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Algorithm Technical Basis Document (ATBD)

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Abstract

This document summarizes the design process, definitions, and algorithmic implementation conducted by the Joint Research Centre to support the development and implementation of a European-wide analysis of forest connectivity. The analysis scheme and data products were designed for the indicator Forest Connectivity in the Regional Yearbook 2022 report by EUROSTAT.

The spatial forest coverage is derived from the Copernicus CORINE Land Cover 2018 dataset. Spatially explicit maps and statistical summaries are derived at European level and for each reporting unit at the GISCO levels of NUTS 0, 1, and 2.

1 Introduction

Forest area and its fragmentation is a key aspect in biodiversity, ecosystem services and the ever-increasing pressure from anthropogenic land use. Forest fragmentation may lead to the isolation and loss of species and gene pools, degraded habitat quality, and a reduction in the forest's ability to sustain the natural processes necessary to maintain ecosystem health. The term forest fragmentation, or its complement forest connectivity, is used in many application fields and the interpretation of it strongly depends on the end-user priorities and reporting needs. The wood-processing sector, tourism industry, environmentalists, nature protection organisations, and policy makers all have their own perceptions and evaluations whether a high degree in forest connectivity is good or bad. For example, in biodiversity a high degree in connectivity can be *good* for certain bird species but at the same time it is very *bad*, because if favours the proliferation of invasive species or forest fires. Equally, some birds/butterflies benefit from a fragmented landscape while other species require unfragmented habitats.

The scope of the indicator forest connectivity described in this document is to mediate the various end-user expectations with the provision of an objective and tangible solution: provide spatially explicit maps, where forest connectivity is measured within a normalised range of [0, 100] %. Summary statistic can then be derived by grouping this range into five sub-ranges with increasing degree of forest connectivity. The map product facilitates the detection of hotspots and locations for forest management activities. The statistic product provides an intuitive reporting summary for status and trend assessments, as well as direct comparison between individual reporting units. Percent of forest connectivity can be easily communicated and serves as a common reference base for all end-users for further interpretation.

The conceptual approach used in this document, Forest Area Density (FAD), is the result of a collaborative development on the reporting on forest fragmentation/connectivity between JRC D.1 and the USDA-Forest Service (USFS). The reporting scheme is used by the USFS for official reporting to the Montréal Process for many years. Customised indicators on forest fragmentation based on the same scheme are provided by the USFS (indicator 1.03 Fragmentation of forests), FAO (indicator 1.5), and the MAES project, (i.e., Fact sheet 3.3.103: Fragmentation by forest cover loss). Fine-tuned versions of the same approach have also been designed by JRC D.1 for reporting on forest fragmentation in FAO's State of the World's Forests – 2020 (SOFO) report and the indicator 4.7 (Forest Fragmentation) in the State of Europe's Forests 2020 report, published by FOREST EUROPE (FE). Measuring forest fragmentation/connectivity with the FAD approach is well documented for over twenty years (Forest Service 2012, 2016; Riitters et al. 2002, 2012; Wickham et al. 2008) and available in the JRC software GTB (Vogt and Riitters, 2017) for interactive analysis and GWB (Vogt et al, 2022) for automated processing, or implemented on the public FAO SEPAL cloud computing platform.

In general, the analysis of forest connectivity depends on the input data source, the definition of forest, the processing settings, and the reporting style of the results. Each end-user must evaluate the analysis conditions and take appropriate decisions to best match the desired results. In this document, we followed most of the decisions taken by the FE expert panel in a Pilot Study on reporting on forest fragmentation.

The following decisions were taken by EUROSTAT to best match the requirements for the regional yearbook reporting:

1. Data source: the Copernicus CORINE Land Cover 2018 (CLC) dataset (version 2020_20u1, accessed in March 2022) is used. CLC is produced and legally acknowledged by all Member States, providing land cover maps throughout Europe via a harmonized method and legend for a series of time points.

2. Definition of forest: from the 44 CLC classes the following 4 classes represent forest land cover: 311 - Broadleaved Forest, 312 - Coniferous Forest, 313 - Mixed Forest, 324 - Transitional Woodland-Shrub. The latter is included because it largely complies with national definitions of forest.

3. Forest Connectivity: the method "Forest Area Density" (FAD) at Fixed Observation Scale (FAD-FOS) was selected to best match the forest connectivity assessment requirements stipulated by EUROSTAT.

4. Analysis scale: forest connectivity depends on the observation/analysis scale. Following the decision taken by the FE expert panel, an analysis scale of ~ 500 hectare was selected to be appropriate for evaluating forest connectivity and its diverse functions in the protection of biodiversity. This analysis scale translates into a moving window size of 23x23 pixels (a local neighbourhood of 529 hectare) for the FAD methodology, when using CLC data with a spatial resolution of 100 meters.

5. Reporting style: reporting of forest connectivity is conducted at the pixel level for each forest pixel. Each forest pixel shows the degree in forest connectivity measured within a local neighbourhood of 529 hectare. The indicator product is twofold and consists of:

a) a spatially explicit map product in GeoTIFF format and

b) tabular summary statistics by reporting unit providing the overall average value in forest connectivity and the percentage of forest cover falling into five classes of forest connectivity:

6. Reporting units: Forest connectivity is provided for the following selected reporting units:

Reporting units at European scale are the full coverage of CLC, the EU28 Member States (as of 2018), and the EU27 Member States (as of 2022). The NUTS (Nomenclature of territorial units for statistics) reporting units are taken from the GISCO statistical unit dataset for the reference year 2021 in equal area projection (EPSG: 3035) matching the CLC 2018 dataset.

2 Implementation summary

This section provides an overview of the data source used, necessary pre-processing steps, details on the algorithms applied, details on the output format and other documentary information on the status product of the indicator Forest Connectivity. All status maps and related statistics are available directly under this doi: 10.6084/m9.figshare.19513879, see also section 2.5

2.1 Input data

The CORINE (CLC) land cover maps (https://land.copernicus.eu/pan-european/corine-land-cover) identify 44 land cover classes at a spatial resolution of 1 hectare per pixel (100 m x 100 m) for a series of assessment years over Europe. Further details can be found in the CLC Technical Guidelines (see references). The following assignment is used in the CLC 2018 map to define the forest mask, see also Table 3:

- **Forest** (2-byte): the CLC classes 311, 312, 313, 324 are combined into a single forest layer
- **Land** (1-byte): the CLC classes 111-512 but excluding the forest layer.
- **Inland waters** (3-byte) the CLC classes 411-512 (inland waters and wetlands) are treated as land but marked separately in the fragmentation for visual purposes.
- **No data** (0-byte): the CLC classes 521 and above (marine waters and missing data) are excluded from the land coverage or reporting unit.

The CLC raster layer is provided in the reference system Lambert Azimuthal Equal Area LAEA (EPSG: 3035) with an extent that includes the overseas French territories (Guadeloupe, French Guyana, Martinique, Reunion, and Mayotte). The analysed CLC map extent is confined to European continent, from Azores (PT) on Turkey as East-West limits, and from Canary Island (ES) to Norway as North-South limits (Table 1).

Table 1. Reporting levels and number of reporting units of forest connectivity.

CORNER	LAEA COORDINATES [metres]	GEOGRAPHIC COORDINATES [degrees, minutes, seconds]
Upper Left	900,000, 5,500,000	56°30'18.51" W, 56°29' 4.75" N
Lower Left	900,000, 900,000	23°49'33.58" W, 24°17' 3.04" N
Upper Right	7,400,000, 5,500,000	72°54'22.09" E, 58°57' 9.90" N
Lower Right	7,400,000, 900,000	40°39'45.75" E, 25°d32'40.96" N

Source: JRC, 2022.

2.2 Definition of reporting units

The reporting unit boundaries were provided by Eurostat GISCO (*Geographic Information System of the COmmission*). The spatial data set version 2021 in ESRI shapefile format covers 37 European countries (Table 4) and has a precision scale of 1:100.000. From this data set were extracted the NUTS vector layers at levels 0, 1 and 2. The NUTS level 0 is divided in 37 units (countries), at level 1 is divided in 124 units (major regions), and the level 2 in 328 units (basic regions). The three NUTS levels are complemented with three reporting units at European level corresponding to the entire CLC coverage, the EU28 (as of 2018) and the EU27 (as of 2022) coverage.

Table 2. List of 37 European countries covered by Eurostat GISCO's NUTS data set.

NUTS ID	COUNTRY	NUTS ID	COUNTRY	NUTS ID	COUNTRY
AL	Albania	FR	France	NL	Netherland
AT	Austria	HR	Croatia	NO	Norway
BE	Belgium	HU	Hungary	PL	Poland
BG	Bulgaria	IE	Ireland	PT	Portugal
CH	Switzerland	IS	Island	RO	Romania
CY	Cyprus	IT	Italy	RS	Serbia
CZ	Czech Republic	LI	Liechtenstein	SE	Sweden
DE	Germany	LT	Lithuania	SI	Slovenia

NUTS ID	COUNTRY	NUTS ID	COUNTRY	NUTS ID	COUNTRY
DK	Denmark	LU	Luxemburg	SK	Slovakia
EE	Estonia	LV	Latvia	TR	Turkey
EL	Greece	ME	Montenegro	UK	United Kingdom
ES	Spain	MK	North Macedonia		
FI	Finland	MT	Malta		

Source: JRC, 2022.

The three NUTS layers, originally in the European Terrestrial Reference System 1989 ETRS89 (EPSG: 4258), were projected to LAEA (EPSG: 3035). Successively, the vector layers were converted to raster files with a pixel resolution of 100 m x 100 m, having the same extent, pixel resolution and spatial reference system as the CLC land cover map.
The spatial transformations for the vector projection and the rasterization were conducted with the following GDAL (version 3.1.4) commands:

```
> ogr2ogr -f "ESRI Shapefile" -s_srs EPSG:4258 -t_srs EPSG:3035
NUTS_RG_100K_2021_LAEA.shp NUTS_RG_100K_2021.shp

> gdal_rasterize -a OBJID -tr 100.0 100.0 -a_nodata 0.0 -te 900000.0 900000.0
7400000.0 5500000.0 -ot UInt16 -of GTiff -at -co "COMPRESS=LZW" -tap
NUTS2_100K_2021_LAEA.shp NUTS2_100K_2021_LAEA.tif
```

2.3 Forest connectivity assessment scheme

Forest Area Density (FAD) is defined as the proportion of all forest pixels within a fixed neighbourhood area. FOS measurements (FOS = FAD at Fixed Observation Scale) are conducted via a moving window algorithm to create a new map of forest area density: the given neighbourhood - a square window of size 23x23 pixels = 529 hectares - is centred over a given forest pixel, the forest area density within that neighbourhood is measured and assigned in a new map at the location of the subject forest pixel. This process is repeated for all forest pixels resulting in a new map of the same dimensions but showing forest area density values for the analysed neighbourhood over each forest pixel. The forest area density map shows the degree in forest connectivity in [0, 100] % for each forest pixel within its local neighbourhood of 529 hectare.
The above outlined assessment scheme (FOS 5-class) is available in the JRC software packages GTB or GWB and further detailed in the dedicated FAD/FOS product sheet.

Table 2 provides an overview of the colour-coding scheme used to segment the full range of FAD into five classes of forest connectivity.

Table 3. Class names and description of forest connectivity.

Colour	Forest connectivity	Forest cover (1)	Forest Area Density (FAD) (1)
	Very low	Rare	[0 ≤FAD < 10] %
	Low	Patchy	[10 ≤ FAD < 40] %
	Intermediate	Transitional	[40 ≤ FAD < 60] %
	High	Dominant	[60 ≤ FAD < 90] %
	Very high	Interior	[90 ≤ FAD ≤ 100] %

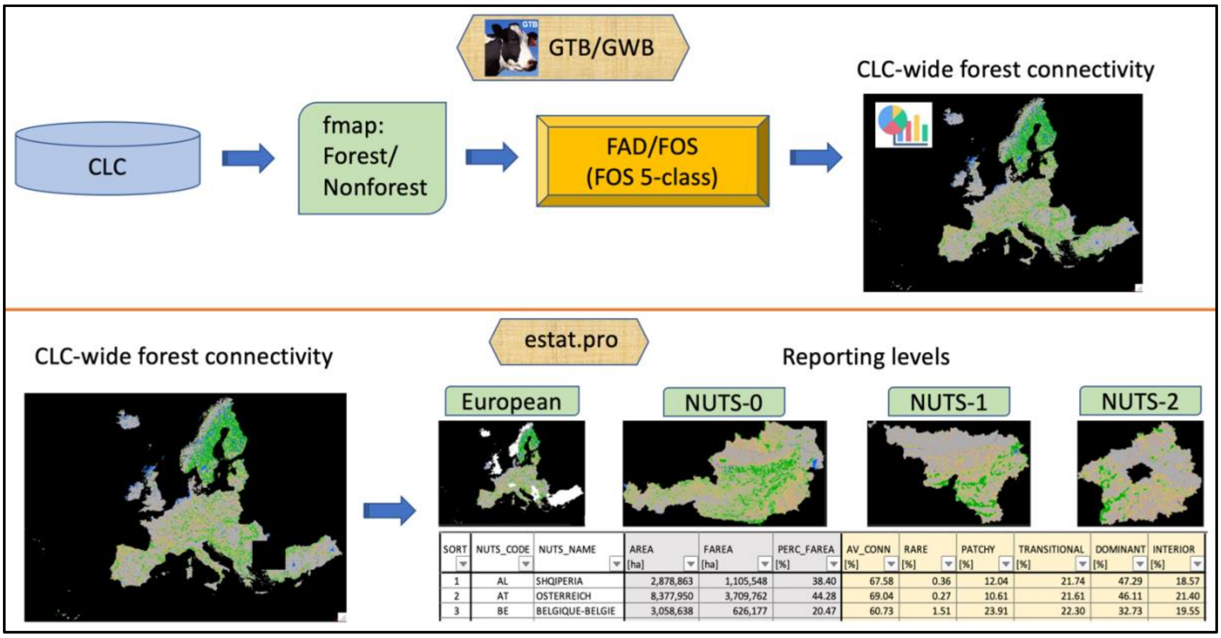
(1) FAD product sheet: https://ies-ows.jrc.ec.europa.eu/gtb/GTB/psheets/GTB-Fragmentation-FADFOS.pdf

Source: JRC, 2022.

Figure 1 provides an overview of the processing chain to derive the forest connectivity status maps and statistics. In the initial phase, GWB is used to build the forest map from the CLC 2018 land cover map. The forest mask (fmap) is then further processed with the FOS5-class scheme (GWB_FRAG in GWB) to provide the CLC-wide map and statistics on forest connectivity. In the second phase, the custom program *estat.pro* (coded in the IDL language) will use the CLC-wide map, cut out and mask the map content and derive the summary statistics for all reporting units at all reporting levels. Please note that summary statistics are derived from the reporting unit cover area that is masked out from the European-wide CLC forest connectivity map. This masking step is crucial to exclude boundary effects, which would appear if the connectivity was calculated directly on the masked reporting unit only.

The source code for all processing steps, all input and output maps and statistics are provided in a single directory **ESTAT** together with this ATBD, see Annex. Further details on the individual processing steps can be found in the Annex or directly in the script *estat.pro*.

Figure 1. Processing flowchart to derive forest connectivity



Source: JRC, 2022.

2.4 Forest connectivity reporting scheme

The result of the forest connectivity assessment scheme are spatially explicit maps showing the degree in forest connectivity in [0, 100] % for each forest pixel considering within its local neighbourhood of 529 hectare. For visual clarity, the full connectivity range of FAD in [0, 100] % is colour-coded into five forest connectivity classes using the FAD threshold values stipulated in Table 1. Please note that the actual pixel values still show the full connectivity range of FAD in [0, 100] %, only the visual display is simplified into five categories of forest connectivity.

Statistics of the forest connectivity status maps for the five categories summarised in Table 2 are summarized with the following parameters for each reporting unit:

Table 4. Field code and description of statistical summary parameters.

Field code	Description [1]	Unit
AREA	Total area of reporting unit	Hectare
FAREA	Forest area within reporting unit	Hectare
PERC_FAREA	Forest proportion in reporting unit	Percent
AV_CONN	Average forest connectivity within reporting unit	Percent
RARE	Proportion of forest where forest connectivity is very low	Percent
PATCHY	Proportion of forest where forest connectivity is low	Percent
TRANSITIONAL	Proportion of forest where forest connectivity is intermediate	Percent
DOMINANT	Proportion of forest where forest connectivity is high	Percent
INTERIOR	Proportion of forest where forest connectivity is very high	Percent

([1]) FAD product sheet: https://ies-ows.jrc.ec.europa.eu/gtb/GTB/psheets/GTB-Fragmentation-FADFOS.pdf

Source: JRC, 2022.

2.5 Forest connectivity dataset structure

This section describes the file hierarchy and input and output formats in the various sub-directories of the base-directory **ESTAT**. The full dataset is available directly under this doi: 10.6084/m9.figshare.19513879. Files are shown in *italics* and directories in **bold**.

- **2018**: directory with input/output data for forest connectivity analysis:
  - **EUROPE**: maps for three EU reporting units and summary statistics under **Derived_Data**.
  - **fmap_fos5_23**: map and statistics output from GWB_FRAG analysis
  - **NUTS0**: maps for 37 NUTS0 reporting units and summary statistics under **Derived_Data**.
  - **NUTS1**: maps for 124 NUTS1 reporting units and summary statistics under **Derived_Data**.
  - **NUTS2**: maps for 328 NUTS2 reporting units and summary statistics under **Derived_Data**.

(The files *CLC_2018_foreststats_*.xlsx* contain enhanced, searchable statistics with field code definitions in a separate sheet)

- **NUTS**: directory with tables and maps at NUTS level 0, 1, 2
  - *CLC_EEAcolors20u1.sav*: colour table for CLC 2018 map used by *estat.pro*.
  - *estat.pro*: IDL program (source code) for pre- and post-processing, providing step-by-step instructions on the individual processing methodologies.
  - *fmap.tif*: forest mask derived from CLC2018 data.
  - TechnicalReport_ESTAT.pdf: current document.

All map products are provided in GeoTIFF format and in the data type byte. Details of the geo-header information can be retrieved with the command *gdalinfo* or by any GIS application. Details on the input and output pixel values are summarized in the following tables:

Table 5. Class names and description of the forest mask.

Forest Mask: base directory, file name: *fmap.tif*				
Value	Land cover class	RGB – Colour Code		Description
0	Missing	0/0/0		Ocean, no data, or outside reporting unit
1	Background	255/255/210		Nonforest
2	Forest	50/150/85		Forest
3	Water	0/100/255		Inland waters

Source: JRC, 2022.

Table 6. Class names and description of forest connectivity.

Forest Connectivity: directory 2018 - EUROPE, NUTS0/1/2; file name: *fos5_2018_<reporting-unit>.tif*				
Value	Forest cover class	RGB – Colour Code		Description
0 - 9	Rare	214/49/39		Forest pixels in connectivity class: very low
10 - 39	Patchy	249/139/89		Forest pixels in connectivity class: low
40 - 59	Transitional	254/199/0		Forest pixels in connectivity class: intermediate
60 - 89	Dominant	139/199/99		Forest pixels in connectivity class: high
90 - 100	Interior	0/174/0		Forest pixels in connectivity class: very high
101	Background	175/175/175		Nonforest land cover
102	Missing	255/255/255		No data or outside reporting unit
105	Water	0/100/255		Inland waters

Source: JRC, 2022.

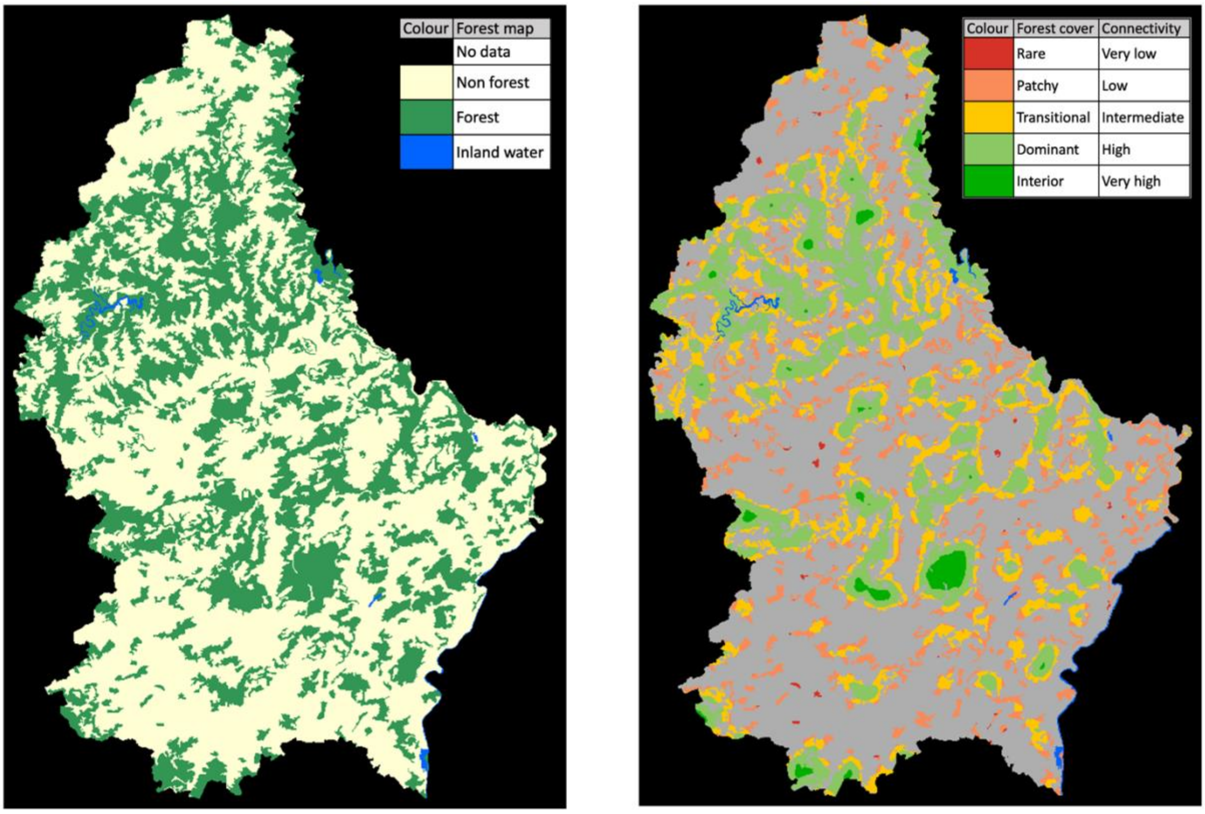
3 Implementation example

This section provides examples of the individual processing steps as well as details on the resulting maps and statistics.

3.1 Forest connectivity in Luxembourg

Figure 2 exemplifies the methodology at NUTS 0 level in Luxembourg. The top panel of the figure shows the forest map derived from CLC 2018 (left) and the spatial distribution of forest connectivity, colour-coded in five categories (right). For example, red colour maps areas where forest cover is *rare*, equivalent to the degree in forest connectivity being *very low*. All forest pixels in Luxembourg with FAD < 10 % are colour-coded in red. The bottom panel of the figure shows the statistical summary for the same reporting unit: the total reporting unit area (derived from the rasterised CLC map with a pixel resolution of 1 hectare) is 261,765 hectares, of which 95,687 hectares are forest, or 35.55 % of the reporting unit are forest. AV_CONN, or the average degree in forest connectivity across all forest pixels in Luxembourg is 54.81 %. 0.46 % of all forest pixels in Luxembourg are *rare* forest cover (red), where the degree of forest connectivity is less than 10 % (see also Table 1). Similarly, 40.1 % of the forest cover in Luxembourg shows *high* connectivity (light green). *High* connectivity is equivalent to areas where forest cover is *dominant* within a local neighbourhood of 529 hectares.

Figure 2. Forest connectivity in Luxembourg: map and statistics at NUTS level 0.



NUTS_CODE	NUTS_NAME	AREA [ha]	FAREA [ha]	PERC_FAREA [%]	AV_CONN [%]	RARE [%]	PATCHY [%]	TRANSITIONAL [%]	DOMINANT [%]	INTERIOR [%]
LU	LUXEMBOURG	261,765	95,687	36.55	54.81	0.46	22.23	34.40	40.10	2.81

Source: JRC, 2022.

Conclusions

This document describes a methodology to map and quantify forest connectivity at European to regional scale. The approach is based on building a forest map from an acknowledged land cover classification and measuring the forest area density (FAD) at a fixed observation scale. The concept assures to simultaneously consider key aspects of forest connectivity including, the amount of forest, the degree of spatially continuous forest cover, perforations inside forest patches, patch shape and linear features, and the distance between individual forest patches. The accuracy of the derived status maps strictly depends on the accuracy of the CLC 2018 input classification and may differ from official statistics on the forest area obtained by other means. In this context, the results of this study are indicative but consistent and comparable across the pan-European mapping space.

The purpose of the map product is to exploit the spatial information, which cannot be retrieved from summary indices and statistics: a geographic map showing the varying degree in forest connectivity is not only visually appealing but permits localizing hotspots of fragmentation, which may support planning and risk assessment. The map product is useful to address spatially explicit assessment questions (***where***) such as:

- Where are forests patches mostly contiguous or fragmented?
- Where in the reporting unit are the small (large) forest patches?
- Where are forest patches close or distant (important for restoration questions)?
- Where are, or which forests patches are in high-risk areas (comparing/intersecting the forest map product with other environmental data layers in a GIS)?
- Trend analysis: if comparable map products over time are available, a change map allows to delineate areas of improvement/degradation or locating areas where the situation is stable. Such geographic detail is essential in landscape management, biodiversity assessments and policy planning. It may also be used to control and measure progress of locally applied political directives.

The purpose of the summary statistics (foreststats_*.xlsx) is to provide a concise and comparative overview allowing to answer essential quantitative assessment questions (***how much***) such as:

- Which reporting unit has the highest overall degree of forest connectivity (sort column G)?
- Which reporting unit has the highest forest proportion (sort column F)?
- Which reporting unit has the highest proportion of interior forest?

The above, and other similar questions can be easily addressed by using the filter function in the summary spreadsheet (foreststats_*.xlsx). Definitions of each field code in the spreadsheet are provided in the second sheet “field_code_definition”.

References

CLC Technical Guidelines, online document available at: https://land.copernicus.eu/user-corner/technical-library/clc2018technicalguidelines_final.pdf

Forest Service U.S. Department of Agriculture. 2012. *Future of America's Forest and Rangelands: Forest Service 2010 Resources Planning Act Assessment. Gen. Tech. Rep. WO-87*. Washington, DC. 198 p., doi:10.2737/WO- GTR-87

Forest Service U.S. Department of Agriculture. 2016. *Future of America's Forest and Rangelands: Update to the 2010 Resources Planning Act Assessment. Gen. Tech. Rep. WO-GTR-94*. Washington, DC. 250 p. https://www.fs.usda.gov/treesearch/pubs/53212

Montréal Process Working Group: https://www.montreal-process.org/documents/publications/techreports/MontrealProcessSeptember2015.pdf

Riitters, K.H., Wickham, J.D., O'Neill, R.V., Jones, K.B., Smith, E.R., Coulston, J.W., Wade, T.G. & Smith, J.H. 2002. *Fragmentation of continental United States forests*. Ecosystems 5, pp. 815-822.

Riitters, K.H., Wickham, J.D. 2012. *Decline of forest interior conditions in the conterminous United States*. Scientific Reports 2, Article number: 653, doi:10.1038/srep00653

Vogt P., Riitters, K. 2017. *GuidosToolbox: universal digital image object analysis*. European Journal of Remote Sensing 50:1, pp. 352-361, doi:10.1080/22797254.2017.1330650

Vogt, P. Product sheet: *Measuring Forest Area Density to quantify Forest Fragmentation*. http://ies-ows.jrc.ec.europa.eu/gtb/GTB/psheets/GTB-Fragmentation-FADFOS.pdf

Vogt, P., Riitters, K., Rambaud, P., d'Annunzio, R., Lindquist E., Pekkarinen A. *GuidosToolbox Workbench: spatial analysis of raster maps for ecological applications*. Ecography, Volume 2022, Issue 3, doi:10.1111/ecog.05864

Wickham, J.D., Riitters, K.H., Wade, T.G., Homer, C. 2008. *Temporal change in fragmentation of continental US forests*. Landscape Ecology 23, pp. 891-898, doi:10.1007/s10980-008-9258-z

List of acronyms

APS	Average Patch Size
ATBD	Algorithmic Technical Basis Document
CLC	CORINE Land Cover
EUROSTAT	ESTAT (European Statistical Office), Directorate-General of the European Commission
FAD	Forest Area Density
AV_CONN	Average FAD of all forest pixels
FE	Forest Europe
FOS	FAD at Fixed Observation Scale
FAO	Food and Agriculture Organization of the United Nations
GIS	Geographic Information System
GISCO	Geographic Information System of the Commission
GTB	GuidosToolbox (https://forest.jrc.ec.europa.eu/en/activities/lpa/gtb/)
GWB	GuidosToolbox Workbench (https://forest.jrc.ec.europa.eu/en/activities/lpa/gwb/)
USFS	United States Department of Agriculture - Forest Service

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