

Reporting on the extent of natural ecosystems under the Kunming-Montreal Global Biodiversity Framework

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1 **Abstract**

2 Unlike its predecessors, the Kunming-Montreal Global Biodiversity Framework
3 emphasises ecosystems in its targets, goals, and monitoring framework. This novelty means
4 that Parties to the Convention on Biological Diversity are now expected to report on this
5 component of biodiversity for the first time. Here we surveyed how Parties reported on
6 Headline Indicator A.2 (Extent of Natural Ecosystems) in their 7th National Reports to the
7 Convention on Biological Diversity. Only a quarter of Parties reported on indicator A.2, so we
8 explored existing global data as a temporary input ahead of the upcoming Global Review of
9 Collective Progress. Although indicator values estimated from global datasets were statistically
10 consistent with those reported by Parties, there was approximately 26.9% variation between
11 the two sources, particularly in geographically small countries. Therefore, although global data
12 could be used to estimate aggregate indicator values – suggesting that 70.5% of global
13 terrestrial ecosystems are still natural – it should be applied cautiously in individual countries.

14

15 **Introduction**

16 The Kunming-Montreal Global Biodiversity Framework (GBF) is unique because,
17 unlike its predecessors, it includes targets, goals, and indicators for ecosystems (Watson et al.
18 2020; Nicholson et al. 2021; Convention on Biological Diversity 2022a). This was a significant
19 development because it placed new onus on Parties to the Convention on Biological Diversity
20 to consider the area, integrity and risk of collapse of ecosystems in their National Targets,
21 National Biodiversity Strategies and Action Plans, and National Reports.

22 In addition to these national instruments, Parties were also requested to report on a suite
23 of headline indicators as part of the GBF monitoring framework (Convention on Biological
24 Diversity 2022b), which is grounded in science and developed in a deliberative and
25 consultative way (Nicholson et al. 2021; Affinito et al. 2024). The rationale is for Parties to
26 report on headline indicators in their national reports, which then feed into Global Reviews of
27 Collective Progress (Convention on Biological Diversity 2022c). However, due to the newness
28 of ecosystem indicators in the GBF, Parties' readiness to report on these headline indicators
29 was only fully laid bare after they had submitted their 7th National Reports by the end of
30 February 2026.

31 With this study, we examine how Parties reported on one of the headline indicators for
32 ecosystems: Indicator A.2 on the Extent of Natural Ecosystems (the other ecosystem indicators

33 being A.1 Red List of Ecosystems on the risk of ecosystem collapse, and B.1 the services
34 provided by ecosystems). In its simplest form, Indicator A.2 is the geographical extent of
35 natural ecosystems as a proportion of a country's total surface area ([https://www.gbfi-](https://www.gbfi.org/metadata/headline/A-2)
36 [indicators.org/metadata/headline/A-2](https://www.gbfi.org/metadata/headline/A-2)). In this context, 'natural' refers to the *type* of ecosystem
37 (i.e., the structure, composition, and function of the ecosystem is predominantly the result of
38 natural, rather than human, factors) and should not be conflated with the *condition* of the
39 ecosystem (i.e., whether the ecosystem has high ecological integrity), which ought to be
40 captured by other related indicators. By contrast, 'non-natural' refers to ecosystems that are
41 created and maintained through human interventions, replacing antecedent natural ecosystem
42 types. Thus, natural and non-natural ecosystems refer to the binary typological identity (*sensu*
43 Delettre 2021), rather than the relative exposure to human intervention as captured by concepts
44 such as human footprint (e.g., Venter et al. 2016) or human modification (e.g., Theobald et al.
45 2025) that consider a gradient of human pressure.

46 The distinction between natural and non-natural ecosystem types is perhaps more easily
47 interpreted through the IUCN Global Ecosystem Typology (Keith et al. 2022), which classifies
48 intensive use and anthropogenic biomes. On land, for example, these non-natural ecosystem
49 functional groups include croplands, sown pastures, plantations, urban areas, and derived semi-
50 natural pastures (Keith et al. 2020; Driver & Botts 2025). Although Indicator A.2 in its basic
51 form is reported as proportion of natural ecosystem extent, the methodological metadata
52 recommends disaggregating this single estimate according to ecosystem functional groups in
53 the Global Ecosystem Typology. To report on this accurately, Parties presumably need
54 geospatial data on the extent of different ecosystem types to distinguish between different sub-
55 groups of natural and non-natural ecosystems.

56 Here we surveyed how Parties reported on Indicator A.2 in their 7th National Reports.
57 In addition to evaluating whether they were able to report on the indicator, we also explored
58 the types of data used to quantify the indicator and whether they disaggregated sub-groups of
59 natural and non-natural ecosystems. Moreover, we examined whether an existing global dataset
60 designed to distinguish between natural and non-natural lands could be used to estimate the
61 extent of natural ecosystems at the country level. Our motivation was twofold. First, to evaluate
62 agreement between Indicator A.2 estimated from different sources. Second, if there is
63 agreement between sources, to apply global sources nationally in countries where local
64 information is still lacking (Buschke et al. 2023). In the short-term, this approach of using

65 existing global data could serve as an important stopgap ahead of the upcoming Global Review
66 of Collective Progress (scheduled for October 2026).

67

68 **Methods**

69 *Review of 7th National Reports*

70 We collected data from Parties' 7th National Reports submitted through the CBD's
71 Online Reporting Tool (<https://ort.cbd.int/national-reports/nr7>). Although the initial deadline
72 for these reports was 28 February 2026, we continued to screen reports submitted until 31
73 March 2026. For each report, we first recorded whether the Party had reported a value for
74 Indicator A.2 and then collated the data value of the indicator as a proportion between 0 and 1.
75 For Parties that reported the indicator as a time-series covering more than one year, we recorded
76 the most recent indicator value. We also limited indicator values to the terrestrial and inland
77 freshwater realms, excluding any information for marine ecosystems (where non-natural
78 ecosystems classes are generally geographically small compared to the total extent of the
79 marine realm).

80 Several Parties only reported the geographical surface area of natural ecosystems,
81 without including the area of non-natural ecosystems. In these instances, we used total surface
82 areas of countries (km²) as the denominator for the indicator, collected through annual
83 questionnaires by the Food and Agriculture Organization (FAO) of the United Nations
84 (accessed through the World Bank Open Data portal:
85 <https://data.worldbank.org/indicator/AG.SRF.TOTL.K2>). When countries only reported
86 surface areas for a subset of natural ecosystems, or if the total areas of natural ecosystems
87 summed to $\geq 100\%$ of the country area, we did not record the indicator value as it was
88 inconsistent with the methodological metadata for the indicator overseen by the UN Statistical
89 Division (<https://gbf-indicators.org/metadata/headline/A-2>)

90 From each report, we classified the type of source data used to report on Indicator A.2.
91 Through our screening, we identified seven broad classes of data: 1. *Ecosystem accounts* (i.e.,
92 tabular data from natural capital accounts); 2. *Ecosystem maps* (i.e., geographical maps of
93 ecosystem classes); 3. *Forest cover* (i.e., geographical distribution of forest or tree-covered
94 ecosystems); 4. *Inventory data* (i.e., survey data of landscape features, like forest, wetlands, or
95 croplands); 5. *Land cover* (i.e., earth observation product of land cover classes); 6. *Mixed*

96 *sources* (i.e., a combination of multiple data sources); 7. *Unclear* (i.e., insufficient information
97 to identify data type).

98 As suggested by GBF guidelines, we also recorded whether parties disaggregated extent
99 data by sub-groups of natural or non-natural ecosystems. This allowed us to identify nine types
100 of disaggregation: 1. *Biome*; 2. *Ecological province*; 3. *Ecosystem type* (i.e., national
101 classifications); 4. *Forest types*; 5. *Global Ecosystem Typology*; 6. *Land cover classes*; 7.
102 *Natural and semi-natural ecosystems* (i.e., natural ecosystem with widespread human
103 interventions); 8. *Protection status*; and 9. *Red List of Ecosystems status*.

104

105 *Global data on natural lands*

106 A single global reference dataset for ecosystems mapped according to the IUCN Global
107 Ecosystem Typology has yet to be developed. Therefore, we used the Science Based Targets
108 Network (SBTN) Natural Lands Map version 1.1. developed by the Land & Carbon Lab
109 (Mazur et al. 2025) a proxy for natural terrestrial ecosystems. This binary dataset aims to map
110 natural and non-natural terrestrial land globally for 2020 and is worth considering when
111 reporting GBF indicator A.2 for several reasons. First, the SBTN Natural Lands Map is a
112 composite dataset made up of multiple input data products, including two global landcover
113 products, 15 supplementary global datasets, and 18 regional datasets. By combining datasets
114 in this way, the ensemble output is reported to be less sensitive to specific characteristics that
115 vary between individual datasets (e.g., the concordance between 11 croplands land cover
116 products varied between 16 and 70% across different African countries: Kerner et al. 2024).
117 Second, unlike its constituent land cover products, the SBTN Natural Lands Map distinguishes
118 between natural and non-natural tree-covered landscapes (e.g., forest vs. plantations), as well
119 as between natural and non-natural short vegetation (e.g., pastures vs. grasslands). Third, the
120 SBTN Natural Lands Map is standardised to the year 2020, which makes it an appropriate
121 baseline for the period 2020-2030 of the GBF. Finally, the SBTN Natural Lands Map is
122 documented (Mazur et al. 2025), and is available through an open license (CC-BY-SA-4.0) on
123 Google Earth Engine (Google Earth Engine Team 2015).

124 Within Google Earth Engine, we quantified the total surface area of natural and non-
125 natural land from the SBTN Map in each country, represented by country boundaries according
126 to the FAO Global Administrative Unit Layer (GAUL) 2015 (FAO 2015). This analysis,
127 therefore, included the United States of America and its unincorporated territories, even though

128 it is not a Party to the CBD. Indicator A.2 (the proportion natural ecosystems per country) was
129 calculated for each Party by dividing the extent of natural land by the country's total land area.
130 At the global scale, we calculated Indicator A.2 as both the value averaged for each country
131 (i.e., unweighted by surface area) and as total proportion of natural land globally.

132

133 *Comparing Indicator A.2 reported by Parties and from global data*

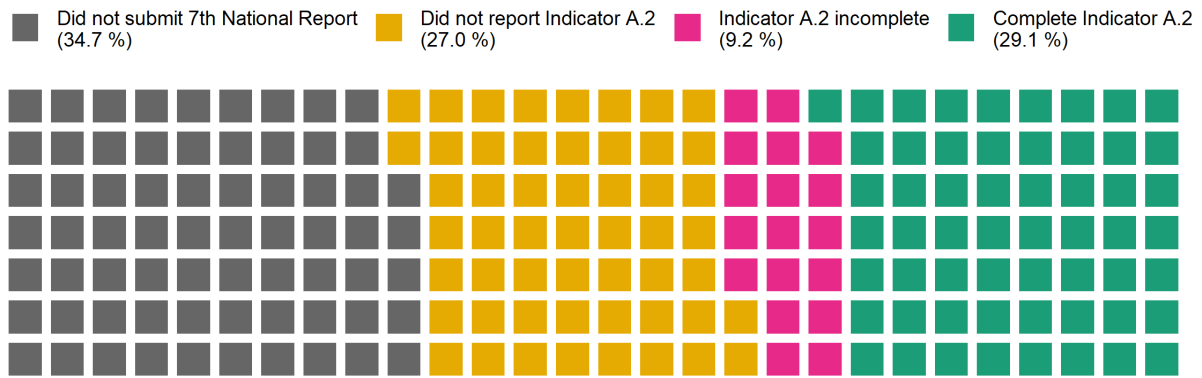
134 We used unity-line regression to compare values for Indicator A.2 reported by Parties
135 to those estimated from the SBTN Natural Lands Map (i.e., a modified ordinary least squares
136 regression that assumes a slope of 1 and an intercept of 0). This was a two-step process in R
137 version 4.5.1 (R Core Team 2025). First, we fit an ordinary least squares regression to the data
138 (`lm` function in `stats` package) but evaluated statistical significance of the slope parameter
139 as the difference from 1, rather than the conventional null hypothesis of 0 (the statistical
140 significance of the intercept parameter was compared to a null hypothesis of 0, as is standard).
141 Next, we calculated the residuals and R^2 based on the assumed 1:1 line, rather than the fitted
142 regression line. Calculating the R^2 and absolute residuals in this way is indifferent to the choice
143 of dependent and independent variables. To evaluate deviations from the 1:1 expectation, we
144 compared the residuals from the unity-line regression to the total surface area of each country
145 (estimated from FAO GAUL 2015) using quantile regression to depict the outer limits of the
146 relationship (0.01, 0.05, 0.95, 0.99 quantiles using the `rq` command in `quantreg` package:
147 Koenker 2025).

148

149 **Results**

150 *Indicator A.2 from 7th National Reports*

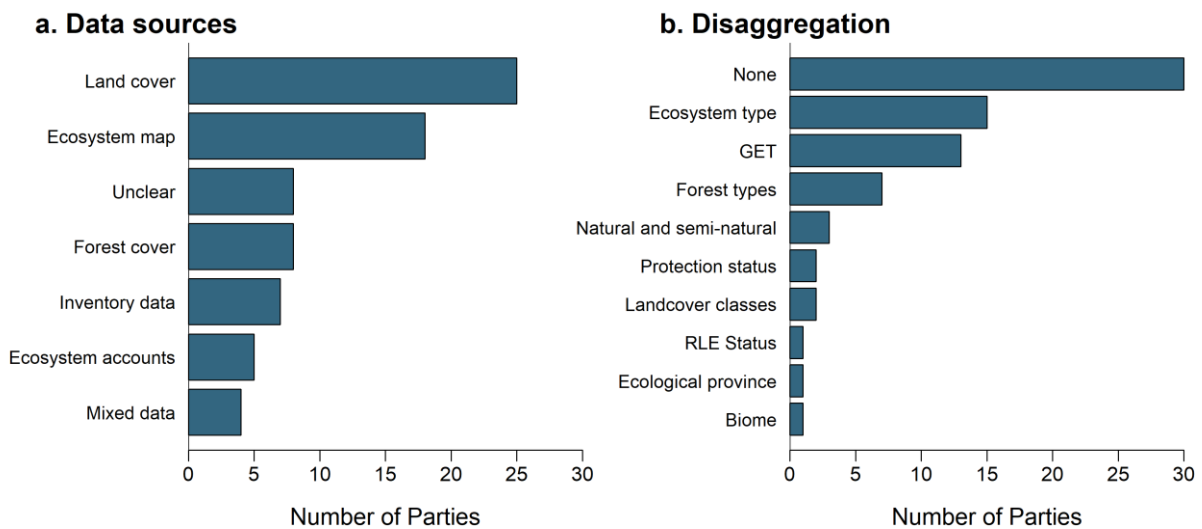
151 As of 31 March 2026, 128 of the 196 Parties to the CBD submitted 7th National Reports
152 (**Figure 1**). However, only 75 reported on Headline Indicator A.2 on the Extent of Natural
153 Ecosystems, and 18 of these had to be excluded because they did not conform to the
154 methodological metadata developed by the UN Statistical Division. This meant that there were
155 estimates for Indicator A.2 for 57 Parties (including the European Union) (**Figure 1**;
156 **Supplementary Table S1**).



157

158 **Figure 1.** Reporting status for Headline Indicator A.2 (*Extent of Natural Ecosystems*) in 7th National Reports to the Convention on Biological Diversity (CBD). Each square represents one Party to the CBD.

160



161

162 **Figure 2.** (a) The sources of information and (b) the type of disaggregation used by the 73 Parties that Reported
 163 on Headline Indicator A.2 (*Extent of Natural Ecosystems*) in 7th National Reports to the Convention on Biological
 164 Diversity. (GET = Global Ecosystem Typology; RLE = Red List of Ecosystems).

165

166 The 75 Parties that reported on Indicator A.2 (both complete and incomplete values)
 167 most frequently used landcover data (25 Parties, 33.3%) and national ecosystem maps (18
 168 Parties, 24%) to calculate the indicator (**Figure 2a**). Forest cover, inventories, and ecosystem
 169 accounts were collectively used by 20 Parties (26.7%), while 4 parties used a combination of
 170 data sources. Eight Parties did not provide sufficient explanation to identify which data they
 171 used in calculating the indicator (**Figure 2a**). Forty-five Parties (60%) made some attempt to
 172 disaggregate Indicator A.2 (**Figure 2b**). The most frequent type of disaggregation used national

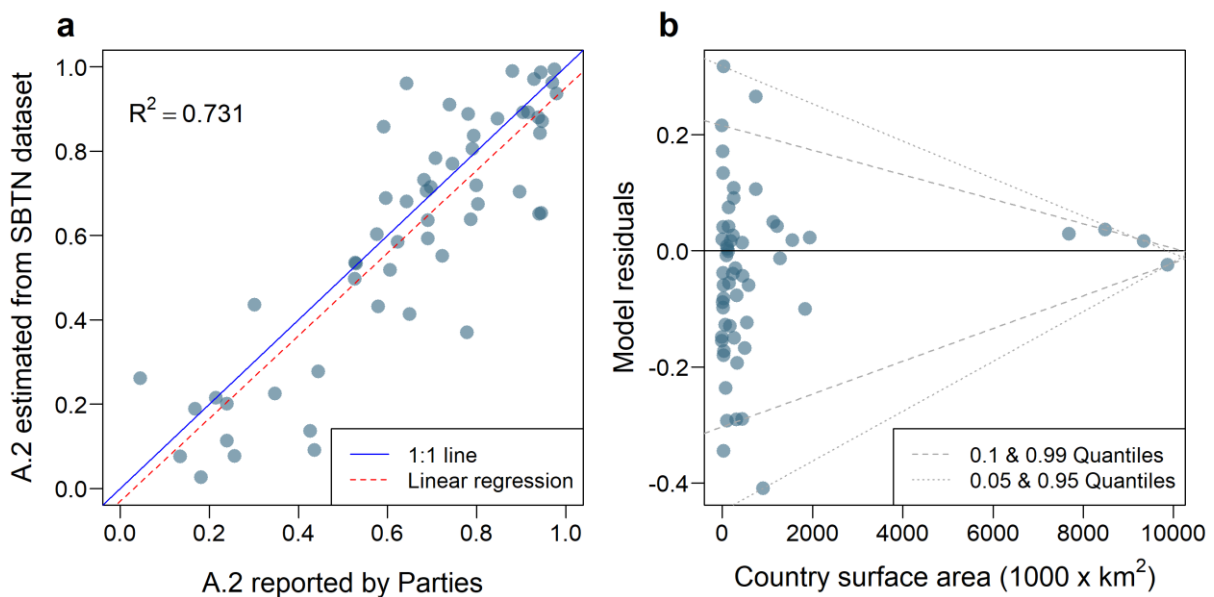
173 classifications of ecosystem types (15 Parties, 20%), while the Global Ecosystem Typology
174 was used by 13 Parties (17.3%).

175

176 *Indicator A.2 from global data*

177 There was a positive relationship between Indicator A.2 for the 57 Parties that reported
178 the indicator in their 7th National Reports and estimates from the SBTN Natural Lands Map
179 (**Figure 3a**). The linear regression was statistically indistinguishable from the unity line,
180 implying a 1:1 relationship (Intercept = -0.029 ± 0.05 ; $t = -0.553$; $p = 0.583$; Slope = $0.980 \pm$
181 0.08 ; $t = -0.269$; $p = 0.789$). However, 26.9% of the variation between the two sources of
182 information remained unaccounted for ($R^2 = 0.731$). Combined, these patterns demonstrated
183 broad concordance between the sources of the indicator but urged caution about drawing
184 conclusions for individual countries. The residuals of the relationship showed that there was
185 no broad pattern in which countries were over- or underestimated, though variation between
186 the two sources was highest in smaller countries (**Figure 3b**).

187



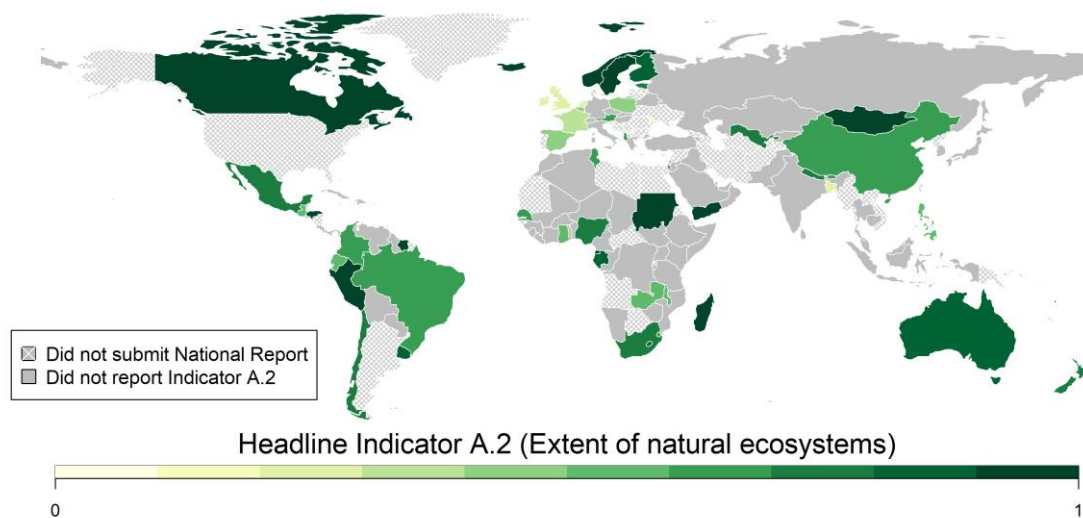
188

189 **Figure 3.** (a) A comparison between Headline Indicator A.2 (*Extent of Natural Ecosystems*) as reported by Parties
190 to the Convention on Biological Diversity in their 7th National Reports and estimated from SBTN Natural Lands
191 Map. The R^2 value is based on a unity line regression assuming a 1:1 relationship. (b) The relationship between
192 model residuals from the comparison and the total surface area of each country. Grey dashed lines depict the outer
193 limits of the data as estimated from a quantile regression (0.1, 0.05, 0.95, 0.99 quantiles).

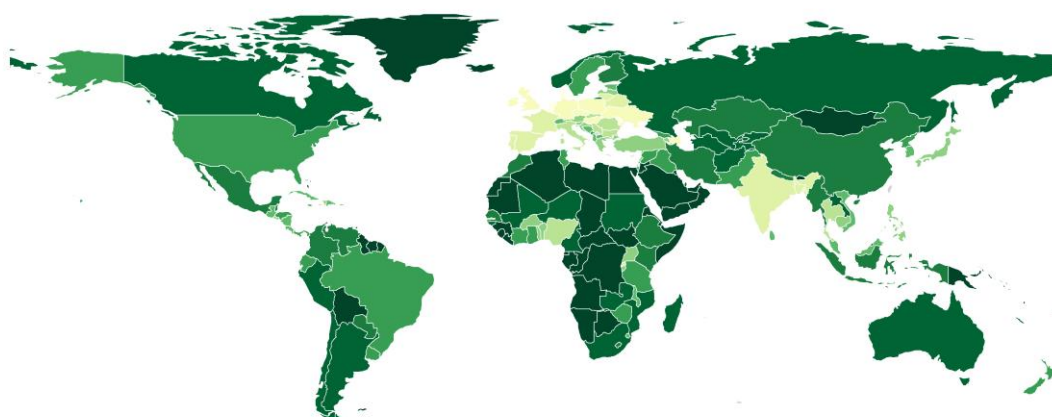
194

195 The subset of Parties that reported on Indicator A.2 was a non-random sample of the
 196 countries covered by the SBTN Natural Lands Map (**Figure 4**), which meant that the country-
 197 averaged values for Indicator A.2 reported by Parties (n = 57; Mean = 0.647; Median = 0.691;
 198 Interquartile range = 0.52 – 0.85) differed from those estimated from the global dataset (n =
 199 196; Mean = 0.597; Median = 0.643; Interquartile range = 0.39 – 0.86). These differences
 200 imply that the total extent of natural ecosystems globally cannot simply be extrapolated from
 201 the subset of Parties that reported on Indicator A.2. Rather, the total extent of natural
 202 ecosystems globally would have to be estimated using a dataset with global coverage; in the
 203 case of the SBTN Natural Lands Map, natural lands covered 70.54% of the total study area.

a. Indicator A.2 reported by Parties



b. Indicator A.2 from SBTN Natural Lands Map



204
 205 **Figure 4.** Headline Indicator A.2 (*Extent of Natural Ecosystems*) as (a) reported by Parties to the Convention on
 206 Biological Diversity in the 7th National Reports and (b) estimated from SBTN Natural Lands Map. Both maps use
 207 a common colour palette.

208 Discussion

209 Roughly one in four Parties to the CBD added complete estimates of Headline Indicator
210 A.2 to their 7th National Reports. An optimist might see this as an improvement on earlier
211 reporting cycles, where only one-fifth of indicators were consistent with CBD
212 recommendations (Bhatt et al. 2020). However, the 57 Parties that successfully reported on
213 Indicator A.2 were outnumbered by the 71 Parties that submitted reports but either did not
214 report on the indicator at all or only provided incomplete information. This points towards the
215 lack of readiness to report on the extent of natural ecosystems.

216 An earlier evaluation ahead of reporting deadlines suggested that while methods had
217 been established for Headline Indicator A.2, and data compiled in some countries, further data
218 collection would be needed before the indicator was fully operational (Affinito et al. 2025).
219 This evaluation has proven to be prescient. The method for calculating the indicator – under
220 the custodianship of the UN Statistical Division – is indeed well developed. Yet 18 Parties still
221 provided information that was insufficient to calculate the indicator. While this could be
222 attributed to incomplete data in these countries, it might justify creating additional national
223 capacities by, for example, translating metadata into additional languages, producing new
224 guidelines, or hosting training workshops. In this regard, the CBD Secretariat’s efforts to host
225 regional dialogues ahead of the 7th National Report deadlines was a step in the right direction
226 (Convention on Biological Diversity 2026a), as is the EU-funded project led by the UN
227 Statistical Division on *SEEA-related Indicators for the Global Biodiversity Framework*
228 (<https://seea.un.org/content/seea-related-indicators-global-biodiversity-framework>).

229 Parties should aspire to develop their own national ecosystem maps, not only for
230 reporting on Headline Indicator A.2, but because such maps are the foundation for spatial
231 biodiversity planning, ecosystem accounting, and Red List of Ecosystems Assessments (Botts
232 et al. 2020; Nicholson et al. 2024; SANBI & UNEP-WCMC 2024; Xiao et al. 2024). However,
233 only 18 Parties reported using national ecosystem maps for their reporting, signalling the
234 absence or underuse of these types of data products. Developing national ecosystem maps from
235 scratch can take several years, followed by continuous updates and improvements that may last
236 decades (Dayaram et al. 2019; Sink et al. 2023). So, although Parties have sufficient time to
237 develop national maps ahead of the 8th National reports due by mid-2029, the need for
238 alternative global datasets remains in the short term.

239 The metadata for Headline Indicator A.2 describes two potential global data sources.
240 The first is ARIES for SEEA (<https://seea.un.org/content/aries-for-seea>), which combines
241 global land cover data with a rules-based look-up table to identify broad ecosystem types
242 (similar to the approach described by Sayre et al. 2020). This approach is relatively fast and
243 accessible, but is sensitive to variations global land cover products (Venter et al. 2022; Kerner
244 et al. 2024), which introduce errors unless validated locally (Meyer & Pebesma 2022; Buschke
245 et al. 2023). The second listed data source is the Global Ecosystems Atlas
246 (<https://globalecosystemsatlas.org/>), which is in the process of synthesising nationally-
247 contributed ecosystem maps standardised using the IUCN Global Ecosystem Typology and
248 filling data gaps using the newly developed ecosystem classification spatial models (e.g.,
249 Brown et al. 2025; Herzog et al. 2025). While the Global Ecosystem Atlas has the advantage
250 of including locally-validated datasets – including for the marine realm – it has not yet reached
251 a level of completeness needed to inform the 2026 Global Review of Collective Progress.

252 The upcoming Global Review of Collective Progress should, therefore, either limit its
253 analysis to data from the subset of Parties that successfully reported on Headline Indicator A.2
254 or, as a temporary solution, use an analysis like the one we performed using SBTN Natural
255 Lands Map. Article 18 of Decision 16/32 of the CBD is unambiguous that national reports
256 should be the primary source of information in the review (Convention on Biological Diversity
257 2026b), but it also makes provisions for content from “other relevant scientific and technical
258 peer-reviewed literature” (Article 18h). Our comparison showed that overall patterns of
259 Indicator A.2 are statistically comparable between the National Reports and the SBTN Natural
260 Lands Map, with unaccounted-for variation greatest in geographically small countries. This
261 suggests that discrepancies between data sources may be due to geoprocessing choices rather
262 than fundamental inconsistencies in underlying datasets. Small differences in geographical
263 projection, country boundaries, data resolution, mapping processes, and analyst biases all affect
264 estimates of surface area (Olofsson et al. 2014), and these discrepancies would be more
265 pronounced in smaller areas where they make up a greater proportion of the total area. As such,
266 it seems likely that discrepancies in Indicators A.2 between the National Reports and the SBTN
267 Natural Land Map are not systematically biased; suggesting that the latter source could be
268 suitable as a stopgap for the Global Review of Collective Progress (data tables are included in
269 **Supplementary Table S1**).

270 Headline Indicator A.2 estimated from the SBTN Natural Land Map has the
271 shortcoming that it cannot be disaggregated according to the Global Ecosystem Typology as

272 recommended in the indicator’s methodological metadata. But seeing that only 13 Parties
273 reported this disaggregation, this drawback of the SBTN remains relatively minor for now. An
274 advantage of the SBTN Global Lands Map is that it can be used to estimate Indicator A.2 for
275 the whole planet, suggesting that 70.5% of terrestrial areas globally remain natural. One should
276 not, however, assume that these areas are necessarily in a state of high integrity. Independent
277 analyses showed that roughly 70% of lands have very low (43%) and low (27%) human
278 modification (Theobald et al. 2025), consistent with our estimate for Indicator A.2. But other
279 estimate of the global ecological footprint show how 75% of the terrestrial surface area faces
280 some form of human pressure (Venter et al. 2016), signalling that a significant part of the
281 remaining natural ecosystem extent is likely exposed to negative pressures. Given these facts,
282 we encourage the continued development of national-level ecosystem data and their subsequent
283 integration in threat assessments (Bland et al. 2017; Nicholson et al. 2024). In the meantime,
284 the Global Biodiversity Framework should continue promoting ecosystems as the focus of
285 policy, planning, implementation, and monitoring. While Parties learn and develop their
286 monitoring systems to incorporate ecosystem data, our study makes the case to apply and
287 validate spatial information from global sources to meet global reporting needs.

288

289 **References**

- 290 Affinito, F., Butchart, S.H.M., Nicholson, E., Hirsch, T., Williams, J.M., Campbell, J.E.,
291 Ferrari, M.F., Gabay, M., Gorini, L., Kalamujic Strojil, B., Kohsaka, R., Painter, B.,
292 Pinto, J.C., Scholz, A.H., Straza, T.R.A., Tshidada, N., Vallecillo, S., Widdicombe, S.
293 & Gonzalez, A. (2025). Assessing coverage of the monitoring framework of the
294 Kunming-Montreal Global Biodiversity Framework and opportunities to fill gaps. *Nat*
295 *Ecol Evol*, 9, 1280–1294.
- 296 Affinito, F., Williams, J.M., Campbell, J.E., Londono, M.C. & Gonzalez, A. (2024). Progress
297 in developing and operationalizing the Monitoring Framework of the Global
298 Biodiversity Framework. *Nat Ecol Evol*, 8, 2163–2171.

299 Bhatt, R., Gill, M.J., Hamilton, H., Han, X., Linden, E. & Young, B.E. (2020). Uneven use of
300 biodiversity indicators in 5th National Reports to the Convention on Biological
301 Diversity. *Envir. Conserv.*, 47, 15–21.

302 Bland, L.M., Keith, D.A., Miller, R.M., Murray, N.J. & Rodríguez, J.P. (2017). *Guidelines for*
303 *the application of IUCN Red List of Ecosystems Categories and Criteria. Version 1.1.*
304 IUCN International Union for Conservation of Nature.

305 Botts, E.A., Skowno, A., Driver, A., Holness, S., Maze, K., Smith, T., Daniels, F., Desmet, P.,
306 Sink, K., Botha, M., Nel, J. & Manuel, J. (2020). More than just a (red) list: Over a
307 decade of using South Africa’s threatened ecosystems in policy and practice. *Biological*
308 *Conservation*, 246, 108559.

309 Brown, C.F., Kazmierski, M.R., Pasquarella, V.J., Rucklidge, W.J., Samsikova, M., Zhang, C.,
310 Shelhamer, E., Lahera, E., Wiles, O., Ilyushchenko, S., Gorelick, N., Zhang, L.L., Alj,
311 S., Schechter, E., Askay, S., Guinan, O., Moore, R., Boukouvalas, A. & Kohli, P.
312 (2025). AlphaEarth Foundations: An embedding field model for accurate and efficient
313 global mapping from sparse label data.

314 Buschke, F.T., Capitani, C., Sow, E.H., Khaemba, Y., Kaplin, B.A., Skowno, A., Chiawo, D.,
315 Hirsch, T., Ellwood, E.R., Clements, H., Child, M.F., Huber, P.R., von Staden, L.,
316 Hagenimana, T., Killion, A.K., Mindje, M., Mpakairi, K.S., Raymond, M., Matlombe,
317 D., Mbeya, D. & von Hase, A. (2023). Make global biodiversity information useful to
318 national decision-makers. *Nat Ecol Evol*, 7, 1953–1956.

319 Convention on Biological Diversity. (2022a). *Kunming-Montreal Global Biodiversity*
320 *Framework* (No. CBD/COP/15/L.25). Conference of the Parties to the Convention on
321 Biological Diversity, Montreal, Canada.

322 Convention on Biological Diversity. (2022b). *Monitoring framework for the Kunming-*
323 *Montreal Global Biodiversity Framework* (No. CBD/COP/DEC/15/5). Conference of
324 the Parties to the Convention on Biological Diversity, Montreal, Canada.

325 Convention on Biological Diversity. (2022c). *Decision adopted by the Conference of the*
326 *Parties to the Convention on Biological Diversity: 15/6. Mechanisms for planning,*
327 *monitoring, reporting and review* (No. CBD/COP/DEC/15/6). Conference of the
328 Parties to the Convention on Biological Diversity, Montreal, Canada.

329 Convention on Biological Diversity. (2026a). *Summary of key findings from regional and*
330 *subregional dialogues on biodiversity monitoring and reporting* (No.
331 CBD/SBI/6/INF/6). Subsidiary Body on Implementation Sixth Meeting, Rome, Italy.

332 Convention on Biological Diversity. (2026b). *Mechanisms for planning, monitoring, reporting*
333 *and review, including the global review of collective progress in the implementation of*
334 *the Kunming-Montreal Global Biodiversity Framework to be conducted at the*
335 *seventeenth and nineteenth meetings of the Conference of the Parties* (No.
336 CBD/COP/DEC/16/32). Conference of the Parties to the Convention on Biological
337 Diversity, Rome, Italy.

338 Dayaram, A., Harris, L.R., Grobler, B.A., Van Der Merwe, S., Rebelo, A.G., Ward Powrie, L.,
339 Vlok, J.H.J., Desmet, P.G., Qabaqaba, M., Hlahane, K.M. & Skowno, A.L. (2019).
340 Vegetation Map of South Africa, Lesotho and Swaziland 2018: A description of
341 changes since 2006. *Bothalia*, 49.

342 Delettre, O. (2021). Identity of ecological systems and the meaning of resilience. *Journal of*
343 *Ecology*, 109, 3147–3156.

344 Driver, A. & Botts, E.A. (2025). *Guidelines for classifying agricultural and plantation forestry*
345 *ecosystems in the IUCN Global Ecosystem Typology*. International Union for the
346 Conservation of Nature, Gland, Switzerland.

347 FAO. (2015). Global Administrative Unit Layers (GAUL).

348 Google Earth Engine Team. (2015). Google Earth Engine: A Planetary-scale geo-spatial
349 Analysis Platform.

350 Herzog, H., Bastani, F., Zhang, Y., Tseng, G., Redmon, J., Sablon, H., Park, R., Morrison, J.,
351 Buraczynski, A., Farley, K., Hansen, J., Howe, A., Johnson, P.A., Otterlee, M., Schmitt,
352 T., Pitelka, H., Daspit, S., Ratner, R., Wilhelm, C., Wood, S., Jacobi, M., Kerner, H.,
353 Shelhamer, E., Farhadi, A., Krishna, R. & Beukema, P. (2025). OlmoEarth: Stable
354 Latent Image Modeling for Multimodal Earth Observation.

355 Keith, D.A., Ferrer-Paris, J.R., Nicholson, E., Bishop, M.J., Polidoro, B.A., Ramirez-Llodra,
356 E., Tozer, M.G., Nel, J.L., Mac Nally, R., Gregr, E.J., Watermeyer, K.E., Essl, F.,
357 Faber-Langendoen, D., Franklin, J., Lehmann, C.E.R., Etter, A., Roux, D.J., Stark, J.S.,
358 Rowland, J.A., Brummitt, N.A., Fernandez-Arcaya, U.C., Suthers, I.M., Wiser, S.K.,
359 Donohue, I., Jackson, L.J., Pennington, R.T., Iliffe, T.M., Gerovasileiou, V., Giller, P.,
360 Robson, B.J., Pettorelli, N., Andrade, A., Lindgaard, A., Tahvanainen, T., Terauds, A.,
361 Chadwick, M.A., Murray, N.J., Moat, J., Plischoff, P., Zager, I. & Kingsford, R.T.
362 (2022). A function-based typology for Earth’s ecosystems. *Nature*, 610, 513–518.

363 Keith, D.A., Ferrer-Paris, J.R., Nicholson, E. & Kingsford, R.T. (eds.). (2020). *IUCN Global*
364 *Ecosystem Typology 2.0: descriptive profiles for biomes and ecosystem functional*
365 *groups*. IUCN, International Union for Conservation of Nature.

366 Kerner, H., Nakalembe, C., Yang, A., Zvonkov, I., McWeeny, R., Tseng, G. & Becker-Reshef,
367 I. (2024). How accurate are existing land cover maps for agriculture in Sub-Saharan
368 Africa? *Sci Data*, 11, 486.

369 Koenker, R. (2025). *quantreg: Quantile Regression*.

370 Mazur, E., Sims, M., Goldman, E., Schneider, M., Pirri, M.D., Beatty, C.R., Stolle, F. &
371 Stevenson, M. (2025). *SBTN Natural Lands Map v1.1: Technical Documentation*.

372 Science Based Targets for Land Version 1 - Supplementary Material. Science Based
373 Targets Network.

374 Meyer, H. & Pebesma, E. (2022). Machine learning-based global maps of ecological variables
375 and the challenge of assessing them. *Nat Commun*, 13, 2208.

376 Nicholson, E., Andrade, A., Brooks, T.M., Driver, A., Ferrer-Paris, J.R., Grantham, H., Gudka,
377 M., Keith, D.A., Kontula, T., Lindgaard, A., Londono-Murcia, M.C., Murray, N.,
378 Raunio, A., Rowland, J.A., Sievers, M., Skowno, A.L., Stevenson, S.L., Valderrabano,
379 M., Vernon, C.M., Zager, I. & Obura, D. (2024). Roles of the Red List of Ecosystems
380 in the Kunming-Montreal Global Biodiversity Framework. *Nat Ecol Evol*, 8, 614–621.

381 Nicholson, E., Watermeyer, K.E., Rowland, J.A., Sato, C.F., Stevenson, S.L., Andrade, A.,
382 Brooks, T.M., Burgess, N.D., Cheng, S.-T., Grantham, H.S., Hill, S.L., Keith, D.A.,
383 Maron, M., Metzke, D., Murray, N.J., Nelson, C.R., Obura, D., Plumptre, A., Skowno,
384 A.L. & Watson, J.E.M. (2021). Scientific foundations for an ecosystem goal,
385 milestones and indicators for the post-2020 global biodiversity framework. *Nat Ecol*
386 *Evol*, 5, 1338–1349.

387 Olofsson, P., Foody, G.M., Herold, M., Stehman, S.V., Woodcock, C.E. & Wulder, M.A.
388 (2014). Good practices for estimating area and assessing accuracy of land change.
389 *Remote Sensing of Environment*, 148, 42–57.

390 R Core Team. (2025). *R: A Language and Environment for Statistical Computing*. R
391 Foundation for Statistical Computing, Vienna, Austria.

392 SANBI & UNEP-WCMC. (2024). *Mapping biodiversity priorities: A practical approach to*
393 *spatial biodiversity assessment and prioritisation to inform national policy, planning,*
394 *decisions and action. Second edition*. South African National Biodiversity Institute,
395 Pretoria, South Africa.

396 Sayre, R., Karagulle, D., Frye, C., Boucher, T., Wolff, N.H., Breyer, S., Wright, D., Martin,
397 M., Butler, K., Van Graafeiland, K., Touval, J., Sotomayor, L., McGowan, J., Game,
398 E.T. & Possingham, H. (2020). An assessment of the representation of ecosystems in
399 global protected areas using new maps of World Climate Regions and World
400 Ecosystems. *Global Ecology and Conservation*, 21, e00860.

401 Sink, K.J., Adams, L.A., Franken, M.-L., Harris, L.R., Currie, J., Karenyi, N., Dayaram, A.,
402 Porter, S., Kirkman, S., Pfaff, M., Van Niekerk, L., Atkinson, L.J., Bernard, A.,
403 Bessinger, M., Cawthra, H., De Wet, W., Dunga, L., Filander, Z., Green, A., Herbert,
404 D., Holness, S., Lamberth, S., Livingstone, T., Lück-Vogel, M., Mackay, F., Makwela,
405 M., Palmer, R., Van Zyl, W. & Skowno, A. (2023). Iterative mapping of marine
406 ecosystems for spatial status assessment, prioritization, and decision support. *Front.*
407 *Ecol. Evol.*, 11, 1108118.

408 Theobald, D.M., Oakleaf, J.R., Moncrieff, G., Voigt, M., Kiesecker, J. & Kennedy, C.M.
409 (2025). Global extent and change in human modification of terrestrial ecosystems from
410 1990 to 2022. *Sci Data*, 12, 606.

411 Venter, O., Sanderson, E.W., Magrath, A., Allan, J.R., Beher, J., Jones, K.R., Possingham,
412 H.P., Laurance, W.F., Wood, P., Fekete, B.M., Levy, M.A. & Watson, J.E.M. (2016).
413 Sixteen years of change in the global terrestrial human footprint and implications for
414 biodiversity conservation. *Nat Commun*, 7, 12558.

415 Venter, Z.S., Barton, D.N., Chakraborty, T., Simensen, T. & Singh, G. (2022). Global 10 m
416 Land Use Land Cover Datasets: A Comparison of Dynamic World, World Cover and
417 Esri Land Cover. *Remote Sensing*, 14, 4101.

418 Watson, J.E.M., Keith, D.A., Strassburg, B.B.N., Venter, O., Williams, B. & Nicholson, E.
419 (2020). Set a global target for ecosystems. *Nature*, 578, 360–362.

420 Xiao, H., Driver, A., Etter, A., Keith, D.A., Obst, C., Traurig, M.J. & Nicholson, E. (2024).
421 Synergies and complementarities between ecosystem accounting and the Red List of
422 Ecosystems. *Nat Ecol Evol*, 8, 1794–1803.
423

424 **Supplementary Information**

425 **Supplementary Table S1:** Headline Indicator A.2 (Extent of Natural Ecosystems) for the 196
 426 Parties to the Convention on Biological Diversity from 7th National Reports and the SBTN
 427 Natural Lands Map. (ISO3 = International Organization for Standardization 3-letter country
 428 code; † Estimates for the European Union are based on aggregations of data from Member
 429 States – excluding overseas territories – and not separate geoprocessing, which may compound
 430 errors.)

No.	Country Name	ISO3	7 th National Report	SBTN	Total area (km ²)
1.	Afghanistan	AFG	-	0.855	642000
2.	Albania	ALB	0.691	0.592	28700
3.	Algeria	DZA	Submitted report, no indicator	0.952	2310000
4.	Andorra	AND	-	0.867	475
5.	Angola	AGO	-	0.928	1250000
6.	Antigua and Barbuda	ATG	-	0.530	453
7.	Argentina	ARG	-	0.802	2780000
8.	Armenia	ARM	Submitted report, no indicator	0.439	29600
9.	Australia	AUS	0.848	0.876	7690000
10.	Austria	AUT	0.650	0.413	84000
11.	Azerbaijan	AZE	-	0.195	165000
12.	Bahamas (The)	BHS	-	0.908	11900
13.	Bahrain	BHR	Submitted report, no indicator	0.532	673
14.	Bangladesh	BGD	0.216	0.214	140000
15.	Barbados	BRB	-	0.156	433
16.	Belarus	BLR	Submitted report, no indicator	0.287	208000
17.	Belgium	BEL	0.436	0.091	30700
18.	Belize	BLZ	-	0.748	21800
19.	Benin	BEN	Submitted report, no indicator	0.471	115000
20.	Bhutan	BTN	0.643	0.960	37700
21.	Bolivia (Plurinational State of)	BOL	Incomplete indicator	0.906	1080000
22.	Bosnia and Herzegovina	BIH	-	0.528	51100
23.	Botswana	BWA	-	0.960	578000
24.	Brazil	BRA	0.643	0.680	8490000
25.	Brunei Darussalam	BRN	Submitted report, no indicator	0.861	5900
26.	Bulgaria	BGR	-	0.368	111000
27.	Burkina Faso	BFA	Submitted report, no indicator	0.495	273000
28.	Burundi	BDI	Incomplete indicator	0.424	26900
29.	Cabo Verde	CPV	-	0.882	4060
30.	Cambodia	KHM	Submitted report, no indicator	0.493	181000
31.	Cameroon	CMR	Incomplete indicator	0.845	465000
32.	Canada	CAN	0.916	0.891	9870000
33.	Central African Republic	CAF	-	0.979	620000
34.	Chad	TCD	Incomplete indicator	0.905	1260000

35.	Chile	CHL	0.782	0.887	753000
36.	China	CHN	0.688	0.705	9350000
37.	Colombia	COL	0.682	0.732	1140000
38.	Comoros	COM	-	0.861	1650
39.	Congo	COG	Submitted report, no indicator	0.977	341000
40.	Cook Islands	COK	Submitted report, no indicator	0.257	242
41.	Costa Rica	CRI	Submitted report, no indicator	0.545	51000
42.	Côte d'Ivoire	CIV	Submitted report, no indicator	0.612	322000
43.	Croatia	HRV	-	0.479	56600
44.	Cuba	CUB	Incomplete indicator	0.557	111000
45.	Cyprus	CYP	Submitted report, no indicator	0.317	9250
46.	Czechia	CZE	Submitted report, no indicator	0.155	78800
47.	Democratic People's Republic of Korea	PRK	-	0.640	122000
48.	Democratic Republic of the Congo	COD	Submitted report, no indicator	0.914	2330000
49.	Denmark	DNK	-	0.052	44500
50.	Djibouti	DJI	-	0.991	21700
51.	Dominica	DMA	-	0.830	751
52.	Dominican Republic	DOM	Submitted report, no indicator	0.520	48100
53.	Ecuador	ECU	0.597	0.688	256000
54.	Egypt	EGY	-	0.943	982000
55.	El Salvador	SLV	0.302	0.435	20700
56.	Equatorial Guinea	GNQ	0.930	0.970	27000
57.	Eritrea	ERI	-	0.917	121000
58.	Estonia	EST	0.724	0.551	45400
59.	Eswatini	SWZ	0.607	0.517	17300
60.	Ethiopia	ETH	Submitted report, no indicator	0.714	1130000
61.	European Union†	EUE	0.455	0.334	4131987
62.	Fiji	FJI	-	0.694	18300
63.	Finland	FIN	0.897	0.703	337000
64.	France	FRA	0.348	0.224	549000
65.	Gabon	GAB	0.881	0.989	264000
66.	Gambia	GMB	Submitted report, no indicator	0.494	11200
67.	Georgia	GEO	-	0.649	69800
68.	Germany	DEU	Submitted report, no indicator	0.119	357000
69.	Ghana	GHA	0.576	0.603	239000
70.	Greece	GRC	Submitted report, no indicator	0.451	133000
71.	Grenada	GRD	-	0.677	319
72.	Guatemala	GTM	0.528	0.535	109000
73.	Guinea	GIN	Submitted report, no indicator	0.909	243000
74.	Guinea-Bissau	GNB	-	0.879	30700
75.	Guyana	GUY	Submitted report, no indicator	0.976	212000
76.	Haiti	HTI	-	0.452	27000
77.	Honduras	HND	0.946	0.653	112000
78.	Hungary	HUN	Submitted report, no indicator	0.165	93100
79.	Iceland	ISL	0.971	0.962	103000

80.	India	IND	Submitted report, no indicator	0.282	2960000
81.	Indonesia	IDN	Submitted report, no indicator	0.725	1890000
82.	Iran (Islamic Republic of)	IRN	-	0.750	1680000
83.	Iraq	IRQ	Incomplete indicator	0.688	436000
84.	Ireland	IRL	0.240	0.112	69800
85.	Israel	ISR	0.623	0.585	20700
86.	Italy	ITA	Submitted report, no indicator	0.312	302000
87.	Jamaica	JAM	-	0.638	11000
88.	Japan	JPN	Submitted report, no indicator	0.439	374000
89.	Jordan	JOR	Incomplete indicator	0.910	89100
90.	Kazakhstan	KAZ	Submitted report, no indicator	0.729	2840000
91.	Kenya	KEN	Incomplete indicator	0.797	582000
92.	Kiribati	KIR	-	0.612	1020
93.	Kuwait	KWT	-	0.908	17400
94.	Kyrgyzstan	KGZ	Submitted report, no indicator	0.869	199000
95.	Lao People's Democratic Republic	LAO	-	0.848	230000
96.	Latvia	LVA	-	0.457	64600
97.	Lebanon	LBN	-	0.563	10100
98.	Lesotho	LSO	0.800	0.718	30500
99.	Liberia	LBR	Submitted report, no indicator	0.960	96100
100.	Libya	LBY	-	0.981	1620000
101.	Liechtenstein	LIE	-	0.474	151
102.	Lithuania	LTU	-	0.271	64900
103.	Luxembourg	LUX	0.169	0.188	2620
104.	Madagascar	MDG	0.939	0.879	589000
105.	Malawi	MWI	0.530	0.533	119000
106.	Malaysia	MYS	Incomplete indicator	0.567	330000
107.	Maldives	MDV	-	0.792	226
108.	Mali	MLI	Incomplete indicator	0.864	1250000
109.	Malta	MLT	0.182	0.026	317
110.	Marshall Islands	MHL	Submitted report, no indicator	0.457	269
111.	Mauritania	MRT	-	0.990	1040000
112.	Mauritius	MUS	-	0.871	2020
113.	Mexico	MEX	0.747	0.769	1950000
114.	Micronesia (Federated States of)	FSM	Submitted report, no indicator	0.152	742
115.	Monaco	MCO	-	0.052	8.348947
116.	Mongolia	MNG	0.976	0.994	1560000
117.	Montenegro	MNE	-	0.672	13800
118.	Morocco	MAR	Incomplete indicator	0.717	414000
119.	Mozambique	MOZ	Submitted report, no indicator	0.823	787000
120.	Myanmar	MMR	-	0.709	667000
121.	Namibia	NAM	Submitted report, no indicator	0.977	824000
122.	Nauru	NRU	-	0.583	21.6
123.	Nepal	NPL	0.708	0.782	147000
124.	Netherlands (Kingdom of the)	NLD	0.257	0.076	35200

125.	New Zealand	NZL	0.788	0.637	270000
126.	Nicaragua	NIC	-	0.577	128000
127.	Niger	NER	Incomplete indicator	0.873	1180000
128.	Nigeria	NGA	0.779	0.370	909000
129.	Niue	NIU	-	0.117	264
130.	North Macedonia	MKD	-	0.571	25400
131.	Norway	NOR	0.948	0.870	324000
132.	Oman	OMN	Submitted report, no indicator	0.981	308000
133.	Pakistan	PAK	Incomplete indicator	0.659	788000
134.	Palau	PLW	Submitted report, no indicator	0.912	453
135.	Panama	PAN	Submitted report, no indicator	0.673	74900
136.	Papua New Guinea	PNG	-	0.957	462000
137.	Paraguay	PRY	Submitted report, no indicator	0.717	399000
138.	Peru	PER	0.905	0.891	1290000
139.	Philippines	PHL	0.527	0.497	296000
140.	Poland	POL	0.427	0.136	312000
141.	Portugal	PRT	-	0.248	88800
142.	Qatar	QAT	Submitted report, no indicator	0.870	11500
143.	Republic of Korea	KOR	Submitted report, no indicator	0.543	99100
144.	Republic of Moldova	MDA	0.135	0.076	33800
145.	Romania	ROU	-	0.321	238000
146.	Russian Federation	RUS	Submitted report, no indicator	0.859	17000000
147.	Rwanda	RWA	-	0.250	25400
148.	Saint Kitts and Nevis	KNA	-	0.550	262
149.	Saint Lucia	LCA	-	0.758	603
150.	Saint Vincent and the Grenadines	VCT	Submitted report, no indicator	0.733	427
151.	Samoa	WSM	Submitted report, no indicator	0.136	2840
152.	San Marino	SMR	-	0.054	60.3
153.	Sao Tome and Principe	STP	-	0.073	991
154.	Saudi Arabia	SAU	Submitted report, no indicator	0.969	1930000
155.	Senegal	SEN	0.698	0.714	196000
156.	Serbia	SRB	-	0.368	88500
157.	Seychelles	SYC	0.580	0.431	501
158.	Sierra Leone	SLE	Submitted report, no indicator	0.954	72300
159.	Singapore	SGP	0.045	0.261	595
160.	Slovakia	SVK	Submitted report, no indicator	0.387	49100
161.	Slovenia	SVN	-	0.489	20300
162.	Solomon Islands	SLB	-	0.866	28300
163.	Somalia	SOM	Submitted report, no indicator	0.951	633000
164.	South Africa	ZAF	0.794	0.836	1220000
165.	South Sudan	SSD	Submitted report, no indicator	0.971	630000
166.	Spain	ESP	0.445	0.277	506000
167.	Sri Lanka	LKA	Submitted report, no indicator	0.598	66200
168.	State of Palestine	PSE	-	0.071	441.7
169.	Sudan	SDN	0.943	0.842	1840000
170.	Suriname	SUR	0.945	0.986	145000

171.	Sweden	SWE	0.941	0.650	449000
172.	Switzerland	CHE	Submitted report, no indicator	0.528	41300
173.	Syrian Arab Republic	SYR	-	0.601	188000
174.	Tajikistan	TJK	-	0.873	142000
175.	Thailand	THA	Incomplete indicator	0.383	515000
176.	Timor-Leste	TLS	-	0.785	14900
177.	Togo	TGO	Submitted report, no indicator	0.496	56800
178.	Tonga	TON	-	0.165	699
179.	Trinidad and Tobago	TTO	-	0.761	5140
180.	Tunisia	TUN	0.692	0.635	155000
181.	Türkiye	TUR	Submitted report, no indicator	0.456	781000
182.	Turkmenistan	TKM	-	0.807	555000
183.	Tuvalu	TUV	-	0.325	46.7
184.	Uganda	UGA	Incomplete indicator	0.481	241000
185.	Ukraine	UKR	-	0.152	601000
186.	United Arab Emirates	ARE	Submitted report, no indicator	0.903	71200
187.	United Kingdom of Great Britain and Northern Ireland	GBR	0.240	0.200	244000
188.	United Republic of Tanzania	TZA	Incomplete indicator	0.676	940000
189.	Uruguay	URY	0.804	0.674	178000
190.	Uzbekistan	UZB	0.791	0.804	450000
191.	Vanuatu	VUT	0.740	0.910	12200
192.	Venezuela (Bolivarian Republic of)	VEN	Incomplete indicator	0.748	912000
193.	Viet Nam	VNM	-	0.515	328000
194.	Yemen	YEM	0.980	0.936	454000
195.	Zambia	ZMB	0.592	0.858	751000
196.	Zimbabwe	ZWE	Incomplete indicator	0.668	391000