15.1.1 Forest area as a proportion of total land area

Compiled by Statistics Portugal with the contributions of:
Austria (NSI) | Czech Republic (NMCA) | EEA
Germany (BKG) | Italy (e-GEOS) | Serbia (NSI)

December 2021
A. INDICATOR CALCULATION AND DISCUSSION

1. DEFINITION

This indicator is used to monitor the progress towards SDG 15 on protecting, restoring, and promoting sustainable use of land. This includes targeting the conservation, restoration and sustainable use and management of forests, combat desertification, and halt and reverse land degradation and biodiversity loss.

At global level, the indicator is defined as the proportion of forest area of the total land area of a country. It follows FAO’s definition regarding the following two components:

   i) Forest area: includes “land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use.”

   ii) Land area: corresponds to the country area excluding area under inland waters (natural or artificial water courses) and coastal waters (comprising internal water, territorial sea, and archipelagic waters).

The indicator corresponds to a tier I level indicator, meaning that it is conceptually clear, it has an internationally established methodology and standards are available.

The indicator is provided at national level, with no further disaggregation being required at global level. Monitoring of the indicator is dependent in the data release calendar, which is set to be at five-year intervals. FAO is the UN custodian agency for this indicator and collects national level data from member countries, proceeding to its standardization and dissemination.

2. METHODOLOGY

This indicator is the result of the percentage relation between forest area and total land area. It therefore requires the existence of information for the two components of this proportion according to a common definition. For international comparability it requires data sources based on harmonised classifications and reliable methodologies.

This indicator is calculated based on the following formula and is expressed as a percent (%):

\[
\frac{\text{Forest area (reference year)}}{\text{Land area (reference year)}} \times 100
\]

At the global level, the methodology relies on country reporting following a questionnaire-standardized format, as described below:

Forest area:
FAO has been collecting and analysing data on forest area, as part of the Global Forest Resources Assessment (FRA) since the late 40’s and the collection frequency has been every five years since 2000. The FRA is based on two primary sources of data: country reports prepared by national correspondents and remote sensing analysis that is conducted by FAO together with national focal points and regional partners. FRA collects country data following a standard format. It includes the original data and reference sources and descriptions of how these have been used to estimate the forest area for different points in time. Detailed methodology and guidance on how to prepare the country reports and to convert national data according to national categories and definitions to FAO’s global categories and definitions can be found in FRA 2020 Guidelines and Specifications.
3. DATA SOURCES

The sources of information available for the calculation of this indicator may differ in terms of their geographical or statistical basis and their scope (pan-European, EU-wide, and national). The following tables present a systematisation of the data sources available, taking into account this segmentation. Nevertheless, it is important, however, to have in mind that when adopting different geospatial layers, land cover maps or Forest Inventories, definitions in terms of forest area may not exactly fit with underlying FAO definition for this SDG indicator.

<table>
<thead>
<tr>
<th>Name</th>
<th>Source</th>
<th>Periods of reference available</th>
<th>Frequency</th>
<th>Spatial Resolution</th>
<th>MMU</th>
<th>INSPIRE Data Theme</th>
<th>Core Data Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESA-CCI Land Cover</td>
<td>MR Satellite</td>
<td>1992 - 2015</td>
<td>1 year</td>
<td>300 m</td>
<td>9 ha</td>
<td>Land cover</td>
<td>Land cover</td>
</tr>
<tr>
<td>Copernicus Global Land Cover</td>
<td>MR Satellite</td>
<td>2015 - Today</td>
<td>1 year</td>
<td>100 m</td>
<td>1 ha</td>
<td>Land cover</td>
<td>Land cover</td>
</tr>
</tbody>
</table>

The Land Cover generated by European Space Agency (ESA) in support to the Climate Change Initiative is based on automatic workflows for the generation of land cover with a resolution of down to 30 meters and a land cover map on a worldwide basis is generated annually from which geospatial layers related to forestry areas can be extracted.

The Copernicus Global Land Cover Map are global annual maps, since 2015, and include a discrete classification with 23 classes, following UN-FAO’s Land Cover Classification System (LCCS) and related surface area statistics (km²) per level 0 and 1 administrative area as defined in UN-FAO Global Administrative Unit Layer.
In the framework of Copernicus Pan-European High-Resolution Layers, geospatial data layers are available at the EU level, allowing the whole computation of the indicator. The Forest Type geospatial layer allows to get as close as possible to the FAO forest definition, with a Minimum Mapping Unit (MMU) of 0.5 ha, as well as a 10% tree cover density threshold applied. For the final 100 m product trees under agricultural use and urban context from the support layer are removed, in line with the FAO forest definition. The Water and Wetness geospatial layer provides a detailed measure of inland waters (to be subtracted to total land area for indicator computation).

The CORINE Land Cover (CLC) consists of an inventory of land cover in 44 classes at EU level. It is a ready-to-use product, and it provides a strategy for the identification of inland waters. It uses a Minimum Mapping Unit (MMU) of 25 hectares (ha), which can be considered as relatively coarse for the purpose of this indicator.
15.1.1 | Forest area as a proportion of total land area

### Table 3 Geospatial National Data Sources

<table>
<thead>
<tr>
<th>Name</th>
<th>Source</th>
<th>Periods of reference available</th>
<th>Frequency</th>
<th>Spatial Resolution</th>
<th>MMU</th>
<th>INSPIRE Data Theme</th>
<th>Core Data Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>PT- Land Use/Cover Map (COS)</td>
<td>Directorate-General for Territory</td>
<td>1995, 2007, 2010, 2015 and 2018</td>
<td>Irregular, expected to be every 3 years</td>
<td>20 m</td>
<td>1 ha</td>
<td>Land Cover</td>
<td>Land Cover</td>
</tr>
<tr>
<td>ES-Information System on Land Cover /Use SIOSE</td>
<td>National Geographic Institute of Spain</td>
<td>2005; 2009; 2011 and 2014</td>
<td>15 m</td>
<td>0.5 ha</td>
<td>Land Cover</td>
<td>Land Cover</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 2 Land Use and Land Cover Map**

In Portugal, the official source for indicator 15.1.1 relies on data from the National Forest Inventory with a territorial detail up to NUTS 3 level. Alternatively, the Land Use and Land Cover Map (COS) can also be used to compute this indicator with a greater territorial disaggregation. COS corresponds to a national product under the responsibility of the Directorate-General for Territory (Portuguese NMCA). Data series are available for Mainland Portugal and correspond to polygonal maps that represent homogenous land use/cover units. COS is based on a vector data model with a MMU of 1 ha. The nomenclature of COS 2018 consists of four levels of detail that can be grouped into 9 classes of first level of detail (1 - Artificial land; 2 - Cropland area; 3 - Grassland area; 4 – Agroforestry areas; 5 - Forest area; 6 - Shrubland area; 7 - Open spaces or sparse vegetated areas; 8 - Wetlands; 9 - Surface water bodies) and there is a common and comparable subset of 83 LCLU classes. Based on COS, it is also possible to analyse the data based on the type of forest and monitor their change and evolution at regional and local level.

Source: Directorate-General for Territory, [Land Use and Land Cover Map](#).

The **SIOSE** is part of the National Monitoring Plan (PNOT), managed and coordinated by the NMCA (National Geographic Institute of Spain), and integrates different data of regional and national administrations. It includes 85 classes and a resolution of 2 ha for forest and natural areas. SIOSE is produced in conformity with INSPIRE implementing rules on interoperability of spatial datasets and services.

### Table 4 Statistical European Data Sources

<table>
<thead>
<tr>
<th>Name</th>
<th>Source</th>
<th>Periods of reference available</th>
<th>Frequency</th>
<th>Max territorial granularity</th>
<th>Other relevant disaggregation</th>
<th>ESS regulation reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Use /Cover Area frame Survey</td>
<td>ESTAT-LUCAS</td>
<td>2012, 2015 and 2018 (EU 27 MS)</td>
<td>3-years</td>
<td>NUTS 2</td>
<td></td>
<td>Part of the Community Statistical Programme</td>
</tr>
</tbody>
</table>
**UN-GGIM: Europe Working Group on Data Integration**  
*Guidelines for SDG Indicator Calculation*

**15.1.1 | Forest area as a proportion of total land area**

**LUCAS survey** is based on *in situ* data, meaning that observations are registered on the ground by field surveyors. It is based on a standardised survey methodology in terms of a sampling plan, classifications, data collection processes and statistical estimators that are used to obtain harmonised and unbiased estimates of land use and land cover.

A mixed panel approach is used, so some points are visited in subsequent years. In the field, the surveyor classifies the land cover and the visible land use according to the harmonized LUCAS land cover and land use classifications. LUCAS data is used to calculate the EU-SDG indicator on the *Share of forest area*, which has a direct correspondence to the one defined at the global level.

**Table 5 Statistical National Data Sources**

<table>
<thead>
<tr>
<th>Name</th>
<th>Source</th>
<th>Periods of reference available</th>
<th>Frequency</th>
<th>Max territorial granularity</th>
<th>Other relevant disaggregation</th>
<th>ESS regulation reference</th>
</tr>
</thead>
</table>

The Portuguese National Forest Inventory (NFI) is the process of producing statistics on the existence, state and condition of national forest resources. It is based on data collection from aerial images and measurements of vegetation on the ground throughout the territory. These data collections are repeated, which makes it possible to monitor the evolution of the forest areas. The NFI is the official data source for the country report to FAO supporting the calculation of the 15.1.1 SDG indicator. It provides data up to NUTS 3 level and the possibility of depicting the forest area according to forest types and monitor its change and progress over time at regional level.

The German **Area survey** of the Federal Statistical Office categorizes the surface by land cover or land use. The main categories are settlement, transportation, vegetation, and water surfaces, which are further subdivided into different subtypes. The area survey as a total calculation is based on administrative data of the Official Real Estate Cadastre of the Länder (federal states).

**4. COMPUTATION**

**Workflow based on global geospatial data source – ESA Land Cover**

The indicator computation using ESA Land Cover can be carried out based on the following workflow:

- ESA Land Cover data and administrative boundaries geospatial layer
- Extraction of the Regional / National area subset of the ESA Land Cover
- Computation of the forest area by selecting the following classes:  
  - ESA Land Cover classes: 40 (Mosaic natural vegetation (tree, shrub, herbaceous cover)/cropland), 50 (Tree cover, broadleaved, evergreen, closed to open), 60 (Tree cover, broadleaved, deciduous, closed to open), 70 (Tree cover, needle-leaved, evergreen, closed to open), 80 (Tree cover, needle-leaved, deciduous, closed to open), 90 (Tree cover, mixed leaf type), 100 (Mosaic tree and shrub/herbaceous cover), 110 (Mosaic herbaceous cover/tree and shrub)
- Computation of the internal water area to be subtracted by considering class 210
- Computation of the total reference unit area from administrative borders
- Calculation of the indicator by applying the formula: \( \frac{\text{forest area}}{\text{administrative unit area} - \text{internal water area}} \times 100 \)
**Workflow based on Pan-European geospatial data source – Copernicus HRL**

The indicator computation using Copernicus HRL can be carried out based on the following workflow:

- Copernicus HRL Forest Type geospatial layer and Copernicus HRL Water and Wetness geospatial layer and administrative borders geospatial layer
- Computation of the total country area by administrative borders geospatial layer
- Computation of the total land area by subtracting water bodies geospatial layer from the total country area
- Computation of indicator based on the ratio HRL Forest Type / Total land area x 100

**Workflow based on National geospatial data source – Land Use and Land Cover Map (COS)**

The indicator computation using the Portuguese Land Use and Land Cover Map (COS) can be carried out based on the following workflow:

- Land Use and Land Cover Map and Official Administrative Map for Portugal (total area)
- Selection and extraction of areas and forest is set to correspond to the first level class 5 – ‘Forest area’
- Total land area is captured as the sum of all classes subtracted of class 9 – ‘Surface water bodies’
- Extract ‘Forest area’ and ‘Surface water bodies’ according to the boundaries of the Administrative Map
- Computation of indicator based on the Forest area / Total land area x 100

### 5. RESULTS

**Results based on ESA Land Cover**

The results of the indicator calculated for Italy for 2012 is 33.4%, a value that should be compared with the one reported in FRA 2010 (36.7%) and FRA 2015 (37.7%). The following figures show the results obtained for the case of Italy considering a disaggregation at NUTS 3 and commune level.

![Figure 3 Forest area as a proportion of total land area by NUTS 3 level, 2012](image1)

![Figure 4 Forest area as a proportion of total land area by commune level, 2012](image2)

**Source:** ESA Land Cover.
Results based on Pan-European data sources

The results of the indicator calculated for Italy for 2012 was 36.9%, also a close value to those reported in FRA 2010 (36.7%) and FRA 2015 (37.7%). The following figures show the results obtained by using only Copernicus geospatial layers for the case of Italy considering a disaggregation at NUTS 3 and commune level.

Results based on Geospatial National data sources

The results based on the Portuguese Land Use and Land Cover Map can be breakdown at a very detailed level such as grid level and for local administrative units, namely at municipality level, as shown in the following figures. This type of results provides a more territorially detailed picture and monitoring of the evolution of forest, a relevant input for regional and local measures regarding forest and policies on land planning.
15.1.1 | Forest area as a proportion of total land area

At national level, the indicator computed for 2015 and 2018 accounted for 39.5%, a value that can be compared to the one reported by FAO (FRA 2015 – 36.2%). The results at municipality level obtained for 2018 indicate that in 64 out of the 308 Portuguese municipalities, forest area occupied more than 55% of the total land area.

Results based on Statistical data sources

The EU-SDG indicator on the share of forest area based on the LUCAS survey provides comparable results up to NUTS 2 level for all EU Member States. The following figure presents the results for 2018 for Portugal at NUTS 2 level having the EU-27 average as a reference. In 2018, the share of forest area for Portugal (mainland) was 49.9%, a value that stood above the EU27 average, and this share was higher in the and Algarve and Centro regions.
The calculation of the indicator based on the Portuguese National Forest Inventory makes it possible to analyse the status and the evolution of forest up to NUTS 3 level. The results for 2015, as shown in the figure, show that the proportion of forest area occupies more than 50% of the total land area in three NUTS 3 regions (Região de Aveiro, Região de Coimbra and Região de Leiria) located in the Centro region and in the NUTS 3 region of Alentejo Litoral in the Alentejo region.

The operationalization of an indicator with a relatively straightforward computation may produce different results depending on the type of data source, and it can be expected that differences between data sources will tend to increase as the territorial breakdown of information also increases.

B. NORMATIVE GUIDELINES

1. ALGORITHM WORKFLOW

The computation steps for the calculation of this indicator are relatively straightforward and the algorithm workflow can be divided into three main phases:

- **Data inventory**, which involves selecting the data source to capture both components of the indicator. Different data sources based on geospatial and statistical data can be used and opting from one can be dependent on the need for international and/or European comparability and the need and relevance to have subnational data at different territorial levels, as shown in the following diagram:

  ![Figure 11 Guideline chart for data source selection](image)

- **Data processing**, in which all data needed for indicator computation are processed to allow capturing both components of the indicator.

- **Computation**, in which the final value of the indicator is computed by making use of the indicator’s formula.

The following diagram summarises processing steps divided into the three main phases for indicator calculation having as a reference the Pan-European Copernicus HRL. The same workflow can be applied on national geospatial land cover data sources.
15.1.1 | Forest area as a proportion of total land area

Figure 12 Chart summarising the steps for indicator computation

Part 1: Data inventory
Select the data sources to capture both components of the indicator

Identify data sources
- Copernicus HRL Forest type
- Copernicus HRL Water&Wetness
- Administrative boundaries

Part 2: Data processing
Use geospatial operations to select and extract areas and intersect with administrative boundaries

Intersect with admin. boundaries
Union with official areas
Extract areas excluding water bodies
Extract forest areas

Part 3: Computation
Compute the indicator for the reference period and intended territorial level

Land area
Forest area

INDICATOR 15.1.1
2. RECOMMENDATIONS

- When using geospatial layers for SDG 15.1.1 indicator it is important to deal with the underlying forest definitions and any deviations from the one proposed by the FAO.
  - If possible, approximate the definition to that defined at the global level by adjusting selection criteria in the data source. At EU level, the indicator being calculated based on LUCAS data has a direct correspondence to the global one as data has been mapped to match FAO definitions.
  - If not possible, deviations from the FAO definition should be identified and reported, to clarify the scope being addressed by the computed indicator in relation to the one defined at the global level.

- At European level, the Copernicus HR Layers (Forest Type and Water & Wetness) should be used for indicator computation as they allow to get as close as possible to the FAO forest definition and provide comparable, reliable, and territorial detailed results.
  - The Copernicus HR Layers (Forest Type and Water & Wetness) Copernicus HRL for 2018 present a more detailed spatial resolution (10 m) than for previous years. In principle, the production and availability of more detailed geospatial products is a positive development area to be encouraged.
  - However, and to enhance the use of this type of sources within the scope of statistical production and within the framework of SDG monitoring, it is important to ensure continuity in terms of data series, so that it is possible to guarantee consistent and comparable data series.

- At the European level, use administrative boundaries from EuroGeographics which are based on national authoritative data. For consistency and comparability of results at the European level, it is important to consider the availability of official data regarding administrative delimitation for the definition of regional and national territorial boundaries. EuroGeographics is working towards providing easy access to pan-European open data created using official map, geospatial and land information.

- At national level, depict the data by types of forest to increase insight on forest monitoring. Although definitions based on national sources may diverge further from those defined at global level by FAO, national data sources can provide greater segmentation of results according to different types of forests (e.g., indigenous forests; deciduous forest), which can be an important input for SDG national monitoring and for forest policy management and planning at local level.