European Environment Agency

8th Environment Action Programme

Forest connectivity in Europe

8TH EAP HEADLINE INDICATOR, 2023

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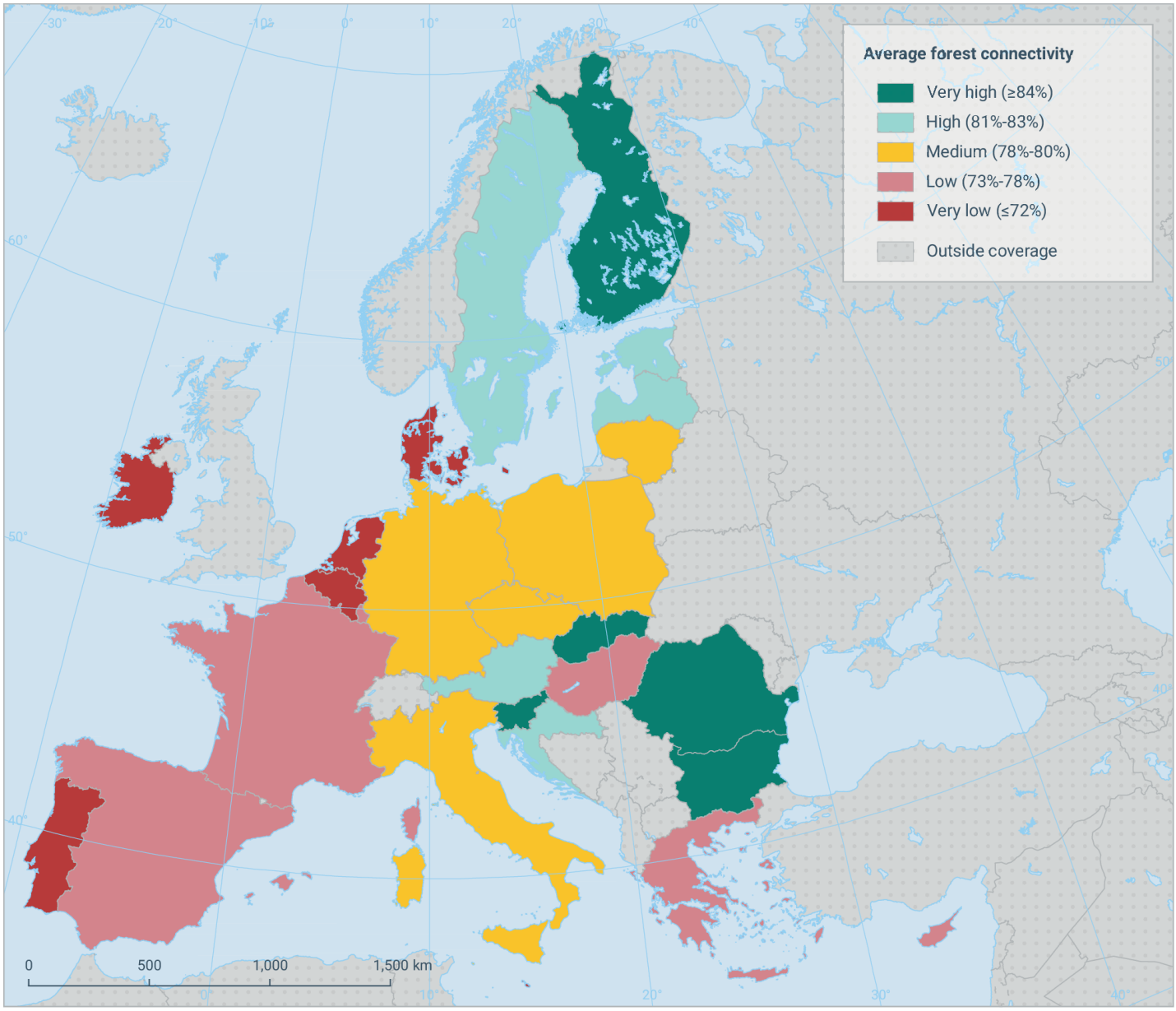
Increasing forest connectivity is crucial for supporting biodiversity. Fragmentation of forests is the main factor limiting their connectivity. In 2018, the EU's average forest connectivity was 79%. The indicator is, at present, limited to that year. Forest connectivity shows no significant changes from 2000 to 2018. The EU Forest Strategy for 2030 and the EU Biodiversity Strategy for 2030, which includes a pledge to plant at least three billion additional trees by 2030, promote forest connectivity. However, the effects of these policies will take time to become visible, making an increase in forest connectivity somewhat unlikely by 2030.

Figure 1. Forest connectivity in EU member states



Reference data: © EuroGeographics, © FAO (UN), © TurkStat Source: European Commission – Eurostat/GISCO

Source: EEA, methodology: Joint Research Centre.

Forests have significant cultural and economic value and are vital in supporting biodiversity and human well-being. Historically, forests have become fragmented due to conversion to cropland and pastures, urbanisation and infrastructure developments [1] [2].

Maintaining forest connectivity and avoiding forest fragmentation benefit species that thrive in a larger area and enable species dispersal [3][4]. Forest patches and woody features such as hedges and tree lines can play a key role in bridging gaps between forests, enhancing connectivity and movement of species between suitable habitats.

The EU Forest Strategy for 2030 [5], the EU Biodiversity Strategy for 2030 [6] and the pledge to plant at least three billion additional trees by 2030 [7], highlight the importance of expanding tree and forest cover to safeguard biodiversity.

The forest connectivity indicator measures the degree of forest density. The indicator shows the percentage of forested land not covered by any forest or woody features within a 10-hectare area surrounding a $100m^2$ forest grid cell [8]. The indicator assesses the forest's structural connectivity on a grid, meaning it provides a general insight into the environment's capability to connect local habitats regardless of the type and quality of the forest, rather than to specifically account for the needs of individual species or species groups.

In 2018, the average forest connectivity index for the EU was 79%. This indicates that on average, 79% of the 10ha area surrounding a $100m^2$ forest pixel was covered by forest or other woody features. The indicator is calculated only on cells of the grid covered by or adjacent to forest land. The indicator shows an average degree of forest connectivity (see Figure 2). However, any statistically averaged indicator value averages out spatial variability and conceals instances where forests can be disconnected or poorly connected. Consequently, regions with large extents of continuous forest cover highly influence the EU average value.

This indicator does not provide a historical trend as data are available only for 2018. However, it uses a similar methodology as the fragmentation indicator reported in Forest Europe [9], Vogt et al. [8], Maes et al. [1], and Vogt and Caudullo [10]. Although these indicators are calculated using different underlying data and resolution, they provide insights into past trends in forest connectivity, which remained relatively stable between 2000 and 2018.

Assessing the prospects for improved forest connectivity by 2030 is challenging and past findings do not show significant changes [9]. The effects of implementing the EU's forest and biodiversity strategies - such as promoting afforestation, reforestation, and restoring forest ecosystems - will most likely only become visible after 2030 due to the time lag between actions in the field and increased connectivity. However, actions to increase forest fragmentation, such as deforestation or removing connecting hedges and tree lines, can have immediate effects.

Figure 2. Share of forest area by forest connectivity classes and average forest connectivity in the EU Member States

Country	Very low (<10%)	Low (10% to <40%)	Intermediate (40% to <60%)	High (60% to <90%)	Very high (≥ 90%)	Average forest connectivity across the country
Slovenia	0%	4%	7%	27%	61%	86%
Romania	1%	7%	8%	22%	63%	85%
Bulgaria	1%	7%	8%	22%	62%	84%
Finland	0%	3%	8%	37%	51%	84%
Slovakia	1%	7%	7%	24%	61%	84%
Sweden	0%	4%	9%	36%	51%	83%
Austria	1%	6%	9%	32%	52%	82%
Estonia	0%	5%	10%	39%	46%	81%
Croatia	1%	8%	10%	27%	54%	81%
Latvia	0%	5%	10%	38%	46%	81%
Czechia	1%	10%	11%	27%	52%	79%
Italy	1%	9%	11%	29%	50%	79%
Lithuania	1%	8%	11%	33%	47%	79%
Poland	2%	10%	10%	27%	51%	79%
Germany	2%	11%	10%	25%	51%	78%
Greece	1%	10%	12%	32%	45%	77%
Spain	1%	9%	13%	32%	44%	77%
Luxembourg	1%	8%	13%	34%	43%	77%
Cyprus	3%	13%	12%	28%	45%	75%
Hungary	2%	13%	12%	27%	45%	75%
France	2%	14%	14%	29%	41%	73%
Belgium	3%	17%	14%	28%	38%	70%
Portugal	1%	14%	18%	38%	29%	69%
Denmark	6%	26%	18%	29%	21%	58%
Netherlands	6%	33%	17%	25%	19%	54%
Ireland	7%	36%	21%	25%	11%	48%
Malta	23%	56%	14%	6%	1%	25%
EU-27	1%	8%	11%	31%	49%	79%

Source: EEA, methodology: Joint Research Centre.

Forest connectivity in the EU Member States correlates strongly to the presence of large forest areas (displayed by the class 'very high connectivity'). In Member States with smaller and fewer continuous forest patches, forest strips play an important role in maintaining connectivity (classes 'low' and 'intermediate' connectivity).

This indicator relies on a map of forest area density at fixed observation scale, prepared following a methodology developed by the European Commission's Joint Research Centre. With this approach, large forest patches show high connectivity (includes not only forest, but also woody features such as treelines). Therefore, most connectivity estimates at the country level range from 70% to 86%. Based on the country quintiles, an indicator above 84% may be considered very high and an indicator below 72% may be considered very low connectivity. The EU average is highly influenced by areas with large continuous forest blocks, mainly in Slovenia, Romania, Finland and Sweden. Few countries show average connectivity below 70%. Experts from a number of EEA Eionet countries have, however, expressed significant reservations concerning the methodology of this current indicator and its ability to properly assess progress towards policy objectives concerning forest connectivity. Reflecting these concerns, the EEA is working to develop an improved indicator to better represent connectivity at both country and EU level.

Supporting information

Definition

Forest connectivity refers to the spatial compactness of forest and woody features within the forest area. It can be seen as the inverse value of fragmentation. It provides an ecosystem level overview, where a higher degree of forest connectivity will favour animal movement, plant dispersal and genetic exchange. More detailed functional connectivity assessments can provide a more specific insight for connectivity of certain species but require local level data and species-specific information on dispersal patterns. A forest with a high degree of structural connectivity faces low fragmentation issues. Structural forest connectivity can be assessed by analysing EU or country level forest maps. While statistical summaries offer an indicative overview for monitoring, connectivity maps aid the design of biodiversity initiatives, like tree planting, by identifying areas to enhance connectivity and combat fragmentation. Forest connectivity may however also have unintended effects such as spreading invasive species, pests, and diseases [11] and facilitating fire spread [12].

The forest definition used in this indicator is derived from the definition used in the Forest resource assessment of the Food and Agriculture Organisation of the United Nations [13]: land spanning more than 0.5 hectares with trees higher than 5 metres 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. This definition is extended to small woody features as mapped in the Copernicus Woody vegetation map. Since the map layers used to calculate the indicator are sourced from remote sensing (Copernicus), an area is considered forest only when tree cover becomes visible on the images. This creates a delay between the land use change, at the time of plantation, and the time the forest cover is reported in this indicator (canopy cover reaching the thresholds). This delay is however quite consistent with the new forest reaching characteristics that make it play a role in connectivity.

Methodology

The methodology used for assessing forest connectivity is called Forest Area Density (FAD) at fixed observation scale, defined as the proportion of all forest area within a fixed local neighbourhood area of each forest pixel [8]. FAD measures the spatial integrity of forest land cover and accounts for key fragmentation aspects, such as isolation of small fragments and perforations within compact forest patches [14] . The degree of forest connectivity is measured for each focal grid cell covered by forest and small woody features by analysing the local neighbourhood of a 10-hectare area surrounding the focal forest grid cell. The indicator is derived from a 10-metre resolution forest and woody vegetation layer covering the EU and neighbouring countries, combining the new FAO compliant 10 metre Forest type product 2018 and a generalisation at 10 metres of the 5-metre woody vegetation map product 2018 from Copernicus.

The primary result is a spatially explicit map showing the degree of forest connectivity for each 10 x 10-metre forest grid cell. The grid cell values are divided into five categories, where forest connectivity is either very high (90% – 100% FAD), high (60% – <90% FAD), intermediate (40% – <60% FAD), low (10% – <40% FAD), or very low (0% – <10% FAD). The connectivity map can be used to aggregate the grid cell level values to an average indicator value at a specific reporting level, for example, at country or EU-level. This aggregated average value indicates the overall degree of structural

connectivity of forest and woody features in the reporting unit. This is one of the summary statistics available to characterise forest connectivity, which is highly influenced by the presence of large continuous forest patches. Ongoing work will aim to refine the indicator's capacity to represent connectivity at both country and EU level.

Policy/environmental relevance

Forest connectivity is a headline indicator for monitoring progress towards the 8th Environment Action Programme (8th EAP). It mainly contributes to monitoring aspects of the 8th EAP priority objective (Article 2.2.e) that shall be met by 2030: 'protecting, preserving and restoring marine and terrestrial biodiversity and the biodiversity of inland waters inside and outside protected areas by, inter alia, halting and reversing biodiversity loss and improving the state of ecosystems and their functions and the services they provide, and by improving the state of the environment, in particular air, water and soil, as well as by combating desertification and soil degradation' [15]. For the purposes of the 8th EAP monitoring framework, this indicator assesses whether the EU will 'increase the degree of connectivity in forest ecosystems' by 2030 [16]. Ensuring connectivity between and inside habitats is a goal set in the EU Biodiversity Strategy for 2030 [6]. The 3-Billion-Tree Pledge For 2030 indicates that 'afforestation should be carried out at landscape level in order to strengthen connectivity with natural or semi-natural areas' and therefore lead to increased forest connectivity.

Accuracy and uncertainties

Data sources and providers

- Forest Type 2018 (raster 10 m), Europe, 3-yearly, Oct. 2020, European Environment Agency (EEA)
- Small Woody Features 2018 (raster 5 m), Europe, 3-yearly, May 2023, European Environment Agency (EEA)

Metadata

DPSIR

State

Topics

Nature protection and restoration # Forests and forestry # Biodiversity

Tags

biodiversity # Forest fragmentation # 8th EAP # forests # Forest connectivity # SEBI029

Temporal coverage

2018

Geographic coverage

Austria
Belgium
Bulgaria
Croatia
Cyprus
Czechia
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Latvia
Lithuania
Luxembourg
Malta
Netherlands
Poland
Portugal
Romania
Slovakia

Slovenia
Spain
Sweden

Typology

Descriptive indicator (Type A - What is happening to the environment and to humans?)

UN SDGs

Life on land

Unit of measure

The degree of forest connectivity is measured in a range from 0% to 100%, with 0% meaning no forest connectivity (very small patches not surrounded by any forest in a 10 hectare surrounding), and 100% meaning full connectivity (full continuous cover of forest). The indicator is calculated as the average of local forest area density (i.e. within a local neighbourhood area of 10 hectares) estimated for each 10 x 10 metre grid cell ($100m^2$) covered by forest.

Frequency of dissemination

Every 3 years

Contact

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