁴⁶. Accordingly, the high
962 number of conflict-related deaths in recent years need to be reduced drastically if SDGs shall be achieved,
963 especially in fragile states and conflict regions. Current trends indicate that the number of violent deaths
964 has been increasing since 2005. SDG target 16.1 also aims to reduce violent crime. However, we propose
965 the number of armed conflict fatalities as an indicator for two reasons. First, armed conflict has the
966 potential to drastically undermine or even reverse development of the overall SDG agenda on a national
967 or regional level. Moreover, in contrast to violent crime, global conflict fatality estimates are readily
968 available in a standardized form dating back several decades. In contrast, e.g. homicide rates are often
969 missing in the least developed countries during many years in the past, making global modelling
970 challenging. While we endorse statistics of violent crime as a suitable measure for regionally restricted
971 analyses, we propose fatalities from armed conflict as our preferred, globally available measure of the
972 most severe form of insecurity. We choose a normative goal in line with the formulation of goal 16 and
973 expect 0-fatalities by 2030 and 2050. Although this is not feasible globally, it is more likely on the country-
974 level.

975 Beyond the absence of violence, strong, responsive and representative political institutions are central
976 preconditions for sustainable development and (positive) peace^{47,48}. We propose to measure these
977 institutional aims using two indices. The Equality Before the Law and Individual Liberty Index⁴⁹ broadly
978 captures target 16.3 ("Promote the rule of law [...] and ensure equal access to justice for all") as well as
979 the protection of fundamental freedoms (target 16.10). Furthermore, the index includes information on
980 torture, i.e. it captures the most severe violation of SDG16.2. Beyond these specific goals, improvements
981 on this index also correlate with decreases in corruption (target 16.5) and effective and transparent
982 institutions (target 16.6)⁵⁰. Alongside more effective institutions, we can expect a reduction in crime
983 (target 16.4) and states should be able to provide a legal identity to all, including birth registrations (target
984 16.9). The second proposed measure, the Equal Access Index⁴⁹, describes whether all social groups "enjoy
985 equal *de facto* capabilities to participate, to serve in positions of political power, to put issues on the
986 agenda, and to influence policymaking" ⁴⁹ (target 16.7). In line with previous research, we expect that
987 political equality decreases economic and social inequalities and, thus, has positive effects on achieving
988 SDG10 ("Reduce inequality in and among countries").

989 Given that both proposed indices are continuous, it is an empirical challenge to identify a threshold that
990 classifies when the political goals of the SDGs are achieved. We used the following steps to define
991 quantified and empirically grounded thresholds for each index:

- 992 • First, we used the fact that each index is based on a larger set of individual, ordinal items that
993 describe specific conditions in countries worldwide. For each of these individual items, we
994 qualitatively identify the ordinal answer categories, which capture the normative goals enshrined
995 in SDG16. Tables S1 and S2 outline for each index the content of each item, the available ordinal
996 categories as well as the categories which we consider to be in line with the goals of SDG16.
- 997 • Second, we draw on V-Dem's empirical measurement of the most likely ordinal value for each
998 item ("_ord" variables reported by V-Dem). Using this measurement, we extract for each index all
999 country-years that reached (or exceeded) *on all items of the index* the respective ordinal category
1000 identified in step 1. This leaves us for each item with the precise subset of countries which,
1001 according to V-Dem's measurement, fulfilled all conditions outlined by SDG16, in a given year.
- 1002 • Third, within this subset of country-years, we then calculate the lowest empirically estimated
1003 index score for each index.

1004

1005 **Application of target space to the SSP scenarios**

1006 The Table below indicates the data used in the assessment

1007

Target space indicator	Implementation
SDG1: #People in absolute poverty	The data on income distribution in the different SSPs could be used to calculate the number of people below 2\$ per person per day ⁵¹
SDG2: #People suffering from hunger	The was directly reported by the AIM model and has been later also reported by multiple model studies (AIM data is used here) ⁵²
SDG3: <5 mortality	The data is available from the original population scenarios of the SSPs ⁵³ .
SDG3: Total fertility rate	The data is available from the original population scenarios of the SSPs ⁵³ .
SDG4: #People w/o. sec. education	The data is available from the original population scenarios of the SSPs ⁵³ .
SDG5: Schooling gender gap	The data is available from the original population scenarios of the SSPs ⁵³ .
SDG6: Area under water stress	Water stress indicators have been calculated for the SSPs by multiple teams. Here, the data of Byers et al is used ⁵⁴
SDG6: #People w/o san/clean water	Data based on SSP2 ⁵⁵
SDG7: #people w/o access clean cooking	Access to clean cooking was based on data from the IMAGE-team, but is also reported by other IAM models
SDG7: #people w/o access electricity	Access to electricity was based on data from the IMAGE-team, but is also reported by other IAM models
SDG10: #people in relative poverty	The data on income distribution in the different SSPs could be used to calculate the number of people below 2\$ per person per day ⁵¹
SDG11: #people poor air quality	Air quality data for the SSPs was reported Rao et al ⁵⁶
SDG13: CO ₂ emissions	Data from the marker scenario of the SSP database were used ⁵⁷
SDG15: Loss of forest cover	Emissions from the marker scenario of the SSP database were used ⁵⁷

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1010 **Table S1: Questions contained in the *Equal Access Index* and SDG-conformable target categories**

V-Dem variable name	Question + answer categories	Clarification (according to V-Dem codebook V 7.1 - July 2017)	SDG-conformable target categories
v2pepwrngen	<p>Is political power distributed according to gender?</p> <p>0: Men have a near-monopoly on political power.</p> <p>1: Men have a dominant hold on political power. Women have only marginal influence.</p> <p>2: Men have much more political power but women have some areas of influence.</p> <p>3: Men have somewhat more political power than women.</p> <p>4: Men and women have roughly equal political power.</p>	/	4
v2pepwrsoc	<p>Is political power distributed according to social groups?</p> <p>0: Political power is monopolized by one social group comprising a minority of the population. This monopoly is institutionalized, i.e., not subject to frequent change.</p> <p>1: Political power is monopolized by several social groups comprising a minority of the population. This monopoly is institutionalized, i.e., not subject to frequent change.</p> <p>2: Political power is monopolized by several social groups comprising a majority of the population. This monopoly is institutionalized, i.e., not subject to frequent change.</p> <p>3: Either all social groups possess some political power, with some groups having more power than others; or different social groups alternate in power, with one group controlling much of the political power for a period of time, followed by another – but all significant groups have a turn at the seat of power.</p> <p>4: All social groups have roughly equal political power or there are no strong ethnic, caste, linguistic, racial, religious, or regional differences to speak of. Social group characteristics are not relevant to politics.</p>	<p>A social group is differentiated within a country by caste, ethnicity, language, race, region, religion, or some combination thereof. (It does not include identities grounded in sexual orientation or socioeconomic status.) Social group identity is contextually defined and is likely to vary across countries and through time. Social group identities are also likely to cross-cut, so that a given person could be defined in multiple ways, i.e., as part of multiple groups. Nonetheless, at any given point in time there are social groups within a society that are understood - by those residing within that society – to be different, in ways that may be politically relevant.</p>	3 ; 4
v2pepwrses	<p>Is political power distributed according to socioeconomic position?</p> <p>0: Wealthy people enjoy a virtual monopoly on political power. Average and poorer people have almost no influence.</p> <p>1: Wealthy people enjoy a dominant hold on political power. People of average income have little say. Poorer people have essentially no influence.</p> <p>2: Wealthy people have a very strong hold on political power. People of average or poorer income have some degree of influence but only on issues that matter less for wealthy people.</p> <p>3: Wealthy people have more political power than others. But people of average income have almost as much influence and poor people also have a significant degree of political power.</p> <p>4: Wealthy people have no more political power than those whose economic status is average or poor. Political power is more or less equally distributed across economic groups.</p>	<p>All societies are characterized by some degree of economic (wealth and income) inequality. In some societies, income and wealth are distributed in a grossly unequal fashion. In others, the difference between rich and poor is not so great. Here, we are concerned not with the degree of social inequality but rather with the political effects of this inequality. Specifically, we are concerned with the extent to which wealth and income translates into political power.</p>	3 ; 4

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Table S2: Questions contained in the Equality before the law and individual liberties Index and SDG-conformable target categories

V-Dem variable name	Question + answer categories	Clarification (according to V-Dem codebook V 7.1 - July 2017)	SDG-conformable target categories
v2clrspct	<p>Are public officials rigorous and impartial in the performance of their duties?</p> <p>0: The law is not respected by public officials. Arbitrary or biased administration of the law is rampant.</p> <p>1: The law is weakly respected by public officials. Arbitrary or biased administration of the law is widespread.</p> <p>2: The law is modestly respected by public officials. Arbitrary or biased administration of the law is moderate.</p> <p>3: The law is mostly respected by public officials. Arbitrary or biased administration of the law is limited.</p> <p>4: The law is generally fully respected by the public officials. Arbitrary or biased administration of the law is very limited.</p>	<p>This question focuses on the extent to which public officials generally abide by the law and treat like cases alike, or conversely, the extent to which public administration is characterized by arbitrariness and biases (i.e., nepotism, cronyism, or discrimination). The question covers the public officials that handle the cases of ordinary people. If no functioning public administration exists, the lowest score (0) applies.</p>	3 ; 4
v2cltrnslw	<p>Are the laws of the land clear, well publicized, coherent (consistent with each other), relatively stable from year to year, and enforced in a predictable manner?</p> <p>0: Transparency and predictability are almost non-existent. The laws of the land are created and/or enforced in completely arbitrary fashion.</p> <p>1: Transparency and predictability are severely limited. The laws of the land are more often than not created and/or enforced in arbitrary fashion.</p> <p>2: Transparency and predictability are somewhat limited. The laws of the land are mostly created in a non-arbitrary fashion but enforcement is rather arbitrary in some parts of the country.</p> <p>3: Transparency and predictability are fairly strong. The laws of the land are usually created and enforced in a non-arbitrary fashion.</p> <p>4: Transparency and predictability are very strong. The laws of the land are created and enforced in a non-arbitrary fashion.</p>	<p>This question focuses on the transparency and predictability of the laws of the land.</p>	3 ; 4
v2clacjstm	<p>Do men enjoy secure and effective access to justice?</p> <p>0: Secure and effective access to justice for men is non-existent.</p> <p>1: Secure and effective access to justice for men is usually not established or widely respected.</p> <p>2: Secure and effective access to justice for men is inconsistently observed. Minor problems characterize most cases or occur rather unevenly across different parts of the country.</p> <p>3: Secure and effective access to justice for men is usually observed.</p> <p>4: Secure and effective access to justice for men is almost always observed.</p>	<p>This question specifies the extent to which men can bring cases before the courts without risk to their personal safety, trials are fair, and men have effective ability to seek redress if public authorities violate their rights, including the rights to counsel, defense, and appeal. This question does not ask you to assess the relative access to justice men and women. Thus, it is possible to assign the lowest possible score to a country even if men and women enjoy equal – and extremely limited – access to justice.</p>	3 ; 4

v2clacjstw	<p>Do women enjoy equal, secure, and effective access to justice?</p> <p>0: Secure and effective access to justice for women is non-existent.</p> <p>1: Secure and effective access to justice for women is usually not established or widely respected.</p> <p>2: Secure and effective access to justice for women is inconsistently observed. Minor problems characterize most cases or occur rather unevenly across different parts of the country.</p> <p>3: Secure and effective access to justice for women is usually observed.</p> <p>4: Secure and effective access to justice for women is almost always observed.</p>	<p>This question specifies the extent to which women can bring cases before the courts without risk to their personal safety, trials are fair, and women have effective ability to seek redress if public authorities violate their rights, including the rights to counsel, defense, and appeal. This question does not ask you to assess the relative access to justice men and women. Thus, it is possible to assign the lowest possible score to a country even if men and women enjoy equal – and extremely limited – access to justice.</p>	3 ; 4
v2clprptym	<p>Do men enjoy the right to private property?</p> <p>0: Virtually no men enjoy private property rights of any kind.</p> <p>1: Some men enjoy some private property rights, but most have none.</p> <p>2: Many men enjoy many private property rights, but a smaller proportion enjoys few or none.</p> <p>3: More than half of men enjoy most private property rights, yet a smaller share of men have much more restricted rights.</p> <p>4: Most men enjoy most private property rights but a small minority does not.</p> <p>5: Virtually all men enjoy all, or almost all property rights.</p>	<p>Private property includes the right to acquire, possess, inherit, and sell private property, including land. Limits on property rights may come from the state (which may legally limit rights or fail to enforce them); customary laws and practices; or religious or social norms. This question concerns the right to private property, not actual ownership of property. This question does not ask you to assess the relative rights of men and women. Thus, it is possible to assign the lowest possible score to a country even if men and women enjoy equal – and very minimal – property rights.</p>	5
v2clprptyw	<p>Do women enjoy the right to private property?</p> <p>0: Virtually no women enjoy private property rights of any kind.</p> <p>1: Some women enjoy some private property rights, but most have none.</p> <p>2: Many women enjoy many private property rights, but a smaller proportion enjoys few or none.</p> <p>3: More than half of women enjoy most private property rights, yet a smaller share of women have much more restricted rights.</p> <p>4: Most women enjoy most private property rights but a small minority does not.</p> <p>5: Virtually all women enjoy all, or almost all, property rights.</p>	<p>Private property includes the right to acquire, possess, inherit, and sell private property, including land. Limits on property rights may come from the state (which may legally limit rights or fail to enforce them); customary laws and practices; or religious or social norms. This question concerns the right to private property, not actual ownership of property. This question does not ask you to assess the relative rights of men and women. Thus, it is possible to assign the lowest possible score to a country even if men and women enjoy equal – and very minimal – property rights.</p>	5
v2cltort	<p>Is there freedom from torture?</p> <p>0: Not respected by public authorities. Torture is practiced systematically and is incited and approved by the leaders of government.</p> <p>1: Weakly respected by public authorities. Torture is practiced frequently but is often not incited or approved by top leaders of government. At the same time, leaders of government are not actively working to prevent it.</p> <p>2: Somewhat. Torture is practiced occasionally but is typically not approved by top leaders of government.</p> <p>3: Mostly respected by public authorities. Torture is practiced in a few isolated cases but is not incited or approved by top government leaders.</p> <p>4: Fully respected by public authorities. Torture is non-existent.</p>	<p>Torture refers to the purposeful inflicting of extreme pain, whether mental or physical, with an aim to extract information or intimidate victims, who are in a state of incarceration. Here, we are concerned with torture practiced by state officials or other agents of the state (e.g., police, security forces, prison guards, and paramilitary groups).</p>	4

v2ckill	<p>Is there freedom from political killings?</p> <p>0: Not respected by public authorities. Political killings are practiced systematically and they are typically incited and approved by top leaders of government.</p> <p>1: Weakly respected by public authorities. Political killings are practiced frequently and top leaders of government are not actively working to prevent them.</p> <p>2: Somewhat respected by public authorities. Political killings are practiced occasionally but they are typically not incited and approved by top leaders of government.</p> <p>3: Mostly respected by public authorities. Political killings are practiced in a few isolated cases but they are not incited or approved by top leaders of government.</p> <p>4: Fully respected by public authorities. Political killings are non-existent.</p>	<p>Political killings are killings by the state or its agents without due process of law for the purpose of eliminating political opponents. These killings are the result of deliberate use of lethal force by the police, security forces, prison officials, or other agents of the state (including paramilitary groups).</p>	4
v2cslavem	<p>Are adult men free from servitude and other kinds of forced labor?</p> <p>0: Male servitude or other kinds of forced labor is widespread and accepted (perhaps even organized) by the state.</p> <p>1: Male servitude or other kinds of forced labor is substantial. Although officially opposed by the public authorities, the state is unwilling or unable to effectively contain the practice.</p> <p>2: Male servitude or other kinds of forced labor exists but is not widespread and usually actively opposed by public authorities, or only tolerated in some particular areas or among particular social groups.</p> <p>3: Male servitude or other kinds of forced labor is infrequent and only found in the criminal underground. It is actively and sincerely opposed by the public authorities.</p> <p>4: Male servitude or other kinds of forced labor is virtually non-existent.</p>	<p>Involuntary servitude occurs when an adult is unable to quit a job s/he desires to leave – not by reason of economic necessity but rather by reason of employer’s coercion. This includes labor camps but not work or service which forms part of normal civic obligations such as conscription or employment in command economies.</p>	4
v2cslavef	<p>Are adult women free from servitude and other kinds of forced labor?</p> <p>0: Female servitude or other kinds of forced labor is widespread and accepted (perhaps even organized) by the state.</p> <p>1: Female servitude or other kinds of forced labor is substantial. Although officially opposed by the public authorities, the state is unwilling or unable to effectively contain the practice.</p> <p>2: Female servitude or other kinds of forced labor exists but is not widespread and usually actively opposed by public authorities, or only tolerated in some particular areas or among particular social groups.</p> <p>3: Female servitude or other kinds of forced labor is infrequent and only found in the criminal underground. It is actively and sincerely opposed by the public authorities.</p> <p>4: Female servitude or other kinds of forced labor is virtually non-existent.</p>	<p>Involuntary servitude occurs when an adult is unable to quit a job s/he desires to leave – not by reason of economic necessity but rather by reason of employer’s coercion. This includes labor camps but not work or service which forms part of normal civic obligations such as conscription or employment in command economies. This question does not ask you to assess the relative freedom of men and women from forced labor. Thus, a country in which both men and women suffer the same conditions of servitude might be coded a (0) for women, even though there is equality across the sexes.</p>	4

v2clrelig	<p>Is there freedom of religion?</p> <p>0: Not respected by public authorities. Hardly any freedom of religion exists. Any kind of religious practice is outlawed or at least controlled by the government to the extent that religious leaders are appointed by and subjected to public authorities, who control the activities of religious communities in some detail.</p> <p>1: Weakly respected by public authorities. Some elements of autonomous organized religious practices exist and are officially recognized. But significant religious communities are repressed, prohibited, or systematically disabled, voluntary conversions are restricted, and instances of discrimination or intimidation of individuals or groups due to their religion are common.</p> <p>2: Somewhat respected by public authorities. Autonomous organized religious practices exist and are officially recognized. Yet, minor religious communities are repressed, prohibited, or systematically disabled, and/or instances of discrimination or intimidation of individuals or groups due to their religion occur occasionally.</p> <p>3: Mostly respected by public authorities. There are minor restrictions on the freedom of religion, predominantly limited to a few isolated cases. Minority religions face denial of registration, hindrance of foreign missionaries from entering the country, restrictions against proselytizing, or hindrance to access to or construction of places of worship.</p> <p>4: Fully respected by public authorities. The population enjoys the right to practice any religious belief they choose. Religious groups may organize, select, and train personnel; solicit and receive contributions; publish; and engage in consultations without undue interference. If religious communities have to register, public authorities do not abuse the process to discriminate against a religion and do not constrain the right to worship before registration.</p>	<p>This indicator specifies the extent to which individuals and groups have the right to choose a religion, change their religion, and practice that religion in private or in public as well as to proselytize peacefully without being subject to restrictions by public authorities.</p>	4
v2clfmove	<p>Is there freedom of foreign travel and emigration?</p> <p>0: Not respected by public authorities. Citizens are rarely allowed to emigrate or travel out of the country. Transgressors (or their families) are severely punished. People discredited by the public authorities are routinely exiled or prohibited from traveling.</p> <p>1: Weakly respected by public authorities. The public authorities systematically restrict the right to travel, especially for political opponents or particular social groups. This can take the form of general restrictions on the duration of stays abroad or delays/refusals of visas.</p> <p>2: Somewhat respected by the public authorities. The right to travel for leading political opponents or particular social groups is occasionally restricted but ordinary citizens only met minor restrictions.</p> <p>3: Mostly respected by public authorities. Limitations on freedom of movement and residence are not directed at political opponents but minor restrictions exist. For example, exit visas may be required and citizens may be prohibited from traveling outside the country when accompanied by other members of their family.</p> <p>4: Fully respected by the government. The freedom</p>	<p>This indicator specifies the extent to which citizens are able to travel freely to and from the country and to emigrate without being subject to restrictions by public authorities.</p>	4

	of citizens to travel from and to the country, and to emigrate and repatriate, is not restricted by public authorities.		
v2cldmovem	<p>Do men enjoy freedom of movement within the country?</p> <p>0: Virtually no men enjoy full freedom of movement (e.g., North Korea).</p> <p>1: Some men enjoy full freedom of movement, but most do not (e.g., Apartheid South Africa).</p> <p>2: Most men enjoy some freedom of movement but a sizeable minority does not. Alternatively all men enjoy partial freedom of movement.</p> <p>3: Most men enjoy full freedom of movement but a small minority does not.</p> <p>4: Virtually all men enjoy full freedom of movement.</p>	<p>This indicator specifies the extent to which all men are able to move freely, in daytime and nighttime, in public thoroughfares, across regions within a country, and to establish permanent residency where they wish. Note that restrictions in movement might be imposed by the state and/or by informal norms and practices. Such restrictions sometimes fall on rural residents, on specific social groups, or on dissidents. This question does not ask you to assess the relative freedom of men and women. Thus, it is possible to assign the lowest possible score to a country even if men and women enjoy equal – and extremely low – freedom of movement. Do not consider restrictions in movement that are placed on ordinary (non-political) criminals. Do not consider restrictions in movement that result from crime or unrest.</p>	4
v2cldmovew	<p>Do women enjoy freedom of movement within the country?</p> <p>0: Virtually no women enjoy full freedom of movement (e.g., North Korea or Afghanistan under the Taliban).</p> <p>1: Some women enjoy full freedom of movement, but most do not (e.g., Apartheid South Africa).</p> <p>2: Most women enjoy some freedom of movement but a sizeable minority does not. Alternatively all women enjoy partial freedom of movement.</p> <p>3: Most women enjoy full freedom of movement but a small minority does not.</p> <p>4: Virtually all women enjoy full freedom of movement.</p>	<p>This indicator specifies the extent to which all women are able to move freely, in daytime and nighttime, in public thoroughfares, across regions within a country, and to establish permanent residency where they wish. Note that restrictions in movement might be imposed by the state and/or by informal norms and practices. Such restrictions sometimes fall on rural residents, on specific social groups, or on dissidents. This question does not ask you to assess the relative freedom of men and women. Thus, it is possible to assign the lowest possible score to a country even if men and women enjoy equal – and extremely low – freedom of movement. Do not consider restrictions in movement that are placed on ordinary (non-political) criminals. Do not consider restrictions in movement that result from crime or unrest.</p>	4

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