SDG indicator metadata

(Harmonized metadata template - format version 1.1)

0. Indicator information (SDG_INDICATOR_INFO)

0.a. Goal (SDG_GOAL)

Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

0.b. Target (SDG_TARGET)

Target 15.4: By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development

0.c. Indicator (SDG_INDICATOR)

Indicator 15.4.2: (a) Mountain Green Cover Index and (b) proportion of degraded mountain land

0.d. Series (SDG_SERIES_DESCR)

Primary series:

ER_MTN_DGRDP - Proportion of degraded mountain land (%) [15.4.2]

ER_MTN_GRNCVI - Mountain Green Cover Index [15.4.2]

Supplementary series:

ER_MTN_GRNCOV - Mountain green cover area (square kilometres) [15.4.2]

ER_MTN_TOTL - Mountain area (square kilometres) [15.4.2]

ER_MTN_DGRDA - Area of degraded mountain land (square kilometres) [15.4.2]

0.e. Metadata update (META_LAST_UPDATE)

2025-04-23

0.f. Related indicators (SDG_RELATED_INDICATORS)

6.6.1, 15.1.1, 15.2.1, 15.3.1, 15.4.1

0.g. International organisations(s) responsible for global monitoring (SDG_CUSTODIAN_AGENCIES)

Food and Agriculture Organization of the United Nations (FAO)

1. Data reporter (CONTACT)

1.a. Organisation (CONTACT_ORGANISATION)

Food and Agriculture Organization of the United Nations (FAO)

2. Definition, concepts, and classifications (IND_DEF_CON_CLASS)

2.a. Definition and concepts (STAT_CONC_DEF)

Definitions:

The indicator is composed of two sub-indicators to monitor progress towards the conservation of mountain ecosystems:

Sub-indicator 15.4.2a, Mountain Green Cover Index (MGCI), is designed to measure the extent and changes of green cover - i.e. forest, shrubs, trees, pasture land, cropland, etc. – in mountain areas. MGCI is defined as the percentage of green cover over the total surface of the mountain area of a given country and for given reporting year. The aim of the index is to monitor the evolution of green cover and thus assess the status of conservation of mountain ecosystems.

Sub-indicator 15.4.2b, Proportion of degraded mountain land, is designed to monitor the extent of degraded mountain land as a result of land cover change in a given country and for given reporting year. Similarly to sub-indicator ''trends in land cover" under SDG Indicator 15.3.1 (Sims *et al.* 2021), mountain ecosystem degradation and recovery is assessed based on the definition of land cover type transitions that indicate improving, stable or degrading conservation status. The definition of degradation adopted for the computation of this indicator is the one established Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)[1].

Concepts:

Mountain area is defined according to the UNEP-WCMC (2002) method. It defines total global mountain area as the sum of seven classes (commonly known as 'Kapos mountain classes'), based on elevation, slope and local elevation ranges (Table 1).

Table 1. Global mountain classes as defined by UNEP-WCMC (2002)

Kapos Mountain Class	Description
Class 1	Elevation >= 4500 meters
Class 2	Elevation >= 3500 & < 4500 meters
Class 3	Elevation >= 2500 & < 3500 meters
Class 4	Elevation >= 1500 & < 2500 meters & slope >= 2 degrees
Class 5	Elevation>= 1000 & < 1500 meters & slope >= 5 degrees OR local (7 km radius) elevation range > 300 meters
Class 6	Elevation >= 300 & < 1000 meters & local (7 km radius) elevation range > 300 meters
Class 7	Inner isolated areas (<=25 Km^2 in size) that do not meet criteria but surrounded by mountains

Prior to the methodological refinement of this indicator approved by the Inter-agency and Expert Group on SDG Indicators (IAEG-SDG) in June 2022, the UNEP-WCMC classification was used to disaggregate the indicator by Kapos mountain classes. This is no longer the case, with Kapos mountain classes having been replaced by bioclimatic belts (see section 2.c below).

Land cover refers to the observed physical cover of the Earth's surface. It includes vegetation and man-made features as well as bare rock, bare soil and inland water surfaces (FAO-GTOS, 2009). The primary units for characterizing land cover are categories (e.g. Forest or Open Water). These categories must be defined following a standardized land cover classification in order to identify land cover changes consistently over time. Several global standards of land cover classifications have been developed by international initiatives for this purpose.

[1] IPBES defines land degradation as "the many human-caused processes that drive the decline or loss in biodiversity, ecosystem functions or ecosystem services in any terrestrial and associated aquatic ecosystems" (IPBES, 2018)

For the purposes of standardization and harmonization when reporting on SDG Indicator 15.4.2, this indicator has adapted the land cover classification established by the United Nations Statistical Commission's System of Environmental and Economic Accounting (UN-SEEA) (UN Statistical Division, 2014) by selecting the most relevant SEEA classes for mountain ecosystems and aggregating all croplands classes (Table 2).

Table 2. Left: Land cover classification established by the UN-SEEA (Source: UN Statistical Division, 2014). Right: Adapted land cover classification for the computation and aggregate reporting on SDG Indicator 15.4.2.

Original UN – SEEA land cover classification (n=14)	SDG Indicator 15.4.2 land cover classification (n=10)
1 Artificial surfaces	1 Artificial surfaces
2 Herbaceous crops	2 Croplands
3 Woody crops	
4 Multiple or layered crops	
5 Grassland	3 Grasslands
6 Tree-covered areas	4 Tree-covered areas
7 Mangroves	Discarded. Not relevant for mountains
8 Shrub-covered areas	5 Shrub-covered areas
9 Shrubs and/or herbaceous vegetation, aquatic or regularly flooded	6 Shrubs and/or herbaceous vegetation, aquatic or regularly flooded
10 Sparsely natural vegetated areas	7 Sparsely natural vegetated areas
11 Terrestrial barren land	8 Terrestrial barren land
12 Permanent snow and glaciers	9 Permanent snow and glaciers
13 Inland water bodies	10 Inland water bodies
14 Coastal water bodies and intertidal areas	Discarded. Not relevant for mountains

Land cover serves different functions for SDG Indicator 15.4.2:

In sub-indicator 15.4.2a, land cover is used to categorize land into green and non-green cover areas. As showed in Table 3, green cover includes areas covered by both natural vegetation and vegetation resulting from anthropic activity. Non-green areas include non-vegetated areas such as bare land, water, permanent ice/snow, urban areas and sparsely vegetated areas. In addition, land cover is used to disaggregate the indicator into the 10 land cover classes included in Table 2, thus increasing the indicator's policy relevance.

Table 3. Classification of SEEA land cover classes into green and non-green cover.

SEEA land cover classes	Green/Non-green
Croplands	Green
Grasslands	Green
Tree-covered areas	Green
Shrub-covered areas	Green
Shrubs and/or herbaceous vegetation, aquatic or regularly flooded	Green
Artificial surfaces	Non-green
Sparsely natural vegetated areas	Non-green
Terrestrial barren land	Non-green
Permanent snow and glaciers	Non-green
Inland water bodies	Non-green

In sub-indicator 15.4.2b, land cover is used to identify areas where changes in the type of land cover (land cover transitions) may indicate a decline or loss of biodiversity, mountain ecosystem functions or services that are considered desirable in a local or national context. A transition that indicates a decline or loss of biodiversity and mountain ecosystem services of the land is considered degradation. The definition of land cover transitions is documented in a transition matrix that specifies the land cover changes occurring in a given land unit (pixel) as being either degradation, improvement or neutral transitions.

2.b. Unit of measure (UNIT_MEASURE)

Both sub-indicators are expressed as proportions (percent) and area (KM2).

2.c. Classifications (CLASS_SYSTEM)

This indicator uses two established classifications: (1) the simplified UN-SEEA land cover classification included in Table 2, and (2) the mountain bioclimatic belt classification established by Körner *et al.* (2011). The latter is used for data disaggregation only.

Körner *et al.* (2011) subdivides mountains vertically into seven bioclimatic belts based on average temperatures, therefore accounting for the latitudinal change in elevation of thermally similar areas in the world's mountains. For the purposes of this indicator, these seven bioclimatic belts are aggregated into four (Nival, Alpine, Montane and Remaining Mountain Areas), as illustrated in Table 4.

Table 4. Mountain bioclimatic belts as defined by Körner *et al.* (2011) and reclassification for data disaggregation of SDG Indicator 15.4.2. Growing season is defined as the number of days between daily mean temperature exceeds 0.9 °C then falls below 0.9 °C

Bioclimatic belts	Growing season mean temperature	Growing season length	Bioclimatic belts adopted for SDG Indicator 15.4.2
Nival	< 3.5 °C	< 10 days	Nival
Upper alpine	< 3.5 °C	> 10 days & < 54 days	Alpine
Lower alpine	< 6.4°C	< 54 days	
THE TREELINE			
Upper montane	> 6.4°C & ≤ 10 °C	---	Montane
Lower montane	> 10 °C & ≤ 15 °C	---	
Remaining mountain area with frost	> 15 °C	---	Remaining mountain areas
Remaining mountain area without frost	> 15 °C		

3. Data source type and data collection method (SRC_TYPE_COLL_METHOD)

3.a. Data sources (SOURCE_TYPE)

Land cover maps developed by appropriate national authorities generally provide the most relevant data source to compute this indicator. However, in certain cases, such data may not be available. In those cases, various regional or global products provide a viable alternative.

The default sources of land cover data for this indicator are the CORINE Land Cover (CLC) product for all countries and territories covered by this dataset[2], the Global 2000-2020 Land Cover and Land Use Change Dataset (GLCLUC2020) (Potapov *et al.* 2022) for countries and territories not covered by CORINE, and the European Space Agency Climate Change Initiative (ESA-CCI) Land Cover product (ESA, 2017) for small island countries and territories not covered by any of the above products. The selection of the land cover product used for each country and territory was based on the following criteria: temporal coverage (at least from 2000 onwards), reported accuracy (products with higher reported accuracies were preferred as values derived from those products are expected to be closer to true land cover condition), spatial resolution and minimum mapping unit (higher resolution was preferred to allow capturing finer scale land cover changes), thematic resolution (higher thematic coverage was preferred to allow capturing finer detailed land cover changes) and future continuity of the product (regular updates and improvements of the products are expected or already underway). Table 5 includes a summary of the key characteristics of each of the above-mentioned land cover data sources.

Table 5. Summary of the key characteristics of each of the 3 land cover data sources used to estimate global default values.

Product	Measurement method	Geographical coverage	Spatial resolution	Thematic resolution	Temporal coverage	Reported accuracy	Link
ESA-CCI-LC	Based on AVHRR, SPOT, PROBA-V and Sentinel-3 satellite imagery	Global	300 m	22 classes	Every year from 1992 to 2022	Aprox. 73%	http://maps.elie.ucl.ac.be/CCI/viewer/index.php
GLCLUC 2020	Based on Landsat 5, 7, and 8 imagery.	Global (except small islands, Arctic islands and Greenland).	30 m	13 classes	2000, 2005, 2010, 2015, and 2020	Above 85%	https://glad.umd.edu/dataset/GLCLUC2020
CORINE LC	Based on Landsat 5, 7, 8, SPOT 4/5, IRS P6, and Sentinel 2.	EEA38 and the UK	100 m	44 classes	1990, 2000, 2006, 2012, and 2018	Above 85%	https://land.copernicus.eu/pan-european/corine-land-cover

A global mountain area map sub-divided by bioclimatic belts has been developed by FAO and made available to national authorities to facilitate the compute this indicator[3]. This map is the result of combining a global mountain area map developed from the Global Multi-Resolution Terrain Elevation Data (GMTED2010), following the UNEP-WCMC methodology (Ravilious *et al.* 2021) and a mountain bioclimatic belt map created by the Global Mountain Biodiversity Assessment[4].

3.b. Data collection method (COLL_METHOD)

Data on both sub-indicators are provided by National Statistics Office (NSO) SDG focal points to the FAO following a standard format every three years. This includes the original data and reference sources, and descriptions of how these have been used to derive sub-indicators values.

In addition, global estimates of both sub-indicators for all countries and territories having mountain areas are computed by FAO using the above-mentioned land cover data sources when national official data do not exist or are incomplete. In such cases, FAO shares country figures with NSO SDG focal points for their validation before publication, in accordance to the IAEG-SDG guidelines of Global Data Flows and Reporting.

[2] European Environment Agency member and cooperating countries (EEA38) and the United Kingdom of Great Britain and Northern Ireland.
[3] Available at: https://mgci-docs.readthedocs.io/en/latest/annexes/annex4.html
[4] https://ilias.unibe.ch/goto.php?target=file_2171234

These figures are calculated through a Python code in a SEPAL[5] environment. Copies of this code are openly available in a GitHub repository and executable in Google Colab for transparency and reproducibility purposes.[6]

3.c. Data collection calendar (FREQ_COLL)

SDG indicator 15.4.2 is updated every three years.

3.d. Data release calendar (REL_CAL_POLICY)

March of every year, in line with the annual SDG reporting cycle.

3.e. Data providers (DATA_SOURCE)

NSO SDG focal points provide reports that include values for both sub-indicators, including the original data and reference sources, and descriptions of how these have been used to derive sub-indicators values. FAO provide country-specific values for both sub-indicators when national official data do not exist or are incomplete, in consultation with concerned countries

3.f. Data compilers (COMPILING_ORG)

Food and Agriculture Organization of the United Nations (FAO)

3.g. Institutional mandate (INST_MANDATE)

Article 1 of FAO's constitution specifies that "The Organization shall collect, analyse, interpret, and disseminate information related to nutrition, food and agriculture." In this regard, FAO collects national level data from member countries, which it then standardizes and disseminates through corporate statistical databases. FAO is the custodian UN agency for 21 SDG indicators, including 15.4.2.

4. Other methodological considerations (OTHER_METHOD)

4.a. Rationale (RATIONALE)

Mountain ecosystems are important biodiversity centres that provide valuable ecosystem services to upstream and downstream areas. Yet, mountains are very fragile and impacted easily by both natural and anthropogenic factors. These can include climate change, unplanned agricultural expansion, unplanned urbanization, timber extraction, recreational activities and natural hazards such as landslides and flooding. The degradation of mountain ecosystems such as loss of the glacial cover, mountain biodiversity and green cover will affect the ability of the ecosystem to supply water downstream. The loss of forest and vegetative cover will reduce the ability of the ecosystem to retain soil and prevent landslides and flooding downstream.

Therefore, monitoring mountain vegetation changes and its estimated impact in terms of ecosystem degradation and recovery provides information on the status of mountain ecosystems. Assessing the changes in land cover differentiated by bioclimatic belts is important in understanding the role that

[5] https://openforis.org/solutions/sepal/

[6] **Sub-Indicator A:** https://github.com/sepal-contrib/sepal_mgci/blob/main/Colab_SDG_15_4_2_Sub_A_Default_values.ipynb
Sub-Indicator B: https://github.com/sepal-contrib/sepal_mgci/blob/main/Colab_SDG_15_4_2_Sub_B_Default_values.ipynb

environmental factors, such as climate, play in explaining variations of mountain green cover across regions and helps to better interpret the direction of those changes.

4.b. Comment and limitations (REC_USE_LIM)

The indicator can be calculated using freely available Earth Observation data and simple Geographic Information Science (GIS) operations that can be processed in free and open source software (FOSS) GIS. Regional and global land cover data derived from Earth observation can play an important role in the absence of, to complement, or to enhance national official data sources. These datasets can help validate and improve national statistics for greater accuracy by ensuring that the data

Recognizing that this indicator cannot fully capture the complexity of mountain ecosystems across the world, countries are strongly encouraged to use other relevant national or sub-national indicators, data and information to strengthen their interpretation, as well as taking into account the following limitations:

- Sub-indicator ''a'' should be interpreted with care given that: 1) lack of green cover does not necessarily mean that a particular mountain area is degraded (i.e. areas of permanent snow and ice, scree slopes and natural sparsely vegetated areas above the tree line, 2) it does not capture significant drivers of change such as conversion of natural areas to cropland or pastureland, and 3) increase in green cover may due to impacts of climate change in mountain areas (i.e. increase in green cover due to snow and glacier retreat due to global warming).

- Because land cover refers to the naturally stable aspects of land and the structure of its key elements, transient aspects such as vegetation phenology, snow or flooding cannot be captured by land cover transitions as measured in sub-indicator 15.4.2b. In the context of SDG Target 15.4, this is particularly relevant for snow cover dynamics (snow cover duration within a year), which has been highlighted as a key impact of global warming in mountain ecosystems with direct impacts to water provision (Notarnicola, 2020).

- Decisions about which land cover transitions are linked to degradation processes would sometimes require information on the use of land, not only land cover. For example, the conversion of tree-covered areas to grassland may be a result of deforestation (change in land cover and land use) or just the result of certain management practices and natural disturbance (change in land cover only). The former could be identified as a negative transition, while the latter could be considered as stable or unchanging. The use of land use information would help to better characterize those changes in the context of sub-indicator "b''.

- Both sub-indicators are not able to capture ecosystem degradation drivers that do not necessarily result in changes in land cover. Some examples of this include conversions of natural forests to intensively managed production systems such as plantation forests, orchards and oil palm plantations; conversion of natural and semi-natural grasslands to intensively used pastures, forest and grassland degradation or invasive species invasion, among others. However, the use of more detailed national land use maps may be able to overcome some of these gaps for sub-indicator 15.4.2b.

- While access to remote sensing imagery has improved dramatically in recent years, there is still a need for essential historical time series that is currently only available at coarse to medium resolution. Therefore, if countries have national land cover maps of higher spatial resolution and comparable or

better quality, FAO advises using them, following the same methodology presented here, for the generation of the indicator's values.

- Area estimations based on remote-sensing-derived land cover maps such as the ESA-CCI product via pixel counting may lead to biased area estimates due to map errors (Olofsson *et al.* 2014). Countries are encouraged to further refine those estimates by comparing them against reference datasets and applying bias corrections.

4.c. Method of computation (DATA_COMP)

Sub-indicator 15.4.2a, Mountain Green Cover Index, is defined as:

$$MGCI = \frac{Mountain\ Green\ Cover\ Area_n}{Total\ Mountain\ Area} \times 100$$

Where:

- *Mountain Green Cover Area*$_n$ = Sum of areas (in km^2) covered by (1) tree-covered areas, (2) croplands, (3) grasslands, (4) shrub-covered areas and (5) shrubs and/or herbaceous vegetation, aquatic or regularly flooded classes in the reporting period *n.*
- *Total mountain area* = Total area of mountains (in km^2). In both the numerator and denominator, mountain area is defined according to UNEP-WCMC (2002).

Sub-indicator 15.4.2b, Proportion of degraded mountain area, is reported as a binary quantification (degraded/non-degraded) of the extent of degraded land over total mountain area, given by:

$$Proportion\ of\ degraded\ mountain\ area = \frac{Degraded\ mountain\ area\ n}{Total\ mountain\ area} \times 100$$

Where:

- *Degraded mountain area*$_n$ = Total degraded mountain area (in km^2) in the reporting period *n.* This is, the sum of the areas where land cover change is considered to constitute degradation from the baseline period. Land cover changes that constitute degradation (as well as improvement and neutral transitions) are defined through a land cover change matrix. The generic land cover change matrix used to produce the FAO global default estimates is included in Annex 1. *Total mountain area* = Total area of mountains (in km^2). In both the numerator and denominator, mountain area is defined according to UNEP-WCMC (2002).

If the country/region has no mountain area, it is assigned the value NA.

4.d. Validation (DATA_VALIDATION)

Once received, national reported indicator values undergo a review process by FAO to ensure the correct use of definitions and methodology as well as internal consistency.

For those countries that have not submitted national indicator values, FAO will provide the NSO SDG focal points with national estimates derived from available global or regional data sources for review and validation.

4.e. Adjustments (ADJUSTMENT)

Not applicable

4.f. Treatment of missing values (i) at country level and (ii) at regional level (IMPUTATION)

- **At country level**

For countries where data is not available or incomplete, FAO will provide default estimates derived from global or regional data sources that would then be validated by national focal points.

- **At regional and global levels**

Not applicable, as the indicator has a universal coverage.

4.g. Regional aggregations (REG_AGG)

The indicator is aggregated to the regional and global level by, in the case of sub-indicator 15.4.2a, summing the spatial extent of green cover and total mountain area, and in the case of 15.4.2b, summing the spatial extent of degraded over total mountain area for all countries and territories reporting in a specific region or globally.

4.h. Methods and guidance available to countries for the compilation of the data at the national level (DOC_METHOD)

Detailed guidance and computation tools to support countries to compute the indicator and report its values using standardised reporting tables is available online at https://mgci-docs.readthedocs.io/en/latest/.

4.i. Quality management (QUALITY_MGMNT)

FAO is responsible for the quality of the internal statistical processes used to compile the published datasets. The FAO Statistics Quality Assurance Framework (SQAF), available at: http://www.fao.org/docrep/019/i3664e/i3664e.pdf, provides the necessary principles, guidelines and tools to carry out quality assessments. FAO is performing an internal bi-annual survey (FAO Quality Assessment and Planning Survey) designed to gather information on all of FAO's statistical activities, notably to assess the extent to which quality standards are being implemented with a view to increasing compliance with the quality dimensions of SQAF, documenting best practices and prepare quality improvement plans, where necessary. Domain-specific quality assurance activities are carried out systematically (e.g. quality reviews, self-assessments, compliance monitoring).

4.j Quality assurance (QUALITY_ASSURE)

Date reported by countries to FAO are subject to a rigorous review process to ensure correct use of definitions and methodology as well as internal consistency. A comparison is made with past assessments and other existing data sources. Regular contacts between national correspondents and FAO staff by e-mail form part of this review process.

4.k Quality assessment (QUALITY_ASSMNT)

Quality of statistics produced and disseminated by the FAO is evaluated in terms of fitness for use i.e. the degree to which statistics meet the user's requirements. The quality dimensions assessed are: Relevance; Accuracy and Reliability; Timeliness and Punctuality; Coherence and Comparability; Accessibility and Clarity. Quality dimensions definitions are provided in the FAO Statistical Quality Assurance Framework (SQAF), which provides the definition of quality and describes quality principles for statistical outputs; statistical processes; institutional environment (http://www.fao.org/docrep/019/i3664e/i3664e.pdf). The SQAF is based on the Fundamental Principles of Official Statistics and the Principles Governing International Statistical Activities (CCSA). Adherence to these principles ensures the quality of FAO statistical production processes and of statistical outputs. Regular quality assessments are conducted through the FAO Quality Assessment and Planning Survey (QAPS), a bi-annual survey designed to gather information on all of FAO's statistical activities, which is used to assess the extent to which quality standards are being met with a view to increasing compliance with the SQAF, and to document best practices and provide guidance for improvement where necessary.

5. Data availability and disaggregation (COVERAGE)

Data availability:
The indicator is generated by geospatial data and therefore has almost universal coverage. Countries or territories with no values on the global SDG database are either A) countries or territories with no mountains where the indicator is not applicable (indicated as NA), B) countries or territories that have not validated FAO's estimates and yet have not provided figures of their own, or C) countries or territories where available land cover data is deemed inadequate for the purposes of this indicator (at the time of writing this is the case of Greenland and some small island archipelagos close to the North and South Poles).

Time series:
Country, regional and global figures are available since the year 2000.

For sub-indicator 15.4.2a, data is available for the years 2000, 2005, 2010, 2015 and 2018, and subsequently every three years.

For sub-indicator 15.4.2b, data is available for the reporting period 2000-2015 (baseline), 2018, and subsequently every three years.

Disaggregation:
In the global SDG database, both sub-indicators are disaggregated by mountain bioclimatic belt as defined by Körner *et al.* (2011) (see section 2c. Classifications). In addition, sub-indicator 15.4.2a is disaggregated by the 10 SEEA classes included in Table 2. Those values are reported both as proportions (percent) and area (in square kilometres).

6. Comparability / deviation from international standards (COMPARABILITY)

Sources of discrepancies:

The global default sources of land cover data for this indicator have varying reported accuracies. The CORINE and the GLCLUC2020 land cover products have overall reported accuracies of $\geqslant$ 85%. The ESA-CCI

Land Cover product has an overall accuracy of 73.2%. However, these accuracy estimates were calculated using the original land cover legends of these products. As the methodology presented here is based on use of aggregate classes, the accuracy can be expected to be higher. The accuracy of the global land cover products can vary regionally and by land cover type. For the same reason, the presented indicator values may differ from those derived using national land cover maps.

The reporting format help to ensure that countries provide references for national data sources used, associated definitions and terminology as well as more detailed analysis of the data based on more detailed land cover classifications.

7. References and Documentation (OTHER_DOC)

ESA (2017) Land Cover CCI Product User Guide Version 2. Tech. Rep. Available at: maps.elie.ucl.ac.be/CCI/viewer/download/ESACCI-LC-Ph2-PUGv2_2.0.pdf

FAO-GTOS. (2009). *Land Cover: Assessment of the status of the development of the standards for the Terrestrial Essential Climate Variables*. Global Terrestrial Observing System, Rome.

IPBES (2018): *Summary for policymakers of the assessment report on land degradation and restoration of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. R. Scholes, L. Montanarella, A. Brainich, N. Barger, B. ten Brink, M. Cantele, B. Erasmus, J. Fisher, T. Gardner, T. G. Holland, F. Kohler, J. S. Kotiaho, G. Von Maltitz, G. Nangendo, R. Pandit, J. Parrotta, M. D. Potts, S. Prince, M. Sankaran and L. Willemen (eds.). IPBES secretariat, Bonn, Germany. 44 pages

Körner, C., Paulsen, J., & Spehn, E. (2011). A definition of mountains and their bioclimatic belts for global comparisons of biodiversity data. *Alpine Botany, 121*, 73-78.

Notarnicola, C. (2020) Hotspots of snow cover changes in global mountain regions over 2000-2018. *Remote Sensing of Environment* 243, 111781.

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

Potapov, P., Hansen, MC., Pickens, A., Hernandez-Serna, A., Tyukavina, A., Turubanova, S., Zalles, V., Li, X., Khan, A., Stolle, F., Harris, N., Song, X-P., Baggett, A., Kommareddy, I., and Kommareddy, A. (2022) The Global 2000-2020 Land Cover and Land Use Change Dataset Derived From the Landsat Archive: First Results. *Frontiers in Remote Sensing* 3: 856903. doi: 10.3389/frsen.2022.856903.

Ravilious, C., Tshwene-Mauchaza, B. and Kapos, V. (2021). *Validation and implementation of the Kapos Mountain Classification: Assessing the impact of DEM resolution on the mapping of mountain classes following the Kapos methodology*. UNEP-WCMC, Cambridge, UK.

Santoro, M., Kirches, G., Wevers, J., Boettcher, M., Brockmann, C., Lamarche, C., . . . Defourny, P. (2015). *Land Cover CCI PRODUCT USER GUIDE VERSION 2.0.* European Spatial Agency. European Spatial Agency. Retrieved from http://maps.elie.ucl.ac.be/CCI/viewer/download/ESACCI-LC-Ph2-PUGv2_2.0.pdf

Sims, N.C., Newnham, G.J., England, J.R., Guerschman, J., Cox, S.J.D., Roxburgh, S.H., Viscarra Rossel, R.A., Fritz, S. and Wheeler, I. (2021). *Good Practice Guidance. SDG Indicator 15.3.1, Proportion of Land That Is*

Degraded Over Total Land Area. Version 2.0. United Nations Convention to Combat Desertification, Bonn, Germany

UN Statistical Division (2014). *System of Environmental Economic Accounting 2012 — Central Framework.* New York, USA.

UNEP-WCMC (2002). *Mountain Watch: Environmental change and sustainable development in mountains.* Cambridge, UK

Annex 1. Generic land cover change matrix used to produce the FAO global default estimates for Sub-indicator 15.4.2b). Land cover change processes are colour coded as improvement (green), stable (yellow) or degradation (red).

	FINAL CLASS									
	Artificial surfaces	**Cropland**	**Grassland**	**Tree-covered areas**	**Shrub-covered areas**	**Wetland**	**Sparsely vegetated areas**	**Barren land**	**Permanent snow & glaciers**	**Water bodies**
ORIGINAL CLASS										
Artificial Surfaces	S	I	I	I	I	I	I	I	I	I
Cropland	D	S	I	I	I	I	D	D	I	S
Grassland	D	D	S	I	I	I	D	D	I	S
Tree-covered areas	D	D	D	S	D	D	D	D	I	S
Shrub-covered areas	D	D	D	I	S	D	D	D	I	S
Wetlands	D	D	D	D	D	S	D	D	I	S
Sparsely vegetated areas	D	D	I	I	I	I	S	D	I	S
Barren land	D	I	I	I	I	I	I	S	I	S
Permanent snow & glaciers	D	D	D	D	D	D	D	D	S	D
Water bodies	D	D	D	D	D	D	D	D	I	S