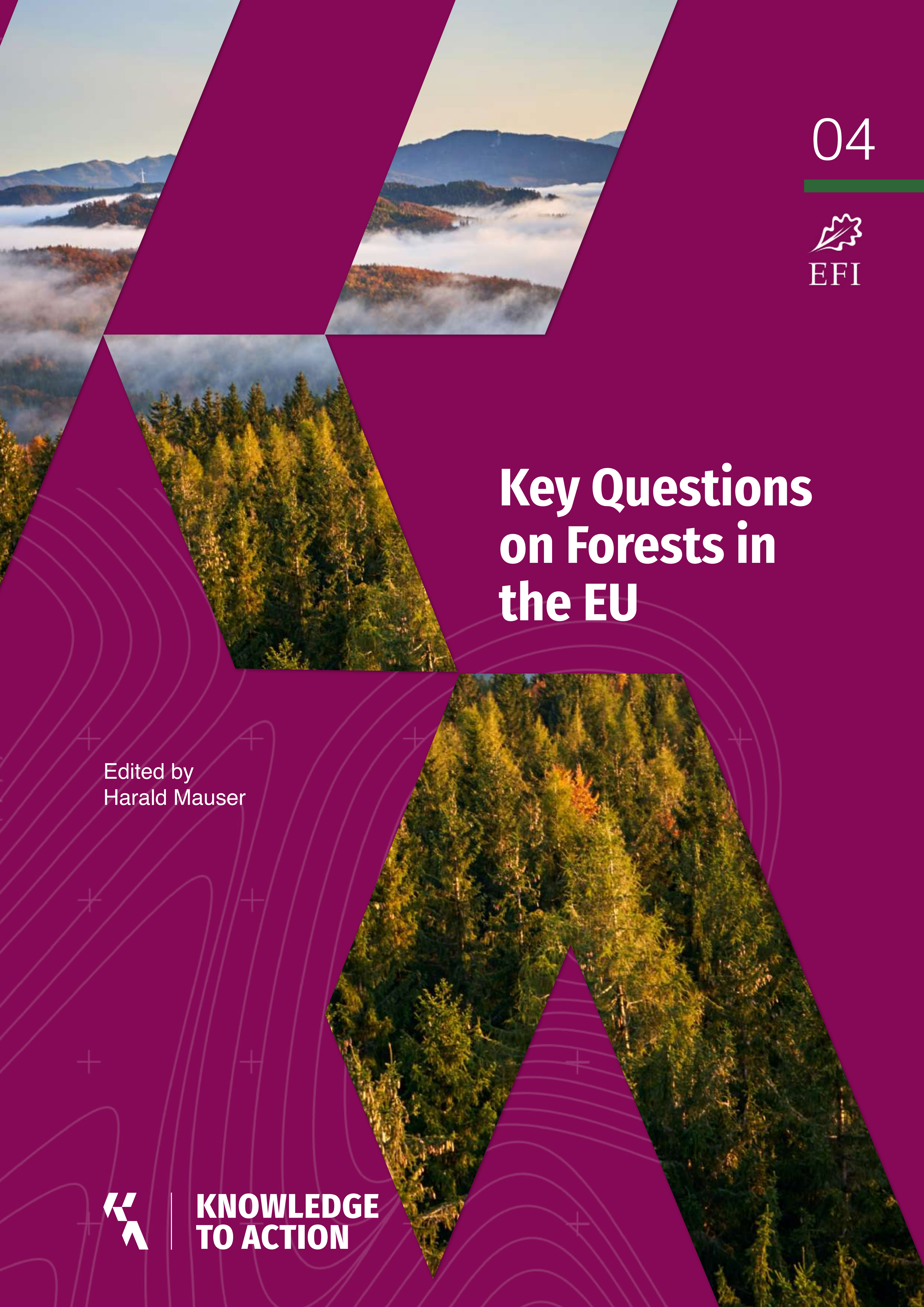

04

EFI

Key Questions on Forests in the EU

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KNOWLEDGE TO ACTION

Photo by: Florian Haider on Pexels

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EFI

Key Questions on Forests in the EU

What do you *see* when you think about forests?

A scenic landscape you want to spend time in?

A treasure you want to hand over in good shape to your children?

The wooden house you want to live in, enjoying wooden furniture and other wood-based products like paper and textiles?

A refuge for biodiversity in which you can experience nature and see wildlife?

A major carbon sink that helps to mitigate climate change?

All of the above?

The listed perceptions people have about forests demonstrate some of the many products and services that the EU's forests provide to society, benefiting citizens in numerous different ways. The expectations for forests are high, and they are subject to many and varied demands. Not all of these demands are necessarily compatible, resulting in societal and policy debates on the role of forests and their multiple products and services. Often such debates focus on the question if and for which primary objectives forests in the EU should be managed, and how.

Sound decision making needs, amongst other things, a holistic understanding of the different interests regarding forests that are represented by multiple directly or indirectly involved stakeholders, and of the complexity, diversity and long-time horizons of ecological processes and management decisions in forests. Different groups of actors tend to have a good understanding of the forest aspects they value the most or they are familiar with. But often information on other aspects and interrelations between them are rather poorly understood or downplayed. This limits proper assessment of the implications of decisions in policy and forest management. Together with myths, misunderstandings, and distrust between actor groups, these gaps impede dialogue and rational policy development.

A solid and holistic understanding of the different roles forests play is necessary to be able to design policies that help to maximize synergies and minimize trade-offs between the different forest uses.

This publication compiles key research findings in the form of 12 questions on forests in the EU and the benefits they provide to society. It aims to inform a wider range of people who are not forest experts, but who are interested in information on some of the many contributions forests make to achieving EU policy goals. Harnessing its ongoing monitoring of recent EU policy processes, EFI selected the following areas in particular: bioeconomy, civil protection, climate change mitigation and adaptation, forestry, impact on global forests, nature conservation, public health and regional development. The geographic scope is the 27 EU member states, although in specific cases it is indicated if EU 28 or European data are used.

For the sake of brevity, this publication only provides a snapshot of the available information. More detailed insights and relevant references are provided on the EFI website; a link is given under each question.

... protect you against natural hazards like avalanches, flooding or rock-falls

... help provide your water, by regulating quantity and quality of supply

... moderate your local climate, helping regulate wind, humidity and temperature

... provide shelter for wildlife and biodiversity, by offering favourable habitats and microclimates

... allow you to build and furnish your home with wood, cork and wood-based products

... heat your house and power your car via biofuels and bioenergy

... offer sustainable alternatives to non-renewable, fossil-based materials used in construction, textiles, packaging and other products, originating from wood and cork

... provide an enormous range of benefits to EU citizens

... support people's livelihoods, by providing employment and income

... help to mitigate our changing climate, by storing carbon in forests and in wood-based products

... keep you healthy with natural medicinal products and space for mental well-being

... nourish your body with berries, mushrooms, fruits and nuts, honey and game meat

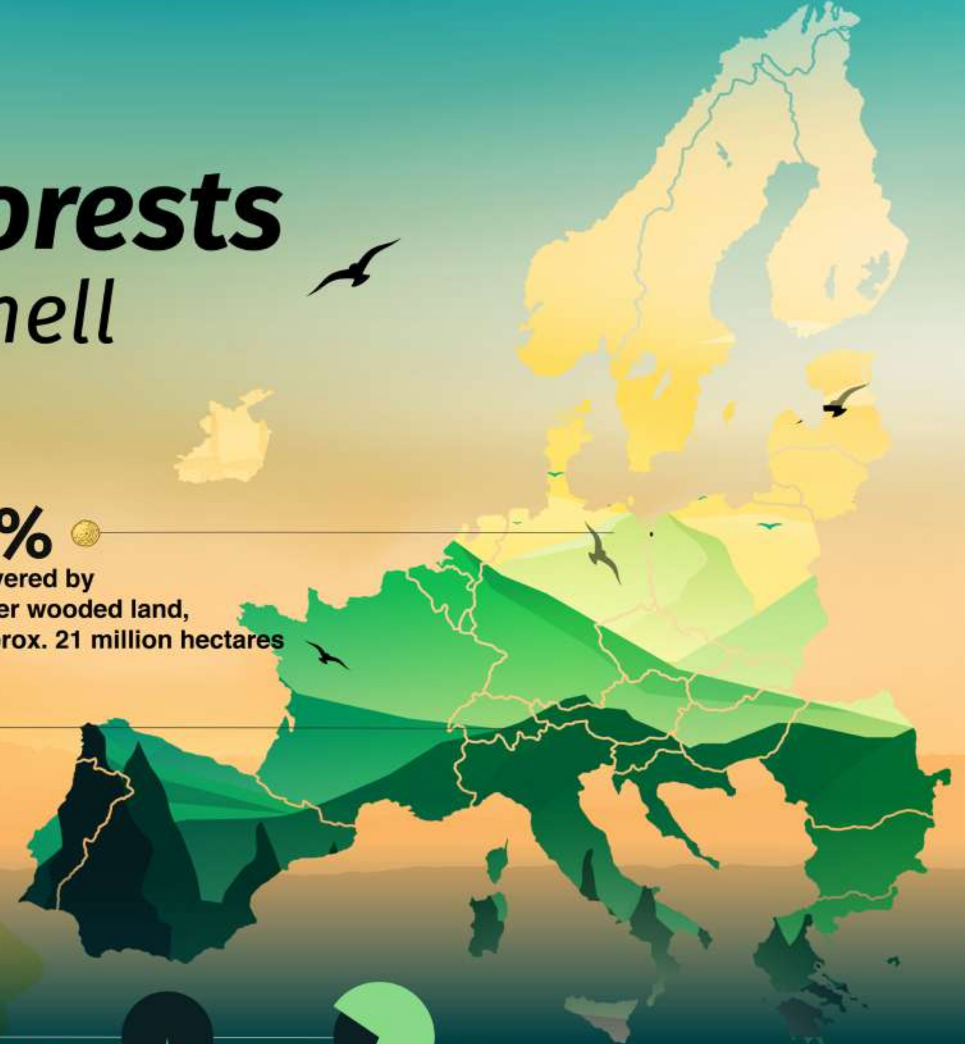
... feed your soul, offering spiritual inspiration in a haven of nature

... bring good cheer with products like resins, tanins, decorative materials, Christmas trees

... offer an inspirational setting for leisure, recreation, adventure and hunting

... are beautiful, an existential part of the landscape where you can connect with nature, experience wildlife and find peace

EU 27 forests
in a nutshell



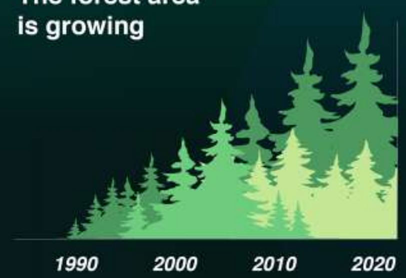
5% Covered by other wooded land, approx. 21 million hectares

40% EU territory covered by forests, approx. 159 million hectares

Forest cover varies from

- >01% Malta
- 11% Ireland, Netherlands
- <74% Finland

The forest area is growing



14 million hectares from **1990** to **2020** equal to the size of Hungary and Slovakia combined.

Sustainable forest management has enabled an increase in **wood harvesting** by

200 *million m³* between **1990** and **2018**.

This had no direct major impact on the total carbon sink in forests, due to increasing forest area and growing stock.

In 2017

Forestry, wood products, furniture, and paper added **15%** of jobs, **19%** of value added to the **EU bioeconomy**

New innovative wood-based products in the textiles, chemicals, plastics, biofuels and bioelectricity industries are not included in these figures.

In 2018

Forests removed **355** million tonnes of CO_2 from the atmosphere + An additional **42** million tonnes were sequestered in harvested wood products.

This sums up to forests sequestering 10,6 % of the EU's annual emissions in 2018.

90% In the majority of EU Member States, more than 90% of forests are accessible to the public.

58% of forests were privately owned in 2015.

The average wood harvesting intensity varied greatly in 2015 between **44%** of the annual increment harvested in Romania and **99%** of the annual increment harvested in Belgium.

85% of forests are available for wood supply and can contribute to wood harvesting.

15% of forests are not available for wood supply due to environmental, social or economic restrictions.

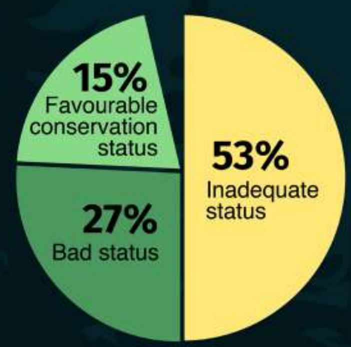
51% of forests were certified in 2015 according to PEFC and / or FSC standards.

9% of forests are within the EU Natura 2000 network of protected areas.

They cover about **22%** of the total land area *of the* **Natura 2000** *network of protected sites.*

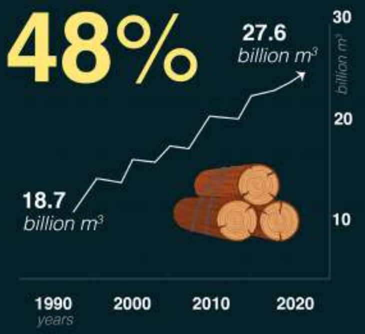
Conservation status

Forest habitats show the highest proportion of improving trends of their conservation status compared to other habitat types.



Between 1990 and 2020, the total volume of timber* in forests increased by

48%



(*i.e. growing stock)

26% of EU households collect non-wood forest products

such as berries, mushrooms, aromatic, medicinal and decorative plant material, nuts, fruits, sap and resin.

(EU 28 and including the European part of Russia).

Their economic value (including self-consumed products) was estimated to be comparable to 70% of the annual roundwood removals value in Europe

70%

Photo by: Bernadett Hiersche on Adobe Stock

1. How did EU 27 forests develop and why do they differ from those of the past?

Forests in the EU have seen major changes over time. The expansion of agricultural areas for food production and the overexploitation of forests for fuel and construction materials for e.g. mining, shipping and built infrastructure resulted in major losses of forest cover during the last centuries to millennia.

Those trends in forest cover change have reversed since the beginning of the 19th century. Forest area has been expanding through active afforestation or natural forest expansion on abandoned pasture and agricultural areas. The timing, pace and extent of this development differs between EU countries and regions. As a result of these human interventions and their interaction with natural processes, a cultural landscape has evolved with predominantly semi-natural forests. Only small and fragmented areas of primary forests remain in a few boreal and mountainous areas in the EU.

The forest resources in the EU currently cover 159 million ha or around 40% of the land area. This corresponds to an area four times the size of Sweden. The share in forest cover is largest in the Nordic countries with a forest cover of 74% in Finland and 69% in Sweden, whereas it is as little as 11% in Ireland and the Netherlands, and 1% in Malta.

As well as the extent of forest in Europe, the structure of forest resources has also been changing. Improved land and forest management practices, as well as nitrogen deposition and climate change have caused the growth rate (or increment) of trees and forests to increase over recent decades. The rate of wood harvesting has also been increasing in recent decades, but at a slower pace than the increase in wood increment. Currently, about 75% of the net annual growth is felled, but with a large variation across regions. As the annual growth rate exceeds fellings, the amount of wood and biomass standing in Europe's forests has been increasing continuously since the end of the Second World War.

Read the full story!

The management of forest resources varies greatly across Europe, depending on local conditions and traditions. Since the 1990s, there has been a trend towards more close-to-nature silviculture and nature-oriented

Photo by: Ruslan Khismatov on Adobe Stock

forest management, although this is implemented in many ways. While in the past, forests were predominantly managed as simple, even-aged-forests (i.e. all trees were the same age), management nowadays aims to increasingly develop more structurally rich forests.

Clearcutting with tree retention (typically 5-10 trees per ha) is still the dominant cutting regime especially in the north of Europe, but there is a move away from clearcutting towards small-scale harvest and selective cutting of individuals or groups of trees, especially in Central and South-Eastern European countries. When clearcutting is applied, harvesting cycles can go from 10 to 30 years in the case of fast growing species (poplar, eucalyptus, some pine or spruce species), but cycles typically exceed 80 years - ranging up to more than 200 years in Central Europe.

Tree species selection is another major management choice. For centuries, land managers, including foresters, favoured relatively few tree species for timber and fuelwood production, as well as other amenities. As a result, European forests deviate substantially from the potential natural vegetation. At the European level, economically important and widespread tree species include Scots Pine, Norway Spruce, Oak and European Beech. Scots Pine and Norway Spruce are coniferous native species in many parts of Europe. They have been particularly promoted (see box) and established outside their natural range as well as their ecological niche. However, a shift towards a larger share of broadleaved species can be observed, especially in Central Europe. Motivated by the realization of the susceptibility of coniferous forests to storm, wildfire and insect outbreaks and climate change, forest managers have been increasingly favouring broadleaved species since the 1990s.

Tree species composition is, however, not always a direct management choice. Especially in southern Europe, forests have been established in recent decades through natural forest expansion following the abandonment of agricultural practices. The tree species composition of these forests is determined, amongst many other factors, by the availability of seeds and the ability of species to reach and occupy new sites. Also, high densities of e.g. roe and red deer populations often lead to failures of deciduous species as they are selectively browsed. In addition, the historical expansion of agriculture typically occurred on fertile and easily accessible areas. The forests and tree species that remained are typically those species that can grow on less fertile soils or in harsher conditions.

WHY WERE SCOTS PINE AND NORWAY SPRUCE PLANTED OUTSIDE THEIR NATURAL RANGE HISTORICALLY?

Better ability to grow and produce sufficient timber on degraded soils depleted of nutrients by previous agricultural uses such as litter raking and grazing.

Faster tree growth enabled meeting in shorter time the increasing wood demand of a growing population and the higher wood demand after wars for reconstruction and reparation payments.

Better energy efficiency of timber processing and usability for high quality products due to stem straightness and fibre length, as well as fewer defects like knots, colouration, tensions and twists in the wood. Timber from pine and spruce was in higher demand, both from sawmills as well as pulp and paper mills.

Silvicultural management to produce good quality timber was easier.

Photo by: Anne Rauhamäki

2. Who owns the forests and how are they managed?

European forests belong to around 16 million private and public forest owners. In the EU, about 60% of the forest area is privately owned and 40% public.

Public forests are owned by municipalities, regional or national governments. Private forests may include traditional, non-industrial types of private ownership including families, farms, rural commons, churches and aristocratic estates. Industrial private owners include forest industry companies, e.g. producing pulp and paper. There are also specific types that are not fully private nor public, such as commonly owned forests by local citizens or farm holdings that go back to historical ownership forms or are triggered by social movements.

Overall, the property sizes range from below one hectare to up to several millions of hectares. However, almost 90% of private forest holdings are smaller than 10 hectares, many are even much smaller. Income generated by forest use spreads to a large number of families and individuals in society (different from income generated from e.g. coal, oil or gas resources).

Due to the different historical, legal and social circumstances, patterns of public and private ownership vary greatly across Europe. For example, in Northern Europe, around 70% of the forests are privately owned, while in South East Europe around 90% are public. While private ownership clearly dominates in western European regions, it is the opposite in Eastern Europe (see Figure 1). The extent of property rights granted to owners by the specific national legal frameworks also differs strongly, with a gradient of a greater freedom for owners in forest management in Western European countries and more legal restrictions in Eastern Europe.

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Societal and political developments, like structural changes in agriculture, urbanization, changes in lifestyles, as well as restitution and privatization after the 1989 fall of the Iron Curtain, and decentralization have led to changes in ownership patterns. When small farms are given up, the agricultural land is usually sold to other farmers, but forests are often kept in the family and may become owned by non-agricultural owners with urban lifestyles. The restitution of nationalized land to its former owners has been a major (and still ongoing)

Private forest ownership map of Europe

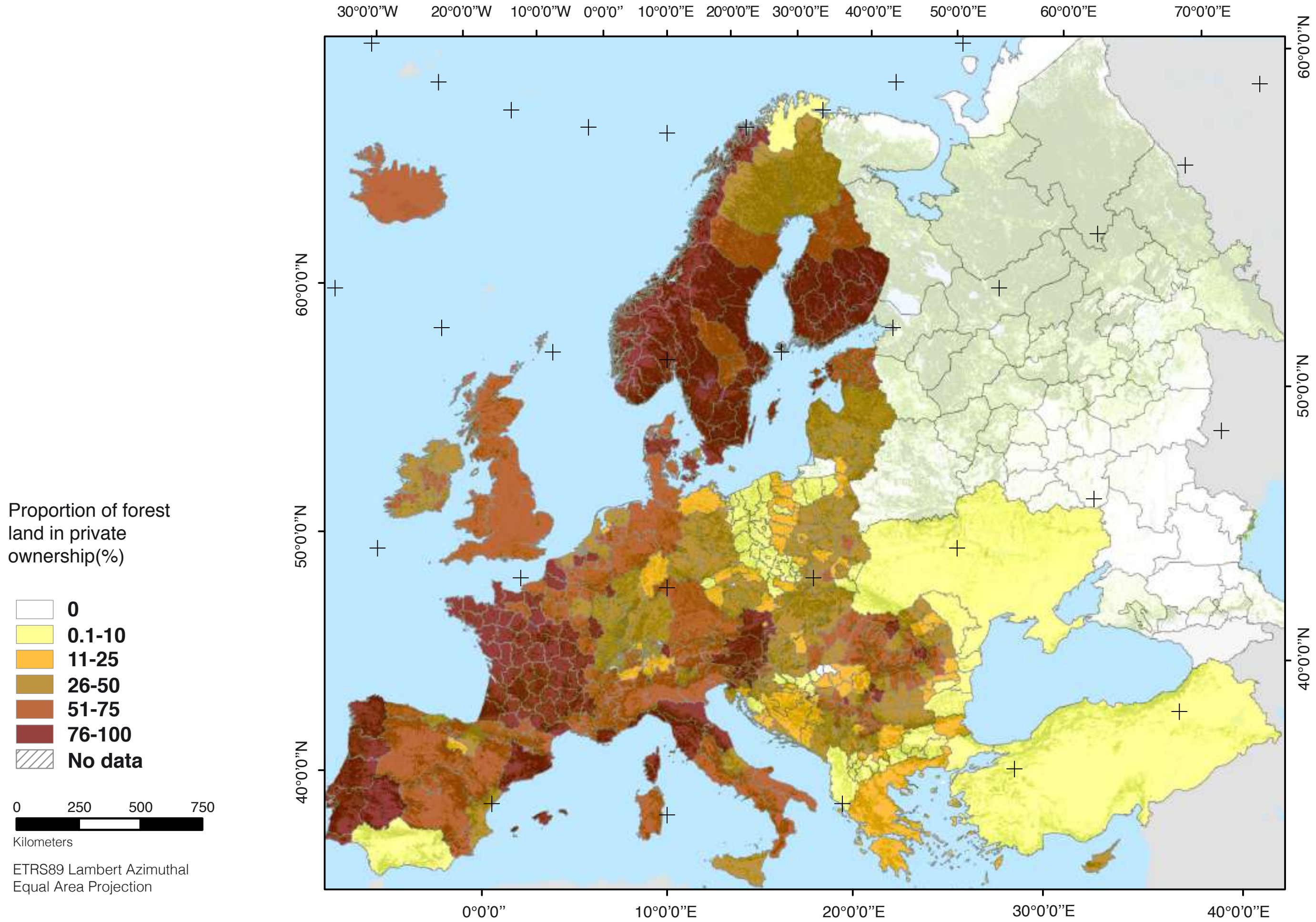

Figure 1. Distribution of private and public ownership across Europe (red-strong private, yellow-strong public) *(Pulla et al, 2013)*[1]

change in some Eastern European countries. The privatization of state forests is observed in the Baltic states.

The goals and motivation of forest owners to manage their forests vary substantially. It depends on their forest size, their connection to their property, their preferences regarding economic, environmental and social values, and their flexibility to respond to market trends. The regional setting and infrastructure (e.g. is there a local industry using wood) is also likely to have a major effect. Together this all impacts on the way forests are managed and on the products and services which are provided to society.

While state forest owners generally actively manage their forests according to political, societal and business objectives, there is a wide variation in private forests, especially in small-scale forest ownership. This may range from active market participation to self-subsistence from forest products, keeping their forest as a reserve for family investments, to altruistic motives to no management at all. Especially owners of very small properties often lack the knowledge, skills, capacities and interest in forest management.

Another important aspect is the urbanization of owners – some have little or no connection to their forests,

may live far away, or not even know that they are forest owners. This is true both for Western European countries (e.g. inherited forests owned by urban people) and for Eastern European countries where owners of restituted forests often lack bonds to their re-acquired properties. In contrast to the existing good understanding of the behaviour of traditional forest holders, in most countries there is much less knowledge about other forest owner types with their specific motives and preferences.

The more fragmented forest ownership becomes the more important (and more difficult) it is to reach forest owners for common forest policy goals. Fragmentation often leads to economic inefficiency in forest management (higher harvesting and transaction costs), disincentives for investment in sustainable forest practices, and greater management problems related to the provision of ecosystem services, including wildlife, water, recreational opportunities and soil protection. However, joint management by private forest associations, forest certification initiatives and support by advisory services can address these disadvantages. The diversity of forest owners also represents a richness since a mosaic of management approaches can increase the resilience of forests, biodiversity at landscape level, and help to provide a more diverse set of forest ecosystem services.

Photo by: Pellinni on Adobe Stock

[1] References used:
Pulla, P., Schuck, A., Verkerk, P. J., Lasserre, B., Marchetti, M., Green, T. (2013) Mapping the distribution of forest ownership in Europe. EFI Technical Report 88. 92 p.

Photo by: V Sot on Adobe Stock

3. What do people think about forests in the EU?

Citizens living in Europe appreciate forests for the many societal benefits they provide, and literally all of them consume forest-based products ranging from furniture to paper products. However, when asked about their perceptions of forests and their benefits, environmental benefits are the most well-known, and receive the highest appreciation.

In a 2016 Eurobarometer study, the benefits most often mentioned as being most important were:

absorbing carbon dioxide to fight climate change
66%

providing animals with natural habitats
63%

protecting people from natural disasters such as floods and avalanches
40%

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The economic potential of forests – for example their ability to provide wooden products and energy, their contributions to employment, green jobs and rural development- did not score highly. Neither did their importance for healthy leisure activities, although there are large regional variations in Europe as outdoor recreation is much more appreciated in the North compared to southern member states. But during the COVID-19 pandemic in 2020, recreation opportunities in forests have been heavily used. Their importance for recreation, health and well-being is well documented in the literature (see Question 8).

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In 2018, 39.3% of the EU population lived in urban areas such as cities, 31.6% lived in peri-urban towns and suburbs, and 29.1% lived in rural areas. While there are differences with regards to respondents' country, age, gender, education and in some cases between people living in rural or urban areas, the overall perception of forests is remarkably consistent across the continent: the environmental benefits of forests are perceived as most important. In particular, female, higher educated individuals or urban citizens tend to give comparatively higher preference to the environmental benefits of forests than male, less educated and rural citizens. Wood and wood-based products such as for construction purposes, composites, chemicals, packaging, textiles or fuels are appreciated as they are substituting fossil-based materials. However, citizens have little knowledge about them and are concerned about their environmental sustainability.

Some studies indicate a general satisfaction with forest management, albeit with regional differences and partially negative perceptions of forestry operations. People with a professional background in forestry and/or forest owners and managers show significantly higher support for silvicultural operations and the economic use of forests than the general public. Visible signs of (intense) wood harvesting (especially clear-cuts, impacts of harvesting machinery on forest areas and forest roads) are frequently perceived negatively by citizens. In turn, mixed and rich structured forests and close-to-nature management are the preferred management options. Trees with large dimensions are perceived as beautiful. However, studies show some differences between verbally stated and visually stated preferences using photos. Apparently, there are trade-offs between societal preferences regarding forest ecosystem services and forestry objectives when these are translated into concrete forest management interventions. They might not be considered by the general public when surveyed.

Some studies point out that a relatively high share of respondents feels rather poorly informed about forests and has little knowledge about the purposes and effects of forest management. This indicates a need to improve information, education and communication on forests and their management, also explaining the synergies and trade-offs between different forest ecosystem services related to different management practices.

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4. How has climate change affected EU forests and what might happen next?

Climate change is ongoing, and global temperatures are now more than one degree above pre-industrial levels. As well as the warming trend, extreme weather events and other disturbances have been amplified, often connected to climate change.

Recently, especially during the 2018-2020 summers, European forests have been affected by severe droughts, a series of windstorms, more severe and widespread wildfires, rapidly expanding bark beetle infestations and several other pest and disease outbreaks. Damage to forests caused by extreme events and disturbances as well as interactions between disturbances (such as bark beetle outbreaks following windstorm or drought damage) have increased in recent decades and are projected to increase under climate change. This is a major challenge for future forest management.

Climate change and associated extreme events are already affecting the growth and stability of forests in Europe. Improved forest growth has been observed in northern parts of Europe and in higher altitudes of mountainous regions (e.g. mountain treeline changes). Negative tree growth has already been reported, for example for spruce and beech in Slovakia and Belgium. Drought-induced growth declines have increasingly been observed at the dry distribution limits of tree species such as in southern Switzerland or Spain, but also in temperate lowland forests following the drought year of 2003. Forests are particularly vulnerable at the warm and dry tree species distribution limits, where intensified drought impacts and wildfire risk are particularly large and no other tree species are available to replace them.

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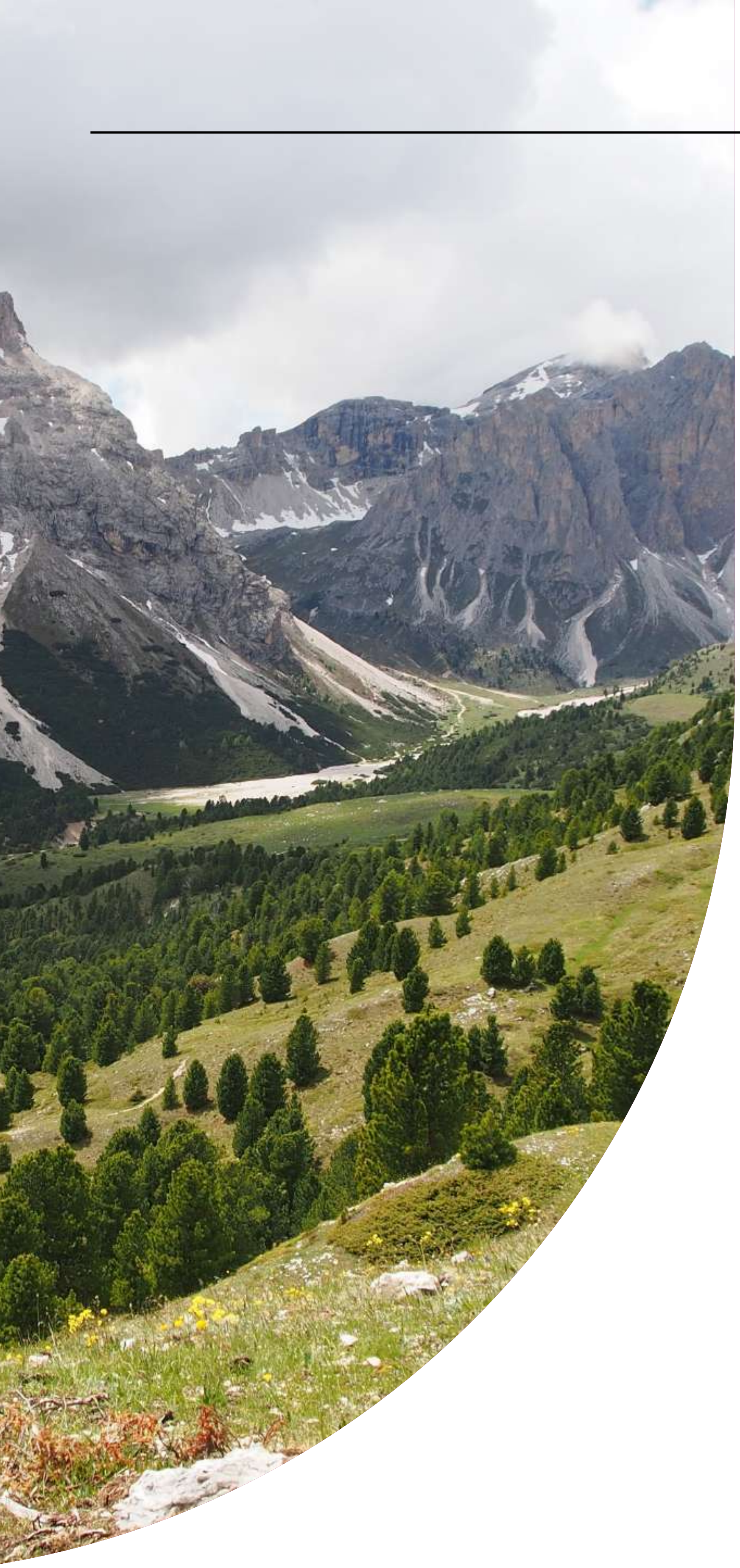
The recent exceptionally long and intensive drought in Central Europe from 2018 to 2020 drastically exceeded previous impacts and resulted in widespread mortality in different species. It caused an unprecedented large-scale bark beetle outbreak, which affected particularly Norway Spruce forests planted outside their native range in Central Europe. This led to salvage cutting on more than a million hectares. Drought-induced mortality also affected several other species including beech and Scots pine within their native range, and partially even native mountain spruce



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forests. Saturated wood markets, collapsing wood prices and subsequent economic losses for many forest owners followed, especially in the Czech Republic, Austria and Germany.

In the future, forest growth and tree species composition in Europe is likely to change, but the location, the amount and partly even the direction of this change is hard to predict. This is due to a number of fundamental uncertainties regarding the:

- ***level of climate warming during the 21st century.*** Future impacts might be magnified if the world fails to meet the Paris Agreement targets.
- ***future evolution of extreme events in a changing climate***. Some of the recent extremes were caused by changing global weather circulation patterns. It is unknown, how they will reoccur and how much worse they could get with continuing climate warming.
- ***effect of increasing CO_2 concentrations in the atmosphere and their impact on forest growth and water use efficiency.*** Increasing CO_2 concentrations in the atmosphere stimulate forest growth with slightly less water uptake. However, interactions with other growth limiting factors (nutrients, water) will likely reduce these effects in the future.
- ***combined effects of productivity changes and disturbance impacts.*** Climate change may enhance forest productivity in years with average climatic conditions, but these gains may be lost or even reversed due to more frequent or intensive disturbances. Therefore, it is necessary to interpret climate change impacts on productivity and disturbance regimes together. Such integrated and quantitative assessments are missing for the EU.
- ***adaptive capacity of land owners, trees and forest ecosystems.*** Locally prevailing species and genotypes get increasingly maladapted. There is only limited knowledge on how trees can adapt to novel climate conditions close to their physiological limits.

The present rate and magnitude of climate change exceeds the speed of natural tree species migration. Active management is therefore needed to enable the future existence of forests and their sustainable management. This could for example be achieved through artificial planting or seeding of better adapted genotypes or species currently not available at the site (so called “assisted migration”).

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5. To manage or not to manage – how can we support forests to mitigate climate change and adapt to its impacts?

Forests play an important role in the global carbon cycle that can help to mitigate climate change via three pathways:

Forests remove carbon dioxide from the atmosphere and store carbon in biomass and soil.

In forests managed for wood supply, part of the carbon (mainly in tree stems and major branches**) is extracted from the forest during harvest.** If the wood is used for materials, the carbon is stored in wood products and only released at the end of their life (which may include one or more phases of recycling).

In addition to carbon storage in forest ecosystems and in wood products, **using wood can avoid or reduce fossil greenhouse gas emissions** by replacing (substituting) products or fuels that emit more greenhouse gases during their production, use and disposal (e.g. steel, concrete).

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Possible approaches for forests range from *no management* with the (sole) aim to store carbon within forest ecosystems to *active management* aiming either to strengthen carbon storage in forest ecosystems (e.g. through tree species selection, breeding, thinning, cutting regimes, etc.) or to strengthen carbon storage in forest ecosystems and in wood-based products and avoiding emissions through substitution effects. An open key question is if forests which are left unmanaged provide larger CO_2 emission reductions than forests managed for the production of wood (with carbon storage in wood products and substitution effects).

Scientific studies to tackle this question may even appear contradictory because they reflect different views and approaches. The carbon effects of managed and unmanaged forests are generally found to be affected by the assumed forest dynamics (growth rate, mortality, disturbances). In the case of managed forests, other relevant factors include the types of forest management, of wood products considered, and the non-wood products that are substituted, and how these products have been produced. In addition, the comparison of managed and unmanaged systems is hampered by limited information on the natural dynamics of unmanaged forests and by uncertainties on the impacts of climate change (see Question 4). Europe's forests are affected by climate change and this is expected to continue in the future with changes of productivity, tree species suitability and extreme events and disturbances.

Especially in a transition from a managed to an unmanaged forest, it is unclear how ceasing management would affect forest development and its carbon balances under climate change. The present rate and magnitude of climate change (including the effects of natural disturbances) exceeds the speed of natural tree species migration and their capacity to adapt to the changing conditions (see Question 4). Ending management limits the possibility to strengthen forest resilience to climate change through *adaptive forest management* – for example by increasing species diversity, introducing better adapted species and provenances - implementing sanitary fellings to contain invasive pest species, reducing the amount of burnable materials in fire-prone areas, etc.

When looking at carbon balances, it is also essential to consider consequences beyond the local level. Reducing wood production may lead to gains in carbon storage in forest ecosystems at one location, but these gains may be offset through the international trade of wood and wood products causing deforestation or degradation elsewhere (a "leakage effect"). There is an increase in material demand due to a growing world population and rising levels of prosperity. The reduced production and use of forest products may result in increased use of competing, non-renewable materials, often with larger carbon footprints, such as steel and concrete.

In most of the EU regions, selling timber is the dominant source of income from forests to fund the costs of the establishment and adaptation of forests to new climate conditions. Changes in forest management limiting the supply of wood have consequences for the economic performance of forest owners, but also for the wood-processing industries and regional economies (see Question 10).

A holistic evaluation is therefore needed to understand the full consequences of changing forest management in supporting climate policy. To strengthen the long-term contribution of forests and forestry to climate change mitigation, as well as the resilience of forests to climate change, the best strategy will therefore be a mix of measures that takes into account regional conditions. This mix combines conservation approaches to strengthen carbon storage in forest ecosystems, as well as active management approaches to store carbon in forest ecosystems and wood products, and avoid emissions through substitution.

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6. How does forest management affect biodiversity?

Most forests in Europe have a long history of human use and have been altered in one way or another (see Question 1). Still, forests are one of the ecosystems with the highest biodiversity. Old-growth and natural forests are particularly valuable for biodiversity and carbon storage. Some intensively managed forests (e.g. coppice forests) can also have high conservation value.

Today 94% of Europe's forests are classified as 'semi-natural' (with regards to tree species composition, regeneration, age and stand structure), 2% are undisturbed by man (mainly found in North, South-East and Central Europe) and 3% are plantations. Since the majority of forests is managed (including forests with a less strict protection status, e.g. Natura 2000 sites), forest biodiversity conservation heavily depends on best-practices of forest management. However, in nearly 24% of European forests, management must take special care to conserve biodiversity as stipulated by the EU Birds and Habitats Directives.

Very often the impact on biodiversity depends on the intensity of forest management. High intensity measures like clear-cutting result in the temporary removal of all trees. Reduced impact logging, like single tree selection, is an example of a low intensity timber harvesting technique. All types of management change some properties of the forest and hence may favour some species - e.g. light loving species in a clear-cut system - while disadvantaging others.

Forests managed primarily for timber production often lack the late development phases found in natural forest ecosystems. Many species live or are dependent on habitat trees, typically large and old trees that bear microhabitat structures such as cavities, cracks, breakages, deadwood, epiphytes or provide possibilities for nest building. Lying and standing deadwood is home to many specialized organisms, in particular saproxylic invertebrates (e.g. insects) and wood decomposing fungi, and in addition contributes to improving the nutrient balance in soils and to preserving water. It is therefore of high importance for biodiversity to integrate these elements of old-growth stages into forests managed for wood supply, i.e. considerable amounts of deadwood, old trees with microhabitats, diverse stand structures or forest gaps.

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Forest management may also aim to increase biodiversity through mimicking natural disturbances, e.g. by prescribed burning, creating gaps of different sizes, and increasing the amount of coarse woody debris.

In addition, the choice of site-adapted tree species is a fundamental forest management decision that influences biodiversity. This not only directly influences tree species diversity, but indirectly affects forest biodiversity, as numerous species have co-evolved and thus depend on specific tree species or species groups. A prominent example is the spotted nutcracker that in its European range depends heavily on the nuts of Swiss pine. The lack of co-evolution is often the reason why, overall, fewer native animal species profit from introduced tree species.

Forest management practices influence forest structure and biodiversity in many different ways, but there is no one-size-fits-all-solution for optimizing biodiversity in forests because of the different demands of forest dwelling species. While forests managed for a range of different ecosystem services will always differ from natural forest ecosystems, silviculture has many options to better integrate biodiversity conservation by imitating natural processes and integrating old-growth forest elements.

Read the full story at: **www.efi.int/forestquestions/q6**

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7. What role do forests play in the water cycle?

Clean fresh water has become a key asset of the 21st century, as continued rise in demand and global change induced drought are leading to chronic shortages in many countries. Forests play an essential role in the stable provision of clean, fresh water and related ecosystem services, such as drinking water, protection from floods, erosion and landslides, and climate regulation.

Trees are multi-tasking water engineers, acting as:

A giant umbrella
Trees have more leaf area than other vegetation, so their canopies are more effective in tempering the erosive forces of rain and creating a more shaded and humid microclimate.

A water pump
Trees have deeper roots, so they can pump up larger soil water volumes for transport to the leaves, resulting in more biomass production, transpiration and precipitation. A big oak tree transpires up to 1600 litres of water per day. European forests transpire about 400 mm per year, or roughly half the rainfall on the continent.

An air conditioner
High evapotranspiration from trees and forests ensures a strong cooling effect on their environment, especially in urban heat islands.

A water tank
Their large litter production and extensive root systems lead to more soil carbon and better soil water infiltration, which improves water retention in the soil and groundwater recharge.

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The exact role of forests in the water cycle has been much debated. In older literature forests were described as "sponges", emphasizing the water buffering capacity of their crowns, roots and soils, moderating flooding and equalizing river flows. But more recently, the multiple benefits generated by green water services of forests (biomass production, microclimate formation, erosion control, atmospheric cooling and precipitation recycling) have been recognized in addition to blue water services (groundwater recharge, water provision for aquatic systems and human needs, Figure 2). As a consequence, the idea of trees as water hogs has been replaced by an integrated approach recognizing the trade-offs between the multiple green water related benefits of trees and their water consumption.

Several principles of water-friendly forest management are well established to manage synergies and tradeoffs in the bundle of water-related ecosystem services forests can provide:

- Essential is avoiding deforestation especially in erosion-prone areas, limiting the area of clearcuts especially on steep slopes, and reducing surface run-off and sediment loss. Land degradation and the loss of tree cover worldwide contribute to the loss of soil carbon, infiltration, water retention and groundwater recharge, with the consequence that drying landscapes become more prone to drought and wildfire.
- Restoring forests along riverbanks contributes to water quality and flood resilience.
- Optimizing the location of intensive plantation forestry with fast-growing tree species can temper evapotranspiration where needed and therefore lead to increased water harvest.
- In drinking water production areas, broadleaved forests are preferred over coniferous because their lower time-averaged leaf area yields more water and reduces contamination of aquifers.
- In the context of climate change and increased summer drought, higher thinning intensity stimulates forest vitality and tree growth. The mixing of tree species often leads to complementary soil exploration by roots and may contribute to improved drought tolerance.
- Greening cities with trees cools urban heat islands and mitigates peak flows.

Moving beyond the scale of forest stands and river catchments to the regional and continental scale reveals the breadth of forest-water interactions. Forest canopies massively produce biological particles that serve as condensation nuclei for rain formation. The evapotranspiration by forests recycles rain into clouds (green water flows in Figure 2), impacting wind and weather patterns and creating "flying rivers" over continents that ensure downwind rainfall deep into continental interiors. This helps to sustain rainfall in many of the major crop producing areas of the world. Therefore, forest protection and sustainable management contribute to global social-ecological stability.

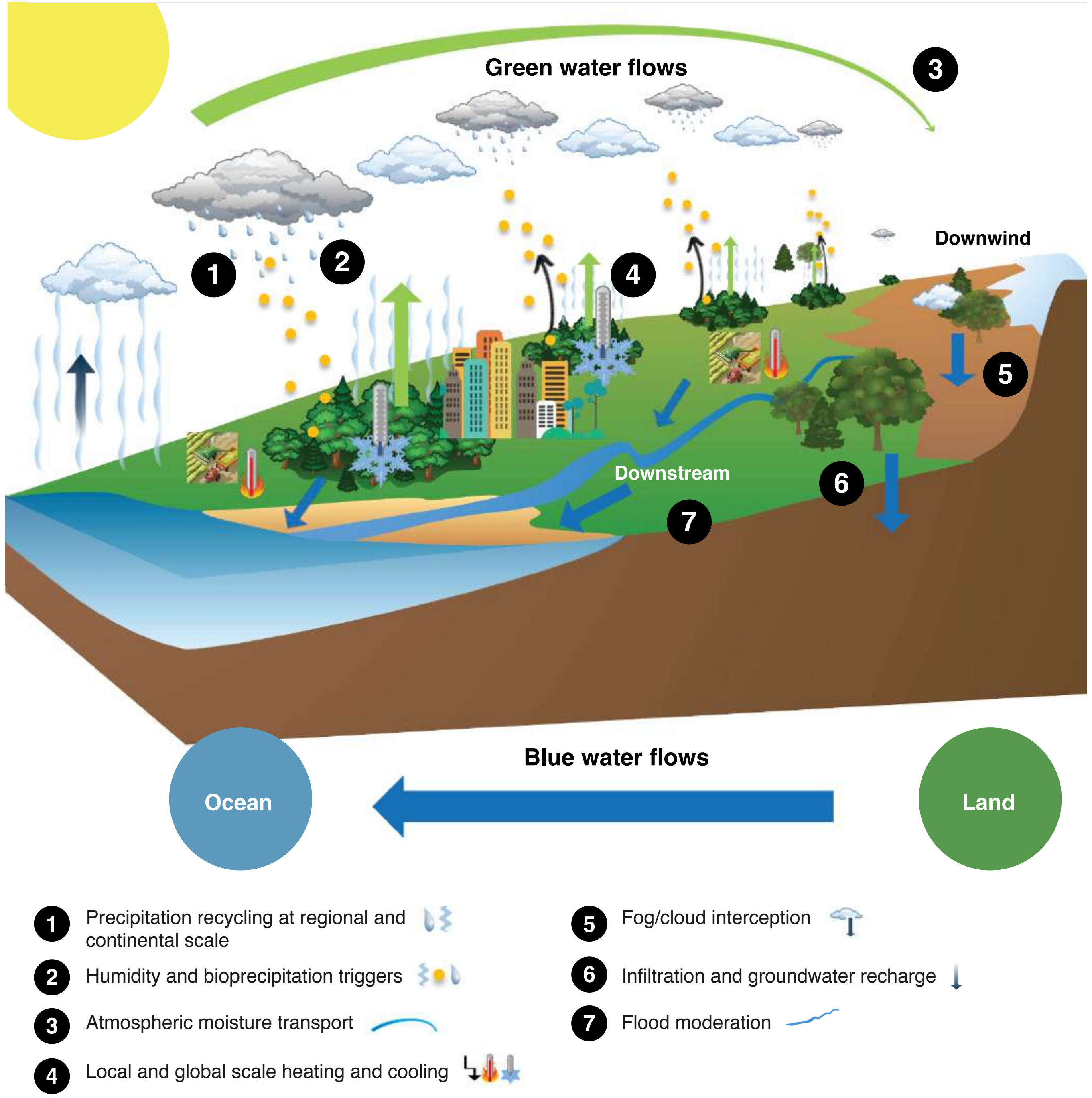

Figure 2. Forests balance blue and green water flows in the landscape.
Green water: water that is intercepted or taken up by plants and returned to the atmosphere by evapotranspiration.
Blue water: water that is running off or percolates and ends up in aquifers, rivers and lakes.
Numbers 1-7 show the water cycle processes that are enhanced by trees and forests.
(modified after Ellison et al. 2019 and Falkenmark & Rockström 2005) [2]

[2] References used:
Ellison, D., Wang-Erlandsson, L., van der Ent, R. & van Noordwijk, M. (2019). Upwind forests: managing moisture recycling for nature-based resilience. Unasylva 70.
Falkenmark M., and Rockström J. (2005). Balancing water for humans and nature; the new approach in Ecohydrology. Earthscan, 247p.

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8. How can forests improve human health and well-being?

Forests have positive proven effects on physical, mental and social health as well as individual well-being. This is important during crises, such as the COVID-19 pandemic, as well as in the public health context in tackling chronic problems such as obesity, depression, and the related loss of work days. The impacts of forests on human health and well-being can be indirect or direct in nature, but are generally found to lead to both short-term and long-term health improvements.

Forests provide ecosystem services such as highly nutritious food supplements, fuelwood, medicinal plants, clean water, protection against natural hazards, and income, all of which *indirectly* impact human health and well-being. Another contribution of forests to human health is related to better environmental quality in and around forest areas, including urban green spaces (see also Question 9).

In terms of *direct effects*, a walk in the forest has a positive influence on the nervous system as heart rate and blood pressure decrease. Forest-based health care activities can improve the quality of sleep and encourage regular physical exercise. Being in a forest environment also has a positive effect on the human emotional state. It contributes to recovering from stress-related exhaustion. People feel more balanced and in a better mood after regularly visiting forests. In the case of hospitals and other healthcare facilities, viewing green spaces can measurably reduce patient stress and improve health outcomes.

Natural settings such as parks, woodland and forests, facilitate social contact and foster communication between different user groups. Programmes of health interventions delivered in such spaces have the potential to positively impact particularly vulnerable groups, such as children and youth, people with low income, with disabilities or people with a migratory background. This could support better social integration. Access to forests, the quality of their management for public enjoyment and proximity to large populations are key factors in maximizing their value for health and well-being. Forests, along with other green spaces need to be viewed as a key component of a green

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infrastructure benefiting public health.

Lock-down phases in the EU during the COVID-19 pandemic have revealed forests to be a critical infrastructure for human health and well-being in times of restricted freedom of movement and assembly. Visitor numbers in urban green spaces and forests around urban agglomerations have increased and new user groups have started to visit forests.

The impact of wood used as a building material on human health and well-being remains a subject for research. There are indications that the stress levels of people living in wooden buildings are generally lower, and that wooden buildings create more healthy interior climates through summer and winter. Wood used in interior design (furniture, flooring, cladding) contributes to self-perceived wellness.

The role of forests for human health and well-being need more research on the many benefits, the dose-effect relations and for improving forest-based care activities. For this, cross-sectoral cooperation with public health professionals, urban developers, and other sectors is encouraged. Additionally, the growing interest in this field represents an opportunity for businesses with innovative approaches towards forest-based health interventions and green care activities to emerge.

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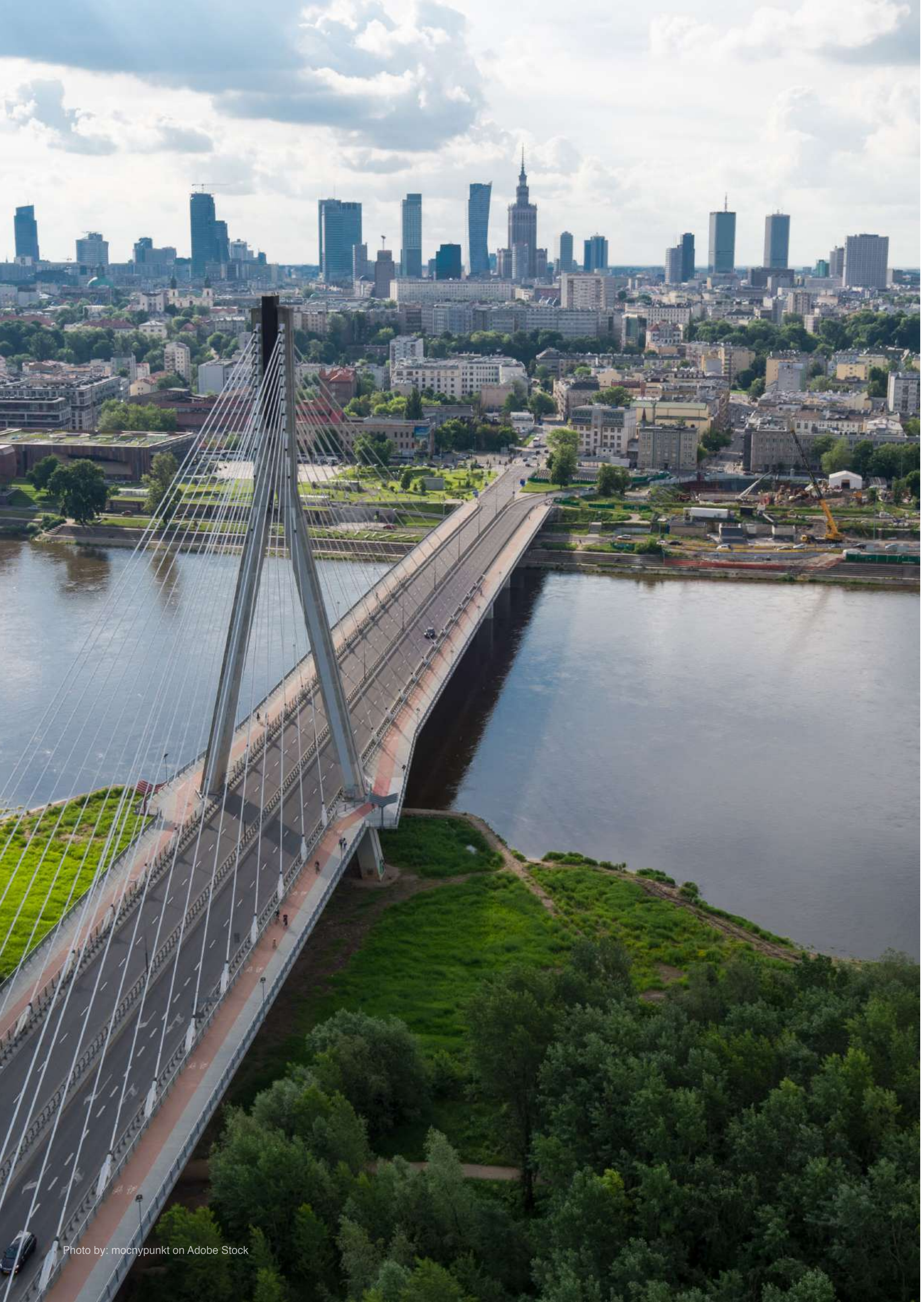

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9. How can trees and forests support sustainable and climate friendly cities?

Forests and trees contribute to climate-smart cities in two ways: by providing renewable, bio-based products (particularly for construction and renovation), and by providing ecosystem services important for climate management and well-being.

As 70% of the global CO_2 emissions are from cities, wood can play a crucial role in the construction and renovation of their built infrastructure by storing carbon and substituting other, more climate unfriendly materials, such as concrete, cement and steel. This shift is being driven by urban designers and architects who are looking to make their developments carbon neutral or carbon negative. Indeed, there is plenty of scientific evidence that using wood products instead of e.g. concrete, steel, synthetic textiles, oil or coal, helps to reduce CO_2 emissions. Moreover, by integrating wood-based products e.g. in buildings and furniture, carbon is stored over longer periods.

This role is likely to increase further as most cities are growing. With their high concentration of resources and people spread over a relatively small geographic area, cities are uniquely positioned to drive modernization including the use of renewable bio-based products in a circular economy.

Forests and trees in and adjacent to cities and towns, including individual trees and smaller urban woods, are fundamental components of the urban fabric. They provide a variety of ecosystem services of importance in sustainability, climate management and the well-being of urban dwellers. For instance, urban and peri-urban forests and trees improve air quality, protect against flooding, and moderate extreme climate events as well as urban heat islands. Even in the densest parts of cities, urban trees and woodlands are a resource that facilitates nutrient cycling and groundwater management.

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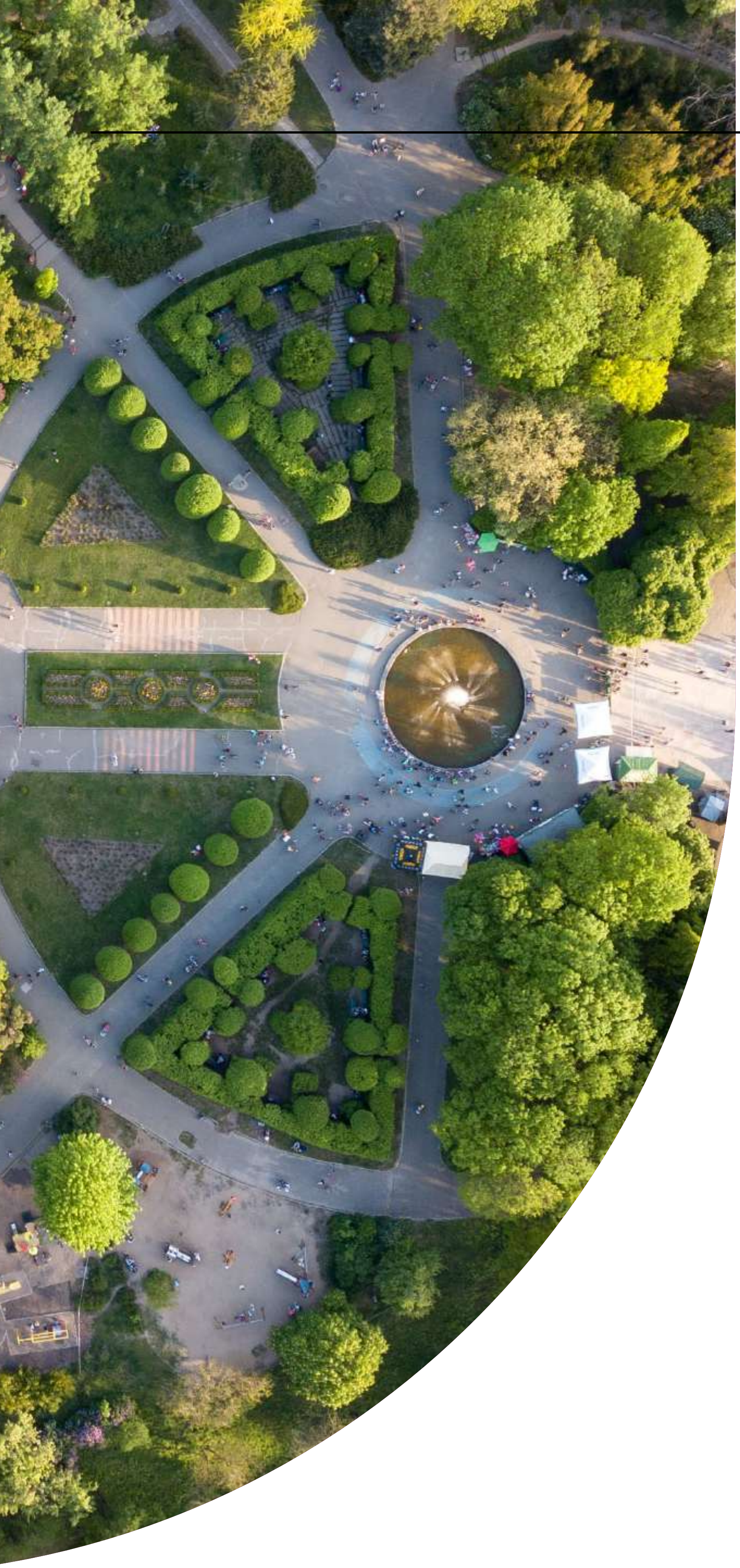
There are notable indirect benefits as well: due to their cooling and shading effects during summer, urban forests and urban trees reduce the use of electricity for air conditioning, hence avoiding carbon emissions. Shade provided by trees leads to lower indoor temperatures in summer. Combined



with a decreased urban heat island effect, this may lead to up to 90% less cooling energy needed. The windbreak effects of urban forests and urban trees can lead to energy need reductions of 20% in winter times.

Urban forests also provide places for sports, recreation and mental restoration, thus improving human health and well-being (see Question 8). In that role, urban forests and trees strongly influence a city's attractiveness and resilience. Finally, trees are an important part of the ecological networks and green infrastructure that connect urban, peri-urban and rural regions. However, potential disservices have to be duly considered, for example allergenic reactions to tree pollen and risks associated with falling trees or branches.

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10. How does forest management and the use of wood contribute to economic prosperity and employment?

Most of the forests in the EU (85%) are available for timber supply, which is an important pillar of the forest's role in income generation, employment and the transition towards a bioeconomy. Forests provide the materials for both traditional and new wood-based products and their related sectors and value chains.

For forest owners in the vast majority of EU regions, selling timber is the dominant source of income from forests. However, forests also provide non-wood forest products such as mushrooms and berries, and in some regions, the income generated by collecting these products and providing them to markets is economically more important than selling wood. A recent study estimates their annual value in Europe (EU 28 and the European part of Russia) to be 23.3 billion euros. This is comparable to 70.7% of the annual roundwood removals value. For about 1.7 million European households, marketing of non-wood forest products is the main income source.

There are no representative quantitative data on how forest-based income is distributed across forest owners in the EU. Pursuing income from forest management is strongly linked to the size of forest holdings: many small-scale forest owners consider forest management financially unrewarding, and forest-based income is more important to forest owners in Western and Northern Europe than in Eastern Europe.

The EU's forest-based industries, as defined by the European Commission, cover a range of downstream activities including woodworking industries like sawmills, panel, flooring and parquet production, large parts of the furniture industry, pulp and paper manufacturing and converting industries, as well as the printing and publishing industries. However, it is difficult to categorize industries into wood and non-wood products, due to dependencies between different production systems. Some 400,000 enterprises were active in these industries across the EU in 2018, making up 20% of all manufacturing enterprises.

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In 2017, the gross value added of the forest-based industries was EUR 129 billion or 7.1 % of the total manufacturing industry in the EU. Forest-industry companies are also major corporate tax payers, contributing to both public finance, and via their employees to state and municipal taxes.

There are significant regional differences, but around 484,000 people worked in the EU forestry sector in 2017, including forest management, logging and tree nurseries. The forest-based industries in the EU 28 employed 2.5 million people in “Manufacture of wood, paper, printing and reproduction” and 2.2 million people in “Manufacture of furniture and other manufacturing”. To a small extent, figures on employment in these manufacturing sectors go beyond the forest industry sector. So in total, EU 28 employment in the forestry and extended wood-based value chains amounted to around 4.5 million people in 2018.

It is estimated that the wider bioeconomy contributes to almost 9% of the EU 27 labour force and 4.7% of the EU 27 GDP. The sectors of forestry, paper production and other traditional wood products employ more than 15% of those persons working in the growing EU bioeconomy, and contribute about 19% of its added value. However, new bio-based products made from wood, like textiles, chemicals, bio-plastics and bio-fuels, are entering the markets, but are not yet well covered by economic and employment statistics. The statistical data currently available do not fully reflect the contribution of forestry and the forest-based industries to other industrial sectors.

In addition, forests also facilitate other economic sectors. They protect human living space against natural hazards and establish an attractive environment that enables the tourism, recreation and health sectors to contribute to regional economies.

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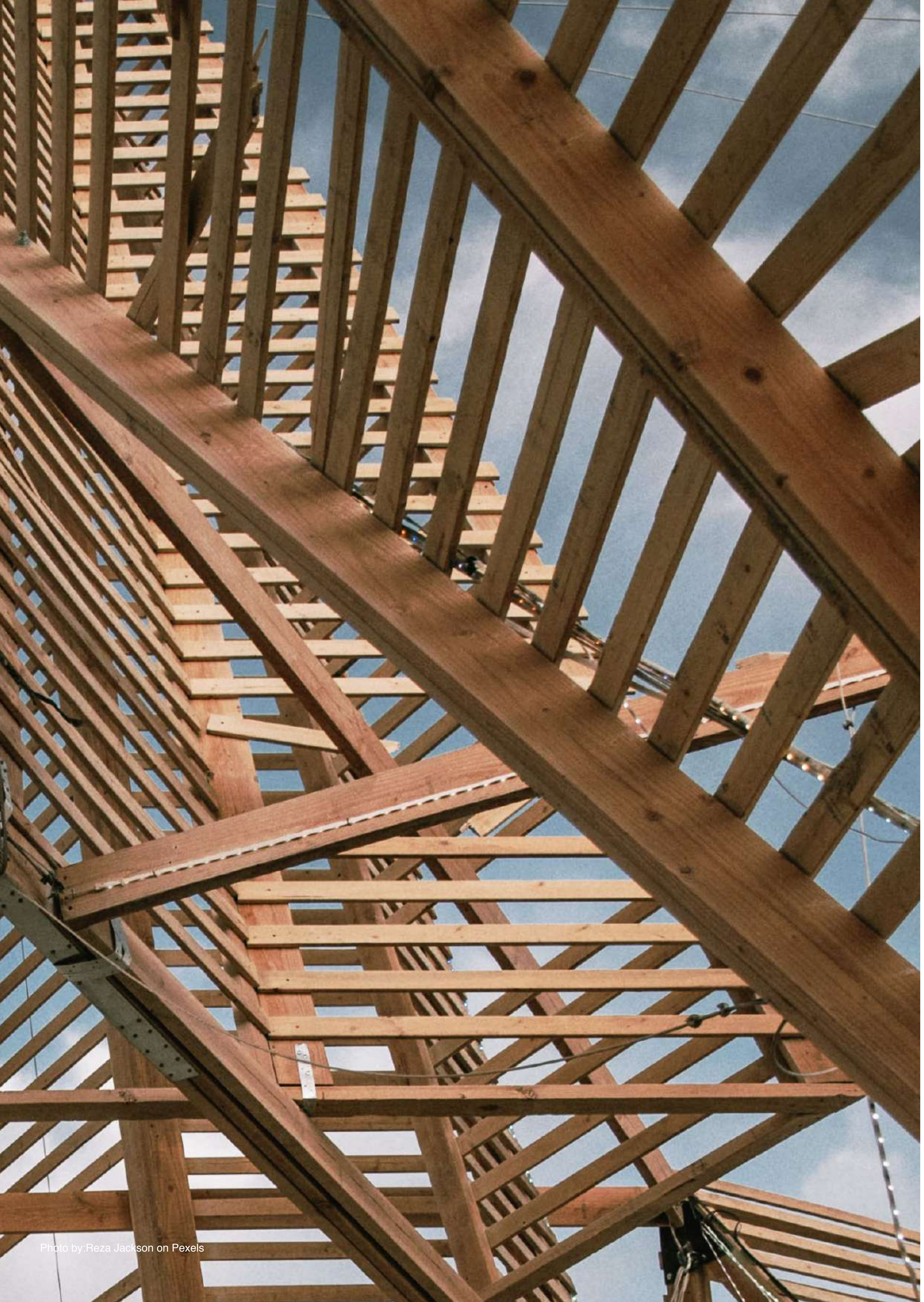

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11. How can a forest-based bioeconomy support biodiversity and climate neutrality?

Forests and forestry play a key role in climate change mitigation. Reducing deforestation and forest degradation lowers greenhouse gas emissions and forest management and afforestation can maintain or enhance forest carbon stocks and sinks. In addition, wood products can store carbon over long time periods and wood products can substitute for emissions-intensive materials.

For example, when using wood instead of concrete and steel as a construction material, emission reductions can be achieved by less energy-intensive construction processes and materials. It has been estimated that by using 1 tonne of wood for structural construction instead of concrete and steel, it is possible to avoid 2.4 tonnes of CO_2 emissions on average.

Forestry is the first stage of most forest-based bioeconomy value chains, providing the biomass used by society in many different ways to generate products and energy. Because it modifies forest structure and composition, biomass production has a profound impact on forest ecosystems and the habitats of forest-dwelling species. This could have a considerable negative impact on biodiversity, in particular if this leads to intensified biomass removals (see Question 6). However, a forest-based bioeconomy also provides many opportunities for supporting biodiversity since it puts emphasis on mitigating climate change, preventing deforestation and reforesting abandoned farmland and degraded areas. Sustainable forest management integrating biodiversity conservation measures, ecological forest management approaches, and agro-ecological approaches integrating more trees in farmland all have beneficial effects for biodiversity.

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Using forests for wood-based as well as non-wood-based forest products establishes an economic interest for forest owners and other stakeholders to engage in sustainable forest management, to maintain and develop their natural resources and favourable ecological status in the long run. Different market mechanisms under development for financially supporting various ecosystem services can serve the same purpose. Economic interest can

therefore create the motivation and financial possibilities for acting against forest disturbances, and maintaining biodiversity and ecosystem services.

Climate Smart Forestry could help to combine objectives related to biodiversity and climate. It involves a mix of measures which aim to reduce emissions of greenhouse gases, build resilience in existing forests, and increase forest productivity. It seeks synergies with other policy objectives such as enhancement of biodiversity, provision of other ecosystem services from forests, and the establishment of a strong bioeconomy. Climate Smart Forestry can help implementing regionally tailored actions under the Paris Agreement by (a) increasing the total forest area and avoiding deforestation, (b) connecting mitigation with adaption measures to enhance the resilience of global forest resources, and (c) using wood for products that store carbon and substitute emission-intensive fossil and non-renewable products and materials.

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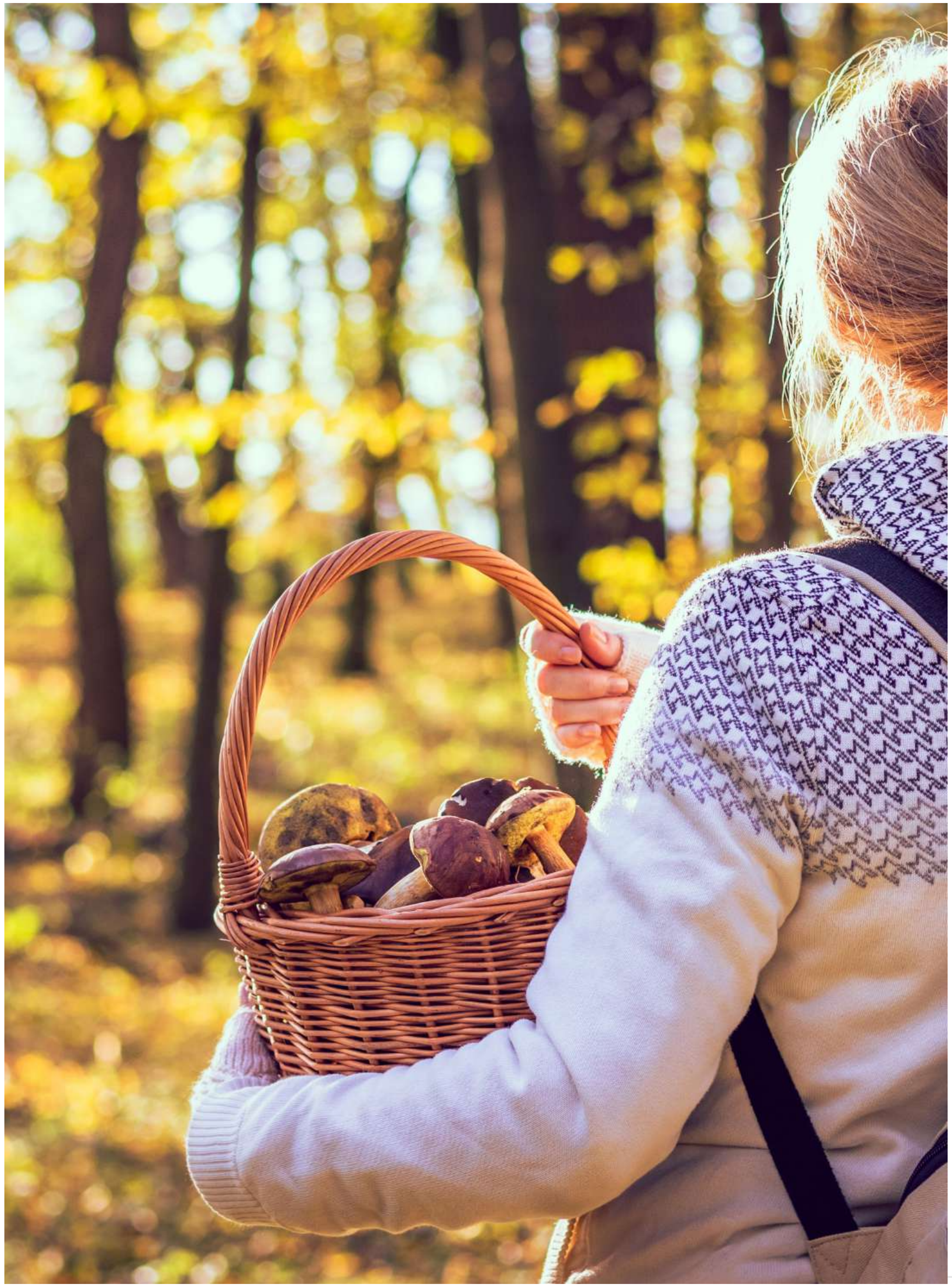

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12. What is the impact of the EU's consumption on the world's forests?

While forest resources in the EU are growing, they are under threat in other world regions. Between 1990 and 2016, the equivalent of 800 football fields of forests was lost every hour. Most of this deforestation occurred in the tropics.

Deforestation is driven by a myriad of complex factors. However, agricultural expansion to produce commodities such as soy, beef, palm oil, coffee and cocoa accounts for almost 80% of all deforestation. While most of these agricultural commodities are consumed locally or regionally, the EU is one of the major global importers of a number of specific commodities associated with deforestation, including palm oil (17%), soy (15%), rubber (25%), beef (41%), maize (30%), cocoa (80%), and coffee (60%). Their import and consumption by the EU represents around 7-10% of the global consumption of crops and livestock products associated with deforestation in the countries of origin, so-called "embedded deforestation". The role of the EU and China is of comparable size when it comes to imports of embedded deforestation. North American imports are comparatively smaller.

The EU initiated several policies to tackle its impact on the world's forests. These include: a pledge to halt global forest cover loss by 2030 and reduce gross tropical deforestation by at least 50% by 2020 compared to 2008 levels; the FLEGT Action Plan tackling illegal logging and related timber trade; and the new European Consensus on Development promoting sustainable agriculture and agricultural value chains that address deforestation. Nine European countries, including Belgium, Denmark, France, Germany, Italy, the Netherlands, Norway, Spain and the United Kingdom joined the Amsterdam Declarations Partnership and committed to eliminate deforestation in relation to agricultural commodities by 2025.

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Despite these efforts, the EU's objective of halving global deforestation by 2020 was not met, although annual deforestation dropped from 12 million hectares per year during the period 2010-2015 to 10 million hectares per year in the period 2015-2020. Hence, in its 2019 Communication on "Stepping up EU Action to Protect and Restore the World's Forests", the European Commission sets out five priorities to reduce the pressure on the world´s forests (see p.54).

FIVE EUROPEAN COMMISSION PRIORITIES TO REDUCE THE PRESSURE ON THE WORLD´S FORESTS:

1. Reduce the footprint of EU consumption on land and encourage the consumption of products from deforestation-free supply chains in the EU.

2. Work in partnership with producer countries to reduce pressures on forests and to 'deforest-proof' EU development cooperation.

3. Strengthen international cooperation to halt deforestation and forest degradation, and encourage forest restoration.

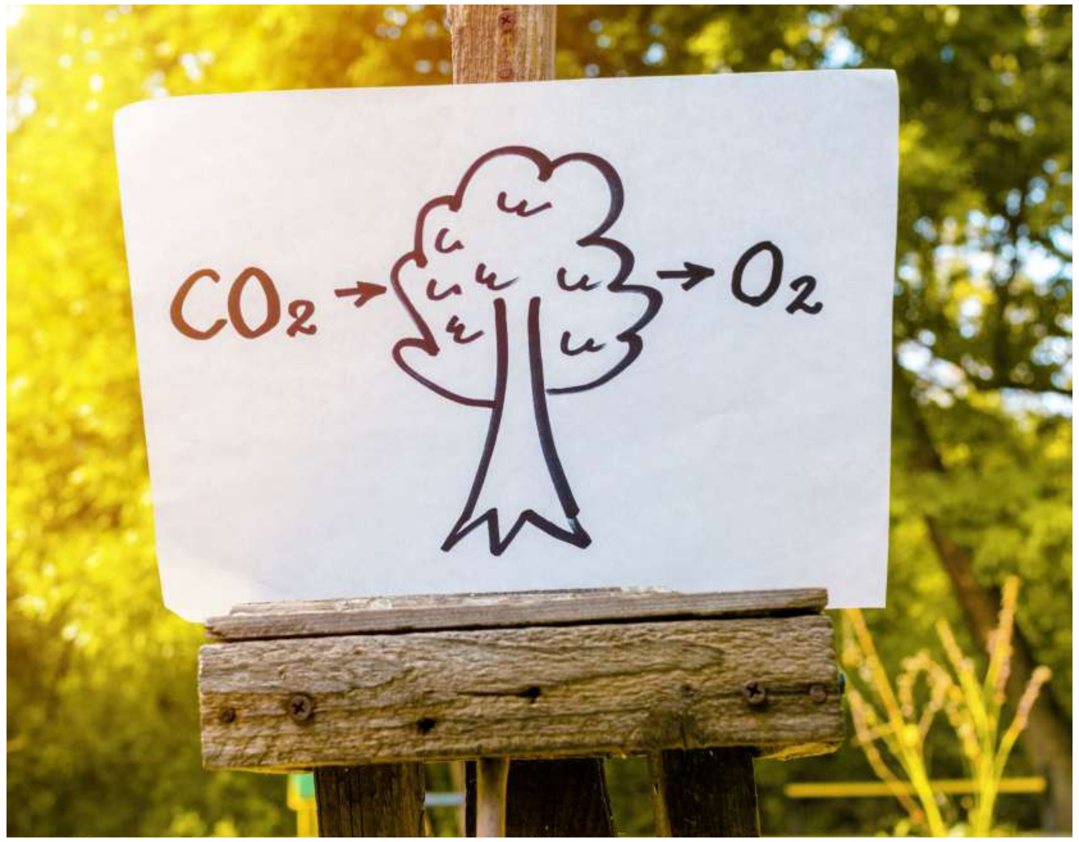
4. Redirect finance to support more sustainable land-use practices.

5. Support the availability and quality of information on forests and commodity supply chains, the access to that information, and support research and innovation.

With 2030 approaching fast, acting early on all five priorities is critical.

In October 2020, the European Parliament called for the development of binding legislation to stop EU-driven global deforestation through mandatory due diligence for companies placing products on the EU market. This means that companies in the EU would have to take appropriate measures to identify, prevent, mitigate and account for how they address deforestation risk.

The emergence of partnerships between producer and consumer countries, businesses and civil society is a critical step to achieve a meaningful impact. It should ensure that producing countries and the millions of agricultural commodities´ producing smallholders can transition towards sustainable land-use practices. These partnerships need to clarify definitions and responsibilities, facilitate the sharing of credible information for decision-makers and foster trust between partners. As such, they will result in increased transparency and accountability in the forest and land-use sectors and induce an enabling environment for forest-friendly development and investment. This will help countries to implement their targets under the Paris Agreement on climate change, also known as Nationally Determined Contributions (NDCs), as well as responding to emerging market requirements.



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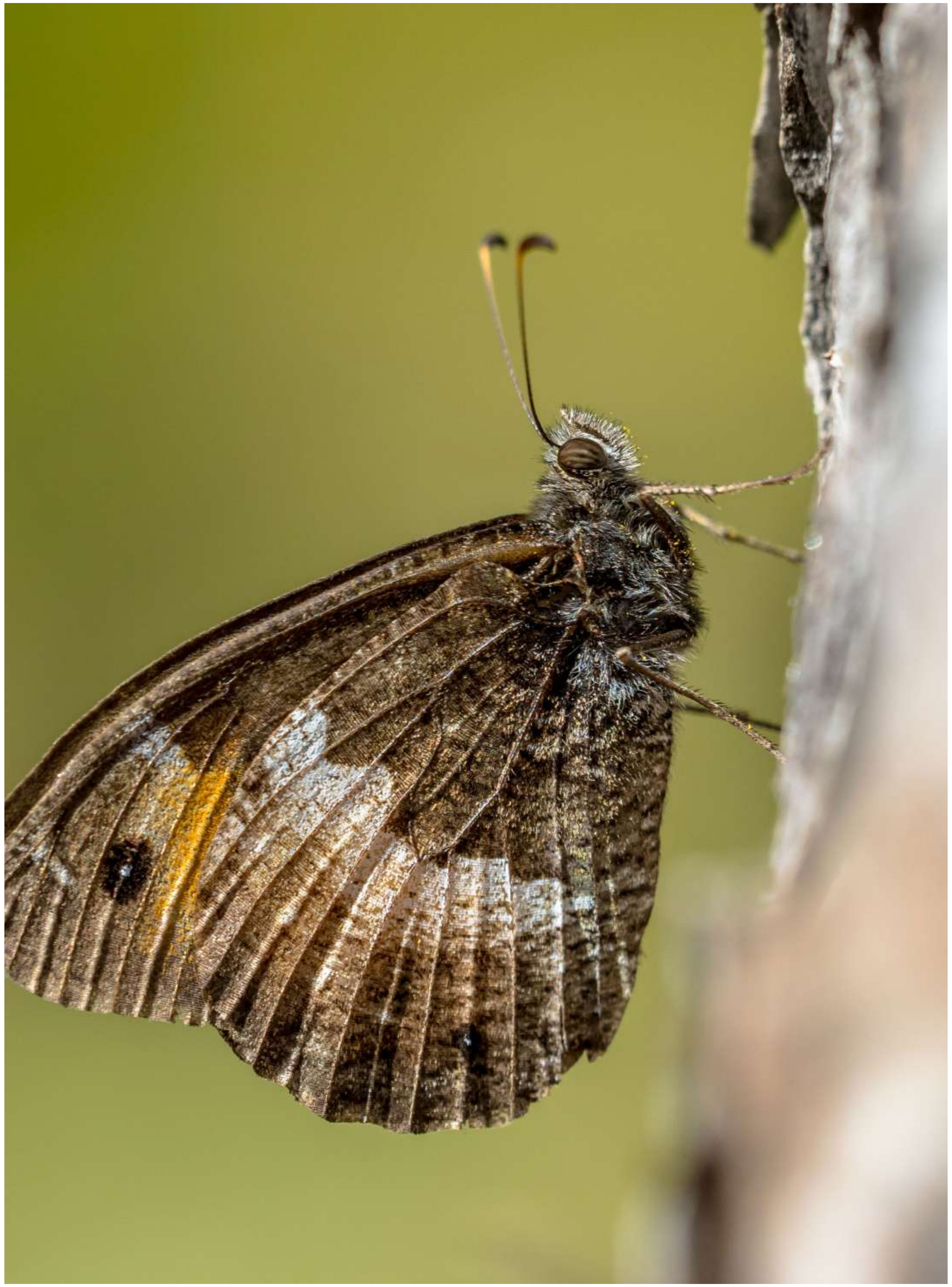

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Glossary

Bioeconomy It includes all primary production sectors that use and produce biological resources (agriculture, forestry, fisheries and aquaculture); and all economic and industrial sectors that use biological resources and processes to produce food, feed, bio-based products, energy and services.

Ecosystem service A service people obtain from the environment. Ecosystem services are the transformation of natural assets (soil, plants and animals, air and water) into things that we value. They include provisioning food and water; regulating services such as flood and disease control; spiritual, recreational, and cultural benefits; or supporting services like nutrient cycling that maintain the conditions for life on Earth.

Epiphyte An organism that grows on the surface of a tree and derives its moisture and nutrients from the air, rain or from debris accumulating around it.

Forest Land with tree crown cover of more than 10 percent and area of more than 0.5 ha. The trees should be able to reach a minimum height of 5 m at maturity in situ.

Forest available for wood supply Forest where any legal, economic, or specific environmental restrictions do not have a significant impact on the supply of wood.

FSC Forest Stewardship Council is an international non-profit, market-based certification program for forests

GDP Gross Domestic Product is a measure of the total economic activity, reflecting both growth in the economy and price change (inflation).

Genotype The genetic constitution of an organism as distinguished from its appearance or phenotype.

Growing stock The volume of timber in living trees. It is also often referred to as the standing volume.

Hectare Unit of area defined as 10 000 square metres (100 m by 100 m).

Increment The increase in diameter, height, volume, quality or value of individual trees or stands during a given period. Typically, increment is expressed on an annual basis.

Litter raking Removal of leaves and needles from the forest floor to substitute for straw to bind the manure of animals held in stables (e.g. cattle, sheep, horse, pig).

Other wooded land Land either with a tree crown cover of 5-10 percent of trees able to reach a height of 5 m at maturity in situ; or a crown cover of more than 10 percent of trees not able to reach a height of 5 m at maturity in situ and shrub or bush cover.

PEFC Programme for the Endorsement of Forest Certification is a global alliance of national forest certification systems.

Peri-urban An area immediately adjacent to a city or urban area.

Provenance The original geographic source of seed or pollen, or propagules. In forestry literature the term is usually considered synonymous with 'geographic origin'.

Social health Ability to interact and form meaningful relationships with other persons. It is a vital part of overall health and wellbeing as social relationships are protective of mental health.

Thinning A felling made in an immature forest stand in order primarily to accelerate diameter increment of the remaining trees, but also to salvage potential mortality and, by suitable selection, to improve the average form of the remaining trees.

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