European Environment Agency

8th Environment Action Programme

Forest connectivity (forest fragmentation) in Europe

8TH EAP HEADLINE INDICATOR, 2024

European Environment Agency

Forest connectivity in Europe

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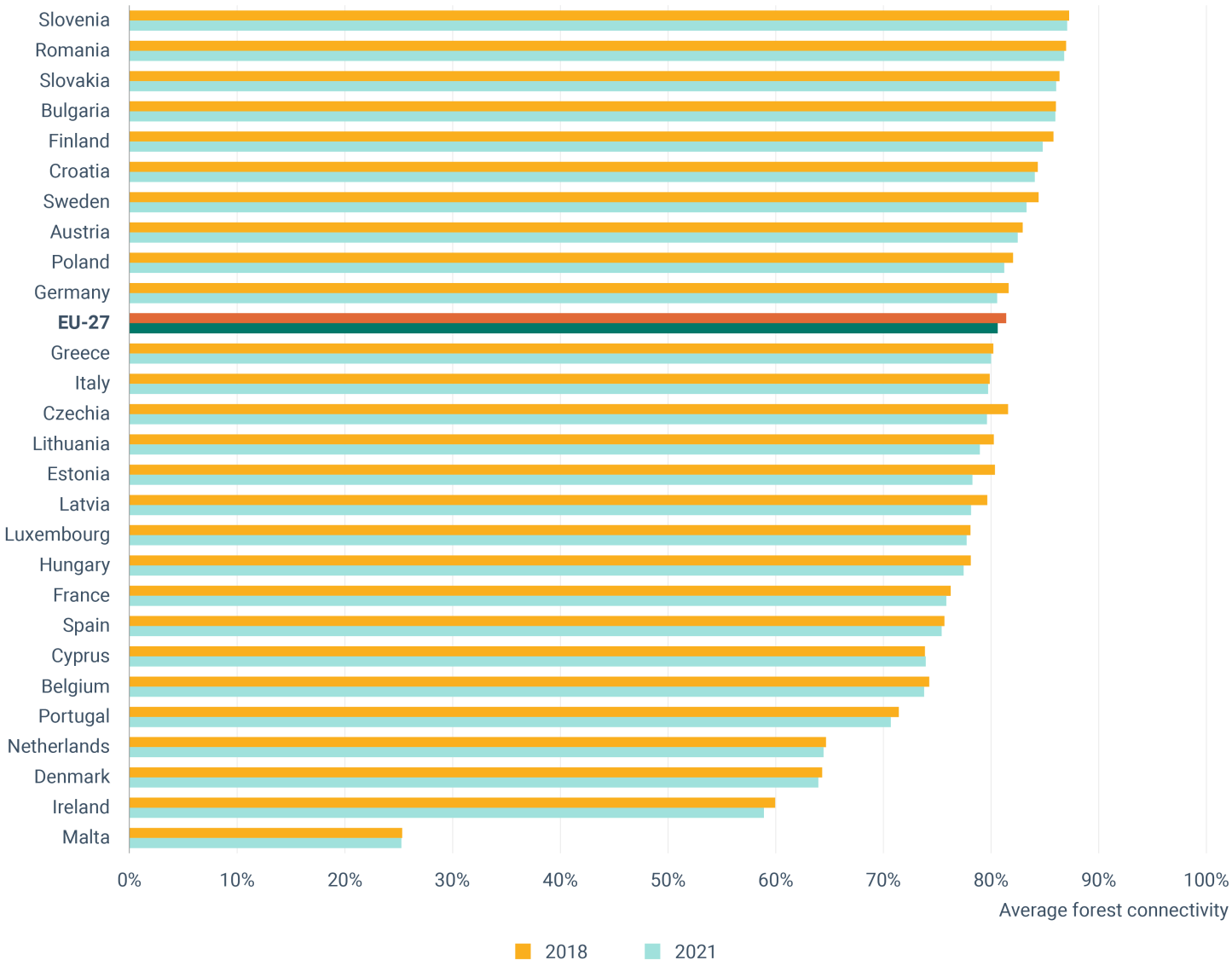
Increasing forest connectivity is crucial for supporting biodiversity. Connectivity within stocked forest areas is limited by elements fragmenting the tree cover. The European Union's average forest connectivity was 80.6% in 2021, a 0.8% decrease from 2018. The EU has effective policies promoting forest connectivity. However, the effects of these policies will take time to appear as pest and fire outbreaks which intensify with climate change lead to immediate, often temporary, losses in connectivity. Therefore, it is unlikely that forest connectivity will increase by 2030.

Figure 1. Change in average forest connectivity in EU member states between 2018 and 2021



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 benefits species that thrive in larger forested areas which enables their dispersal[3][4].

Policies are promoting forest connectivity within the EU. The Nature Restoration regulation, the EU forest strategy for 2030, the EU biodiversity strategy for 2030 and the pledge to plant at least three billion additional trees by 2030 all highlight the importance of expanding tree and forest cover to safeguard biodiversity.

This indicator measures the degree of forest coverage within a local, pre-defined neighbourhood area (assessment scale)[5]. It provides a general insight into the environment's **local habitats** without requiring additional knowledge on the type and quality of the forest, or individual species or species groups demands.

The primary information source used for calculation is the High-Resolution Layer Forest Type from Copernicus Land Monitoring Service (CLMS). This layer is derived from satellite imagery (Sentinel-2), which due to the nature of spectral analysis, only maps the stocked areas, and not temporarily unstocked areas (clearcut, burnt or windthrown forests). Therefore, both temporarily and (semi-)permanently unstocked areas are considered as fragmenting the **forest cover**.

The EU's average forest connectivity was 80.6%[6] (Figure 2) in 2021. This indicates that on average, 80.6% of the 10-hectare area surrounding a 100m^2 forest grid cell was covered by forest. Forest connectivity **decreased** by 0.8% from 2018 to 2021.

Assessing prospects for improved forest connectivity by 2030 is challenging and past findings show **no significant changes**[7]. Effects of implementing the Nature Restoration regulation, the EU forest and biodiversity strategies - such as promoting afforestation, reforestation, and restoring forest ecosystems - may only become visible after 2030 due to the time lag between actions in the field and increased connectivity. Actions increasing forest fragmentation, such as deforestation, clearcuts and salvage logging, and the effect of major disturbances such as wildfire, windstorms, pests and diseases, can have immediate effects.

Figure 2. Forest connectivity in the EU Member States in 2018 and 2021

Country	Average connectivity		Change in connectivity 2018-2021	Share of forest by connectivity classes in 2021				
	2018	2021		Very low	Low	Intermediate	High	Very high
Slovenia	87.2%	87.1%	-0.2%	0.1%	3.1%	7.2%	26.6%	63.0%
Romania	87.0%	86.8%	-0.2%	0.3%	4.4%	7.5%	22.5%	65.3%
Slovakia	86.3%	86.1%	-0.3%	0.3%	4.9%	7.2%	24.2%	63.4%
Bulgaria	86.0%	86.0%	0.0%	0.3%	5.4%	7.5%	22.4%	64.4%
Finland	85.8%	84.8%	-1.0%	0.0%	2.5%	7.9%	36.6%	53.0%
Croatia	84.3%	84.0%	-0.3%	0.3%	5.8%	9.3%	25.6%	59.0%
Sweden	84.4%	83.3%	-1.1%	0.1%	3.3%	9.1%	37.7%	49.9%
Austria	82.9%	82.5%	-0.4%	0.2%	5.1%	9.8%	33.0%	51.9%
Poland	82.0%	81.2%	-0.8%	0.5%	7.6%	9.8%	29.4%	52.7%
Germany	81.6%	80.6%	-1.1%	0.6%	8.1%	10.8%	27.9%	52.6%
EU-27	**81.4%**	**80.6%**	**-0.8%**	**0.4%**	**6.9%**	**10.8%**	**32.5%**	**49.5%**
Greece	80.2%	80.0%	-0.2%	0.4%	8.1%	11.4%	30.3%	49.9%
Italy	79.9%	79.7%	-0.1%	0.5%	8.7%	11.3%	29.1%	50.4%
Czechia	81.6%	79.6%	-2.0%	0.5%	8.4%	11.6%	29.6%	49.9%
Lithuania	80.3%	79.0%	-1.3%	0.4%	7.0%	11.9%	37.2%	43.6%
Estonia	80.4%	78.3%	-2.1%	0.1%	5.5%	13.4%	41.9%	39.1%
Latvia	79.6%	78.1%	-1.5%	0.2%	5.9%	12.8%	42.6%	38.5%
Luxembourg	78.1%	77.7%	-0.4%	0.5%	7.5%	13.4%	36.4%	42.2%
Hungary	78.1%	77.5%	-0.7%	0.8%	10.2%	12.5%	29.7%	46.7%
France	76.3%	75.8%	-0.4%	0.7%	11.2%	13.8%	31.2%	43.1%
Spain	75.7%	75.4%	-0.2%	0.5%	10.3%	14.5%	35.1%	39.6%
Cyprus	73.9%	73.9%	0.1%	1.3%	14.9%	12.6%	27.6%	43.6%
Belgium	74.3%	73.8%	-0.5%	1.0%	12.9%	14.5%	31.5%	40.1%
Portugal	71.4%	70.7%	-0.7%	0.6%	13.8%	17.7%	36.8%	31.1%
Netherlands	64.7%	64.4%	-0.2%	2.4%	22.0%	17.5%	29.7%	28.5%
Denmark	64.3%	63.9%	-0.4%	2.1%	21.0%	18.9%	32.7%	25.2%
Ireland	60.0%	58.9%	-1.1%	2.5%	24.1%	23.2%	33.2%	17.0%
Malta	25.3%	25.3%	-0.1%	13.2%	71.0%	12.1%	3.3%	0.4%

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

This indicator is derived from a forest cover mask using a methodology developed by the European Commission's Joint Research Centre[5]. **Higher connectivity** is found within extended larger tree-covered forest patches with this approach. Therefore, most connectivity estimates at the country level range from 71% to 87%. Based on the country quintiles, an indicator above 84% may be considered very high and an indicator below 71% may be considered very low connectivity.

The **EU average** is highly influenced by areas with large continuous forest coverage, mainly in Slovenia, Romania, Finland and Sweden. Few countries show average connectivity below 70%. Forest connectivity was stable (less than 0.1% change) in four countries, whereas it decreased by more than 1.5% in Estonia, Czechia and Latvia, possibly due to logging, partly related to storms and bark beetle outbreaks.

Supporting information

Definition

The forest connectivity indicator quantifies the degree of spatial agglomeration of forest cover. It assesses structural connectivity using EU level forest.

High forest connectivity supports animal movement, plant dispersal, preserves forest microclimate[8], and genetic exchange. Connectivity maps are crucial for biodiversity initiatives, like tree planting, by identifying areas lacking connectivity. However, increased connectivity may also facilitate the spread of invasive species, pests, and diseases[9] and fire[10].

The calculation of the indicator is based on the High-Resolution Forest Type Layer from the Copernicus programme. For this layer, in line with the definition of the Food and Agriculture Organisation of the United Nations[11], forest are "land spanning more than 0.5 hectares with trees higher than five metres and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It excludes agricultural and urban land". However, for technical reasons, forest land use not covered by trees is not mapped as forest. Therefore, on the one hand, in the cased of afforestation, there is a delay between the conversion of land use to forestry (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. On the other hand, temporarily unstocked forest areas (such as clearcut or burnt areas) are not mapped as forest in this layer, which leads to considering that these areas fragment the forest.

Methodology

The methodology used for assessing forest connectivity is called Forest Area Density (FAD). FAD is the ratio of forest area with respect to the local neighbourhood area surrounding a given forest grid cell[5]. Connectivity is scale-dependent, and the scale is chosen by the size of the local neighbourhood for which connectivity is assessed, here 10 hectares. FAD measures the degree of spatial agglomeration of forest land cover and accounts for key fragmentation aspects, such as isolation of small fragments and perforations within compact forest patches[12] . It provides scalable and consistent assessments across large regions, like the EU, but does not account for specific ecological functions or species-specific needs. Unlike species-specific models, which are manifold and highly variable, FAD focuses on general structural connectivity, which is independent of habitat quality or species-specific demands. Efforts are underway to refine FAD by integrating additional data layers to complement the connectivity assessments.

The indicator is derived from the FAO compliant 10-metre resolution forest type products 2018 and 2021 from Copernicus.

The primary result is a spatially explicit map showing the degree of forest connectivity for each 10x10-metre forest grid cell. For the statistics presented in Figure 2, 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 for any given reporting level, for example, at country or EU-level. This aggregated average value indicates the overall degree of structural connectivity of forest cover in the reporting unit. This is one of the summary statistics available to characterise forest connectivity, which is mainly driven by the presence of large continuous forest patches.

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'[13]. 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[14]. Ensuring connectivity between and inside habitats is a goal set in the Regulation on Nature Restoration[15] and the EU Biodiversity Strategy for 2030[16]. The 3-Billion-Tree Pledge For 2030[17] indicates that 'afforestation should be carried out at landscape level to strengthen connectivity with natural or semi-natural areas' and therefore lead to increased forest connectivity.

Accuracy and uncertainties

Under processing

Data sources and providers

- Forest Type 2018 (raster 10 m), Europe, 3-yearly, Oct. 2020, 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
2021

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

SDG15: 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 (a single grid cell forest patch without any other forest grid cell in a 10-hectare surrounding neighbourhood), and 100% meaning full connectivity (full continuous forest cover in a 10-hectare surrounding neighbourhood). At reporting unit level, the indicator is calculated as the average value of Forest Area Density (FAD) of all forest grid cells of the reporting unit.

Frequency of dissemination

Every 3 years

References and footnotes

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6. This share differs from the 2023 release due to a change in the underlying data. The method stayed the same. The 2023 release was derived from a 10-metre resolution forest and woody vegetation layer for 2018, combining the FAO compliant 10 metre Forest type product and a generalisation at 10 metres of the 5-metre woody vegetation map product from Copernicus. This 2024 release relies on the Copernicus FAO-compliant 10-metre Forest type product for 2018 and 2021.
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