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Chapter 14

The Way Forward: Management and Policy Actions



Lauri Hetemäki, Jyrki Kangas, Antti Asikainen, Janne Jänis, Jyri Seppälä, Ari Venäläinen, and Heli Peltola

For every complex problem there is an answer that is clear, simple, and wrong.

Henry L. Mencken.

Abstract Along with the evidence and analyses expounded on in this book, this chapter provides conclusions and suggestions concerning policy implications. These are based on a perspective that calls attention to the need for a holistic approach to look at the nexus of forests, the bioeconomy and climate change. Moreover, it is emphasised that, given the different uses of forests and the scarcity of forest resources, it makes sense to try to find ways to maximise synergies and minimise trade-offs between the different usages of forests. The forest-based sector contributes to climate-change mitigation via three channels—forests are a carbon sink, forest-based products can substitute for fossil-based products, and these products can store carbon for up to centuries. However, achieving these mitigation potentials in the future depends on forests being made resilient to the changing climate. Therefore, mitigation and adapting forests to climate change are married, both needing to be advanced simultaneously. Globally and in the EU, around 80–90% of the CO₂ emissions originate from the use of coal,

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oil and natural gas. Consequently, the core issue in the fight against climate change is the phasing out of fossil-based products. Reaching this goal will not be possible without substituting also forest-based bioproducts for the purposes we are using oil, coal and gas for today. In the EU, this implies paying more attention to the need to develop new innovations in the forest bioeconomy, improve the resource efficiency and circularity of the bioproducts already available, and monitor the environmental sustainability of the bioeconomy.

Keywords Forest bioeconomy · Climate change · Adaptation to climate change · Holistic approach · Climate smart forestry · Science policy

14.1 The Nexus of Forests, the Bioeconomy and Climate Change

The quote preceding this chapter is fitting for the topic of this book—the nexus of forests, the bioeconomy and climate change. How are forests, the bioeconomy and climate change interlinked, and how do they impact on each other? As this book has demonstrated, the answers to these questions are characterised by complexity and a fair number of features that point even to wicked problems. When you first think you have found a clear and simple answer, a second thought reveals it to be only partially useful, or applicable only under a set of restrictive conditions or, in the worst case, simply wrong.

In this chapter, we provide insights and recommendations for policy actions. Along with the evidence and analyses expounded on in the previous chapters, these are also based on a perspective that emphasises the need for a *holistic approach* for viewing the nexus of forests, the bioeconomy and climate change. By this, we mean the following.

First, the approach is based on a self-evident, but often forgotten, fact. That is, forest resources are not limitless, but always scarce, despite being renewable. This is true even for the most forested country in the EU—Finland—where forests account for 74% of the land area. Moreover, there are multiple needs for forests and their use, such as providing raw materials, biodiversity, food (e.g. berries and mushrooms), recreation, hunting and carbon sequestration. Their importance has also evolved over time, especially in response to changing societal values, human needs, environmental change and technological development. For example, forest carbon sequestration has become a large societal need only in the last decade. The scarcity of forest resources relative to human need has always created potential trade-offs between the different uses of forests.

These facts bring to the fore the second most important feature of this book's approach. That is, given the different uses of forests and the scarcity of forest resources, it makes sense to try to find ways to maximise synergies and minimise trade-offs between the usages. Oftentimes these possibilities are not fully

appreciated by people, policy-makers or even scientists, who may, for example, find the trade-offs between wood production and climate mitigation or between wood production and biodiversity inevitable. Therefore, one seems to have to choose an either/or. However, these trade-offs are not always inevitable and, in cases where these exist, there is usually the possibility of trying to minimise the trade-offs and maximise the synergies. This could be done e.g. using multi-objective forest management in which the simultaneous maximisation of multiple objectives increases the overall production levels of several ecosystem services (Biber et al. 2020; Díaz-Yáñez et al. 2020; Krumm et al. 2020). Indeed, it has even been argued that, in a modern society for example, biodiversity is necessary to the bioeconomy, and vice versa (Hetemäki et al. 2017; Palahi et al. 2020a, b). On the other hand, to achieve climate-change mitigation goals in the long term, forests should also be used for products that can substitute for fossil-based raw materials, the use of which is the root cause of climate change.

If one accepts the principle of these arguments, then the need to find synergies and minimise trade-offs between the bioeconomy, climate-change mitigation and biodiversity becomes a necessity. The downside of understanding this is that the world becomes much more complex. As a result, there is no longer any one single and simple solution to how the forest-based sector could, in the best possible way, contribute to climate-change mitigation or ensure biodiversity. Instead, diverse and tailored solutions are needed to accommodate different regions and circumstances. In this book, we have argued that *climate-smart forestry*, tailored to regional circumstances, provides a useful approach for increasing the forest-based sector's mitigation potential and helping forests adapt to the changing climate, while at the same time paying attention to the other needs for forests.

14.2 Multiple Forms of Knowledge and Expertise Required

The chapters in this book have included discussions on the feedback impacts between the natural biological world (forests) and social and technological processes (the technosystem), as well as the leakage impacts between regions. Moreover, it has become clear that, for research to derive results, it always needs to impose restrictions and assumptions, and analyse each phenomenon from some very particular perspective. Also, it is impossible to formulate alternative scenarios (counterfactuals) and evaluate their impacts with certainty. For example, in theory, we could compare the development of forest carbon sinks under two alternative scenarios involving wood harvesting levels. In one, the current level of annual wood harvesting in the EU is maintained, whilst in the other, the forest carbon sink is increasing due to a reduction in annual wood harvesting of 50% by 2050. What would be the impacts and differences between these two scenarios in terms of climate-change mitigation? The list of key impacts one would need to consider for this comparison is daunting—carbon sequestration in forests, the substitution impact of wood products, greenhouse gas (GHG) emissions technology

development in non-wood sectors, carbon storage in wood products, the impacts of adaptation to the changing climate and forest disturbances, impacts on the forest carbon sink and wood harvesting in other regions (leakages), etc. Also, the analysis would need to be dynamic, making assumptions, for example, about what types of products forest products could substitute for in 2050 and how significant would their substitution impacts then be, or how much the changed climate at that time had increased the occurrence and impact of forest disturbances (forest fires, bark-beetle outbreaks, wind damage, etc.).

Moreover, it should be noted that the climate benefits from increased carbon sequestration in forests, gained by tailoring (adapting) forest management practices or by lowering wood-harvesting levels, may also be reinforced, counteracted or even offset by other concurrent changes. For example, by surface albedo, land-surface roughness, emissions of biogenic volatile organic compounds, transpiration and sensible heat flux (Luysaert et al. 2018). Consequently, the tailoring of forest management could offset CO₂ emissions without halting the global temperature rise. However, it would probably be impossible for one study, or even a meta-study, to capture all these impacts. Even if it could, a number of restrictions and assumptions would need to be imposed, the realism of which would elicit many different views among scientists. Thus, currently *no absolute truth* of the impacts of different scenarios can be produced.

As Hulme et al. (2020) stated, “Technical and scientific knowledge is always partial, uncertain and often contradictory”, but “that is not to say that such knowledge is not valuable... It is rather to say that to effectively deal with crises, multiple forms of knowledge and expertise are required, and political judgment is then necessary to sort, select and present it to public” (p. 4). Priebe et al. (2020) also explored a range of interacting obstacles that inhibited the increased use of forests as a climate-change mitigation tool. They state that “it is not a lack of knowledge or technical solutions that inhibits adapting measures to tackle climate change mitigation”, but “current attempts to advise, guide, and implement sustainability suffer from an inability to examine and challenge prevailing values, habits, and ways of thinking” (p. 82).

Clearly, despite the complexity of the issue, the answer is not for us to raise up our hands and do nothing to mitigate climate change. Instead, scientific evidence should continue to be an important part of informing policy-makers, and the Intergovernmental Panel on Climate Change (IPCC), the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) and similar works are needed for assessing, synthesising and communicating this evidence for the making of policy (see Box 11.1).

In the scientific literature, there has been perhaps too much focus on the trade-offs between different actions and their impacts on mitigating climate change. Also, climate-change *mitigation* is often analysed separately from climate-change *adaptation* and *other societal aspirations*, such as reaching the United Nations’ Sustainable Development Goals (SDGs). For example, Luysaert et al. (2018) suggested that the primary role of forest management measures in Europe in the coming decades was not to protect the climate, but to adapt the forests to future climate

in order to sustain the provisioning of wood and ecological, social and cultural services, while avoiding harmful (positive) climate feedbacks from fire, wind, pest and drought disturbances. Consequently, climate-change mitigation needs to be addressed simultaneously with other objectives, and the right balance of measures must be found that are politically possible to implement in the shortest time possible, because we are in a hurry to mitigate climate change.

Another issue that is important to bear in mind when interpreting scientific results is that the issue at hand can be more diverse and extensive than what the research may have considered. Let us illustrate this point with one example. In Chaps. 7 and 8, the role of wood as a substitute for fossil-based products was taken up. Related to this, a frequent suggestion from the research is that wood should not be used for short-lived products, such as energy and packaging, but instead for long-lived products that store carbon for a long period, such as wooden buildings. Also, the European Commission (2021) “leaked” Forest Strategy draft document recommended moving from short-lived wood products to long-lived ones. However, it is uncertain how workable this suggestion is in practice.

First, the world will not do without short-lived products, such as packaging, hygiene and textiles. They should also be made as low-carbon as possible. Short-lived products can also help to reduce CO₂ emissions. For example, food packaging helps to reduce food waste, and therefore also food production, which is associated with CO₂ emissions. Short-lived products may also be made from a different wood material than long-lived products—pulpwood, wood chips and production by-products (e.g. lignin) could be used. Logs are usually more suitable for producing long-lasting products, such as wooden buildings. Second, it might be possible that, in some cases, the net carbon mitigation impact of a short-lived forest-based product may be greater than for a long-lived product (Leskinen et al. 2018). This could also be possibly, for example, in the case when a country exports short-lived, wood-based textile fibres to China, where they help to replace synthetic, oil-based textiles in a manufacturing process that is also heavily coal based, versus using the wood fibre for some more long-lived product in the exporting country. For example, the EU27 exported 63% of its dissolving pulp in 2019, mainly to China and India. In these countries, dissolving pulp is used to replace synthetic (oil-based) fibres in the textile industry. Third, the climate-mitigation perspective is not the only important perspective; there are other possible environmental factors, such as plastics waste in the oceans or the quantity of materials used. Finally, the average service life of wood fibres in short-lived products could be substantially prolonged using recycling practices. For the reasons above, recommendations to use wood only in long-lasting products could be an oversimplification, and not necessarily optimal for climate mitigation.

Despite these complexities, it is self-evident that the forest-based sector can improve its performance in climate-change mitigation, for example, by reducing the use of fossil fuels in every part of the value chain, from harvest to the end-product market. Improvements in resource and production efficiency and circularity along the product chain can also decrease emissions and enhance biodiversity (e.g. less wood needs to be harvested, *ceteris paribus*).

Finally, when advancing a sustainable circular bioeconomy and tackling the grand challenges of the day, *discussion culture* is important. Unfortunately, we live in times in which some key politicians, parts of the traditional media and, especially, social media are enhancing societal polarisation. People seem to be taking evermore opposite and competing views, in which there is only black and white, with no shades of grey. This sometimes seems to rear its head in scientific discussion, or the science is used as a pretext for adopting clear positions and values (Pielke 2007; Hetemäki 2019). Opinions such as, “it is necessary to conserve all forests to act as carbon sinks” or “clear-cut harvesting is always a positive climate action”, do not help us to reach urgently needed solutions. In this context, it is also important to monitor what type of perceptions the public gets from science and media, since perceptions shape opinions, media and voting, and therefore also political decisions.

14.3 Public Perceptions and Forest Bioeconomy

Public perception studies have shown that EU citizens appreciate forests mostly for the environmental services they provide; that is, as places for biodiversity, but also for their climate effects and the recreational opportunities they offer (Ranacher et al. 2020). However, Ranacher et al. (2020) also indicated that the potential role of the forest bioeconomy in climate mitigation is not well understood by the public. However, there are no clear research results that explain why this might be so. One guess is that this could be partly related to the fact that an increasing number of EU citizens live in urban areas, and they might be more inclined to appreciate the services that forests provide, rather than the products and welfare that is generated by the forest bioeconomy (Mauser 2021). In the EU in 2019, urban and peri-urban citizens accounted for a 75% share of the population, and therefore their views weight particularly strongly in public perceptions.¹

For urban citizens, forests may have different meanings than for rural people and for those who live in and manage forests. Urban citizens may also be unaware of the benefits they derive from the forest-based sector. During an ordinary day, they may use or benefit from several wood-based products, such as buildings, furniture, food, packaging, clothing and energy, without realising that these are based on forests. Some of the benefits of the forest bioeconomy may be even more hidden; for example, in some EU countries with significant amounts of forests and forest industries (e.g. Austria, Estonia, Finland, Germany, Sweden), wood production and forest products help to generate income-, capital- and corporate-tax revenues, besides the more visible employment and income opportunities. These tax revenues can be used

¹ <https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?end=2019&locations=EU&start=2019>

to fund such things as social security, education and other societal infrastructure for the benefits of all citizens.²

Understandably, the forest-based sector and the benefits it generates may lie outside the urban bubbles in which the bulk of us live in the EU. Clearly, the forest-based sector has an interest and responsibility itself to communicate and inform the public of its sector and why it is important. In addition, to achieve a greater acceptance of the forest bioeconomy among citizens and policy-makers, it is important to provide facts about how the forest bioeconomy can be applied in order to respond to the more ambitious targets of climate-change mitigation and biodiversity conservation.

However, when EU or national policies are designed, it is also the responsibility of the European Commission, the European Parliament and national politicians to be informed and to be appreciative of *the many benefits*—not only some—that the EU forest-based sector provides for society. On the other hand, just as important is to acknowledge that the forest-based sector can also generate visible or hidden *dis-benefits* for society, in terms of negative externalities, such as the loss or lack of biodiversity, the carbon sink, recreational opportunities and flood control. These disbenefits can be significant, especially if the forests are not managed and their bioproducts are not produced sustainably.

The European Green Deal (European Commission 2019) proposal did acknowledge the potential disbenefits of the forest sector and suggested important measures to tackle these. However, it failed to fully appreciate the potential benefits, such as a sustainable forest bioeconomy for climate mitigation and for achieving the SDGs (Palahí et al. 2020a, b). Emphasising only some of the benefits of forests is more likely to enhance the polarisation on this topic in society, which in turn could backfire by making it more difficult to further climate-mitigation and biodiversity objectives. In summary, it is essential that policy-makers have *a holistic approach* to the forest-based sector, and take into account all the many diverse impacts it can have, not just some.

14.4 The Role of EU Forests and the Forest-Based Sector

The European Green Deal (European Commission 2019) has set the overarching targets for EU policies in the coming years. At the heart of it is achieving climate neutrality by 2050, halting biodiversity loss and reaching the SDGs. In other words, paving the way to policies that will help the EU to live within the planetary boundaries. According to the messages coming from this book, how should the EU-forest-based sector help in this, and what types of policies could support this?

²For example, in Finland, the major forest-industry companies are the highest corporate tax-payers, the 10 largest of these alone paying €321 million in corporate taxes in 2019. For comparison, this is about the same amount that all the banks and insurance companies in the top 100 corporate tax-payers (17 companies) paid in 2019 (€335 million).

14.4.1 Role of the EU Forests

The urgency of mitigating climate change is key due to its potentially widespread and drastic impacts. Climate change also impacts all the other goals of the EU, such as biodiversity and the SDGs. The urgency itself makes things more difficult, especially in forests and the forest-based sector, which rely on slowly renewable—from decades to centuries—nature and wood. The urgency has also shifted political and public eyes to the land sector (agricultural land and forests) for help in reaching the climate-mitigation goals. There is an expectation that the speed at which we can reduce the root cause of climate change—burning fossil raw materials—is too slow for the set targets. Therefore, simultaneously increasing carbon storage and the forest sink in the coming decades is necessary, despite the fact that this could potentially become an excuse for some to continue to use fossil materials. Nevertheless, the reality seems to be that the EU will need larger land-based sinks in order to reach carbon neutrality by 2050 (IPCC 2019; Simon 2020).

As Chap. 2 explained, the EU27 forests account for 3.9% of the world's forests. Given this, it can have only a marginal direct impact at the global level via increased forest carbon sequestration. But every region has to contribute to climate mitigation. The aggregate impact of different regions counts, in the end, towards the global forest sink. Moreover, the indirect impacts of increasing EU forest carbon sequestration in the coming decades may be even more important. The EU is one key region in which the forest area, the annual volume growth of growing stock and the forest carbon stock have increased in the last decades. What is notable is that this happened at the same time as the EU27 wood production increased by 43%, from 1990 to 2019 (FAOSTAT 2021). The forest area has increased through natural forest expansion and the afforestation of low-productivity agricultural lands. Improved forest management practices and changing environmental conditions (e.g. nitrogen deposition and climate change) have increased the annual volume growth, carbon sequestration and storage of the EU forests. These have also been increasing because the annual wood harvesting has clearly been lower than the annual volume growth of the forests for a number of decades. This example of how to continue to increase forest growth and the carbon stock is important for other, less successful regions.

The book suggest various ways in which forest carbon sequestration can be increased in the future. Accordingly, the intensity of forest management and harvesting, and the severity of climate change and the associated increases in natural forest disturbances, will together determine the future development of carbon sequestration and storage in EU forests. Increasing the use of tailored adaptive forest management measures, such as the site-/region-specific cultivation of different tree species and genotypes (improved regeneration material), adjusting the frequency and intensity of thinnings and rotation lengths, using forest fertilisation and growing mixed forests, may still help to increase carbon sequestration and enhance forest resilience in the EU under the changing climate. Carbon sequestration may also be increased by increasing the forested area through natural forest expansion and the afforestation of low-productivity agricultural lands. However, forest carbon

sink can also decrease due to an increase in natural forest disturbances. Overall, though, carbon sequestration and sinks in EU forests are likely to increase in the coming decades, as long as the annual wood harvesting and natural drain remains lower than the annual volume growth of the forests.

Forest conservation can play an important role in achieving carbon neutrality in the EU by 2050, but it is difficult to see how it could be the whole solution. Recent evidence from those regions that have not managed or harvested their forests for a long period of time, and that have suffered from serious disturbances, including forest fires, bark-beetle outbreaks and storms, for example, points to this conclusion (Högberg et al. 2021). Such regions occur e.g. in Australia, California, Canada, Russia and, in the EU, the Czech Republic, Portugal and Spain. As a result, forests have been destroyed and large amounts of GHGs have been emitted to the atmosphere. According to Camia et al. (2021), the wood harvested due to natural disturbances reached over 100 million m³ (22.8% of the total removals) in 2018, in just 17 of the EU Member States that were surveyed. Moreover, old, unmanaged forests seem to sequester carbon less than young, managed forests (Gundersen et al. 2021). Thus, not managing forests and conserving them (which is clearly needed for many reasons) may also pose serious risks for climate-change mitigation. Between the extremes of conservation and deforestation, there are options for sustainably managing forests in ways that can retain them for generations as a source of a wide variety of ecosystem services.

In summary, it seems apparent that conserving the bulk of EU forests may not be an optimal climate-mitigation strategy (Nabuurs et al. 2017; EU 2018; IPCC 2019). The question is more about synergies and trade-offs between forest carbon sinks and forest management intensity in the short and medium terms. The land use, land-use change and forestry (LULUCF) regulation (EU 2018) allows member states to increase their forest utilisation for industrial and energy-production purposes in the future, if they can maintain or strengthen their long-term carbon sinks in forests and wood products. The EU wants to see a climate-neutral pathway to 2050 where the sinks of the LULUCF sector and all GHG emissions caused by humans are taken into account.

14.4.2 Role of the EU Forest-Based Bioeconomy

In general, the EU forest-based bioeconomy is responding to all sustainability challenges from the viewpoint of economic and environmental concerns and the societal transition towards sustainability (European Commission 2018, 2020). The starting point is that, by using more and more efficiently renewable materials, the increasing demand for non-renewable raw materials in the world can be curbed (International Resource Panel 2019), and this can lead to a more sustainable future, given that the biomass resources are used in sustainable way.

The updated EU Bioeconomy Strategy (European Commission 2018) highlights actions that will lead the way towards a sustainable and circular bioeconomy. They

are: (1) strengthen and scale-up the bio-based sectors, unlock investments and markets; (2) deploy local bioeconomies rapidly across Europe; and (3) understand the ecological boundaries of the bioeconomy. In these ways, the Bioeconomy Strategy will maximise the contribution of the bioeconomy to the major EU policy priorities of sustainability, the creation of jobs, climate objectives, and the modernisation and strengthening of the EU industrial base. However, it is necessary to develop the bioeconomy in a way that lessens pressures on the environment, values and protects biodiversity and enhances all ecosystem services.

The role of, and necessity for, the forest bioeconomy in climate mitigation and the phasing out of fossil raw materials and products has been demonstrated in this book and in several studies (e.g. Hetemäki et al. 2017; Hurmekoski et al. 2018; IPCC 2019; Palahí et al. 2020a, b). Globally and in the EU, around 80–90% of the CO₂ emissions originate from the use of coal, oil and natural gas. Consequently, the core issue in the fight against climate change is the phasing out of fossil fuels and materials. If major efforts are not put into tackling these, they will remain a nuisance. In this context, it is difficult to see how climate mitigation can be possible without also using forest biomass to replace fossil-based raw materials and products. The forest bioeconomy is not going to be a sufficient way to solve the climate-change challenge on its own, but it is *a necessary part of it*.

In 2018 in the EU27, the GHG emissions were 3893 Mt. CO₂eq., of which 83.5% came from two sectors—energy production and industry (Eurostat data). In 2010–2016, EU forests helped to remove, on average every year, 10.4% of the total EU CO₂eq. emissions (Eurostat data). Including the impact of harvested-wood products, this figure was 11.3%, on average (Eurostat data). The EU is aiming to be climate-neutral by 2050—that is, a region with net-zero GHG emissions. Therefore, given the above figures, it is clear that the main priority should be to reduce emissions from fossil-based energy and industry to get them as close to zero as possible. Increasing EU forest removals will not reach this policy target. That is not to say that they are not important, or that the LULUCF regulation is needed to enhance this. Clearly, the EU has to do its share to increase the forest sink and removals, and in this way, show how it can be done. However, it is very important that the LULUCF regulation does not lead the debate and draw the focus of EU climate-change mitigation towards technical and relatively smaller issues, and away from the main issue itself, which is phasing out fossil fuels (Appiah et al. 2021, Berndes et al. 2018). This implies paying more attention to the need to develop new innovations in the forest bioeconomy, as well as improve the resource efficiency and circularity of current bioproducts.

In summary, it is essential that we use forest-based bioproducts for the same purposes we are currently using oil, coal and gas. However, given that it is unrealistic to phase out all fossil production by 2050, any remaining GHGs from these need to be balanced with an equivalent amount of carbon removal, for example by increasing the forest sink and through direct carbon capture and storage (CCS) technologies. Indeed, as Nabuurs et al. (2017) have argued, the EU can significantly increase the forest-based sector mitigation impact through forest removals and

forest-product substitution impacts. These can be achieved by introducing new climate-smart forestry measures, and it is essential to seek to utilise this opportunity.

14.5 Combining Climate Mitigation with Other Goals

In the EU, climate mitigation is a top priority, but not the only one. The SDGs are also important priorities, and these include responsible consumption and production, sustainable cities and communities, and affordable and clean energy, among other things. According to the statistics reported in Chap. 1 (Box 1.1), employment in the forest bioeconomy in the EU28 was about 2.5 million, generating around €277 billion value added, in 2015. Moreover, wood-based construction, textiles and packaging are viewed as promising ways to make the EU's construction, clothing and packaging industries more sustainable.

Phasing out fossil-based industries will create a need to replace lost jobs (see Chap. 4, Box 4.3). Moreover, as the EU has emphasised, the Just Transition Mechanism is a key tool for ensuring that “the transition towards a climate-neutral economy happens in a fair way, leaving no one behind” (European Commission 2020). Even if the climate disaster looms with a 2, 3 or 4 °C temperature rise, it is possible that people could still reject the societal transition if they believe it to be unjust. As the former American Secretary of State, Henry Kissinger, has said “*No policy—no matter how ingenious—has any chance of success, if it is born in the minds of a few and carried in the hearts of none*”. The better the climate mitigation measures support other economic and societal goals and needs, the wider and stronger support they are likely to get amongst the citizens of the EU Member States. As a result, the mitigation measures could be adapted more promptly, and their implementation could be more efficient.

In summary, the circular forest bioeconomy may meet many diverse societal needs in the EU, along with its climate mitigation impact. Clearly, the success of meeting all these needs depends on how well the Member States are also able to impose the environmental sustainability of the forest bioeconomy. For this to happen, improving forest management and better adapting forests to the changing climate, increasing the resource efficiency of forest bioeconomy products, their circularity and new product innovations, as well as monitoring the bioeconomy's environmental sustainability are a must.

Key Messages

1. The forest-based sector³ contributes to climate change mitigation via three channels—***forests are a carbon sink, forest-based products can substitute for fossil based-products, and these products can store carbon for up to centuries***. However, in order to produce climate benefits, the possible loss of carbon stock (sinks) in forests due to harvesting should be smaller than the increased

³The forest-based sector is here understood to include forests, forestry and forest-based products and energy.

- GHG benefits of wood utilisation in the selected time frame. To achieve this mitigation objective in the future, forests also need to be resilient to changing climate. Therefore, *mitigation and adapting forests to climate change are married*, and both need to be advanced simultaneously.
2. The root cause of climate change and the scale of the impacts of different measures to mitigate it are important to keep in mind. Sometimes in the climate discussion, these self-evident facts seem to get lost, and small and large measures and impacts may get mixed. Globally and in the EU, around 80–90% of the CO₂ emissions originate from the use of coal, oil and natural gas. Consequently, *the core issue in the fight against climate change is the phasing out of fossil fuels*. It is essential to acknowledge that reaching this goal will not be possible without also using forest-based bioproducts to substitute for the current use of oil, coal and gas. In the EU forest-based context, this implies *paying more attention to the need to develop new innovations in the forest bioeconomy, improving the resource efficiency and circularity of current bio-products, and imposing and monitoring the environmental sustainability of the bioeconomy*.
 3. The optimal strategy to use forests and the forest-based sector to mitigate climate change, and to adapt them to the changing climate, requires *a holistic approach*. There is no single, optimal way for the forest-based sector to contribute to maximising mitigation and adaptation gains. Conserving forests only for carbon sequestration (storage, sinks) or using forests only for producing wood for forest bioproducts will not work. Both are needed for many different reasons, as the chapters in this book have explained. Moreover, *the optimal strategy needs to be tailored to the regional circumstances and characteristics. It may also need to be adjusted frequently over time as climate change proceeds*.
 4. European forests belong mainly to the boreal and temperate forests. The life-cycles of the trees in these forests range from less than 100 years in managed forests to several hundred years in natural forests. The harvesting of trees to produce wood products takes place over a range of 20–100 years after one forest regeneration. Therefore, *when making decisions on forests, it is essential to keep in mind a time horizon of up to a century*. However, this is becoming increasingly difficult in our evermore rapidly changing world, in which continuous change is the norm. Also, the urgency of mitigating climate change and halting the loss of biodiversity call for rapid actions. This situation heightens the importance of the holistic approach and *the involvement of all science disciplines and societal perspectives* to plan sustainable actions regarding the entire forest-based sector. No single political party or interest group is likely to have the wisdom, and perhaps not always even the interest, to see the holistic picture.⁴
 5. The risks of large-scale disturbances induced by weather extremes, such as droughts, storms and forest fires, have to be taken into account when appropri-

⁴American writer Upton Sinclair once stated: “It is difficult to get a man to understand something when his salary depends upon his not understanding it.”

ate forest management measures are being defined over time to adapt to the changing climate. Carbon circulates between the atmosphere and forests either through natural cycles (e.g. decaying litter and organic matter and forest fires), or through harvesting and the use of wood for materials and energy. A viable forest sector enables the management of forests over large areas and adjustments to forest management measures, when needed. ***The recovery of damaged wood or the reduction of the fuel load in forests is possible on a large scale, if there is a techno-system to enable both the harvesting and use of wood for the needs of society.***

6. The willingness of forest owners and society to adopt certain forest management measures depends on how they impact the other benefits generated by forests. The more synergies that can be found and the fewer trade-offs between them, the more likely and effectively they can be implemented. In short, ***the effectiveness of the management measures needs to be assessed in their socio-economic context.***
7. The EU is not an island and its activities have impacts beyond its borders, for better or worse. It can serve as a good example to other regions of how ambitious climate and biodiversity goals can be achieved simultaneously. It can also demonstrate how the synergies can be maximised and the trade-offs minimised between a circular bioeconomy, climate-change mitigation and the maintenance of biodiversity. On the other hand, the EU climate mitigation and biodiversity policies can have negative ***leakage impacts*** on the climate-change mitigation and biodiversity in non-EU countries (Kallio et al. 2018; Dieter et al. 2020). Consequently, ***the EU should assess the impacts of its policies in the global context, not only within its own borders.***
8. The world states are evermore interconnected, and therefore the problems they face tend to be increasingly global in nature, such as climate change, biodiversity loss, economic crises and pandemics. However, the consequences of such crises, and how they are solved, vary significantly, depending on regional features, such as national institutions and decision-making. How countries have been dealing with the COVID-19 pandemic is a good example of this. The nexus between forests, the bioeconomy and climate-change mitigation is no different. These things are linked by global challenges and opportunities, but their optimal implementation requires tailoring to regional and local circumstances—***one size does not fit all.*** It is essential to acknowledge this when the EU is planning policies related to forests, the bioeconomy and climate-change mitigation for its Member States. ***It can be argued that the stronger the EU is, the better it will succeed in coordinating common actions, but with Member State level tailoring and optimisation.***
9. It is important that science-based bodies like the IPCC and the IPBES make syntheses of the available knowledge and inform policy-making. However, the technical and scientific knowledge is always partial, uncertain and can even be contradictory. That is not to say that such knowledge is not valuable and needed. Rather, it points to the fact that to effectively deal with global-scale problems like climate change, multiple forms of knowledge and expertise are required. Moreover, how to best use the forest-based sector to mitigate and adapt to climate

change is not just a reducible engineering-type of problem, like how to get a man to the moon. ***Rather, it is a complex technological, economic, social, cultural and value problem.*** “In the end the decisions are made by policymakers, and therefore, the decisions are political not scientific. In most societies, these decisions rest on democratic mandate, and so it should be” (Hetemäki 2019, p. 15).

10. The fundamental transformation of our society to carbon neutrality and sustainability is probably the greatest socio-political question we have faced since World War II. ***It has to be carried out in a way that people see it as just.*** Otherwise, there is a danger that the whole process will be derailed and the transition will not happen. This is also true in the EU forest-based sector.

Box 14.1: Science Role in Informing Policy-Making

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Politicians, the media and the public, especially in the EU, are increasingly demanding evidence-based information to inform policy-making on complex issues such as climate change and biodiversity (Hetemäki 2019). According to Gluckman and Wilsdon (2016), “Scientific advice to governments has never been in greater demand; nor has it been more contested”. Populist ‘post-truth’ politicians and social media warriors have questioned the legitimacy of science-based information. Ex-President Trump’s questioning of the scientific evidence on climate change is one well-known example. But science skeptics can be found in Europe, as well, such as the senior British politician Michael Gove, who stated, during the Brexit referendum, that “people in this country have had enough of experts”.

The matter is made more complex by the fact that there have occasionally been striking disparities between what the scientists’ messages are (Hetemäki 2019). At the same time, there is an increasing amount of science information available. According to UNESCO (2015), almost 1.3 million scientific articles were published in 2014 alone, and there were 7.8 million full-time-equivalent researchers in 2013. Moreover, evidence-based policy-making has been the subject of much debate in the literature, particularly through critiques that question assumptions about the nature of the policy-making process, the validity of evidence, the skewing in favour of certain types of evidence, and the potentially undemocratic implications (Pielke 2007; Parkhurst 2017; Hetemäki 2019). One concern with evidence-based policy-making is that it does not recognise the contested nature of evidence itself—an area that has been the subject of a large body of research in the fields of the sociology of science and science and technology studies (Pielke 2007; Parkhurst 2017). These studies have drawn attention to the inevitably value-laden nature of scientific inquiry, and the choices that are made about what to

(continued)

Box 14.1 (continued)

research and how to undertake that research. Moreover, the choice of evidence can be value-laden and political in itself.

In December 2020, the Royal Swedish Academy of Agriculture and Forestry (KSLA) organised a seminar with the title ‘Research results on forests are not always evidence’.⁵ It may seem strange that an academic and science-based institution would choose to organise such a seminar, especially at a time when science information is so often being contested. However, as one might expect, the KSLA seminar did not question the importance of science knowledge in informing policy, as such, but rather it wanted to raise concerns about how evidence-based policy support can also be used incorrectly, and to advance specific interests and agendas. The seminar explained that research findings, or the conclusions that are drawn from the research, are not always well substantiated. The question was asked whether scientists and science publishers were seeking to gain power over policy-making, and if so, what did this mean for the democratic process? A key objective, therefore, is how to find a reasonable balance between more use of evidence-based information, whilst critically assessing new research results and keeping policy-making in the hands of politicians not scientists.

The KSLA seminar also raised questions about the role science publishers and the European Commission, in particular, drawing on the recent example of an article by Ceccherini et al. (2020), published in one of the most esteemed science journals—*Nature*. Using satellite data, the article reported an increase of 49% in the European harvested forest area alongside a biomass loss of 69% for the period 2016–2018 relative to 2011–2015. The article suggested that these increases reflected expanding wood markets, encouraged by the EU’s bioeconomy policies. The article was written by the staff of the European Commission’s Joint Research Centre—an institute responsible for providing evidence-based policy support for the EU. The article received an exceptional amount of media publicity all over Europe, as well as major policy attention, especially within the European Commission. *Nature* also published an Editorial (Nature 2020) based on the article, from which it drew the following conclusions and policy implications: “This is an important finding. It has implications for biodiversity and climate-change policies, and for the part forests play in nations’ efforts to reach net-zero emissions... the increase in harvested forest area has been driven, in part, by demand for greener fuels, some of which are produced from wood biomass. This increase in biomass products can, in turn, be traced to the EU’s bioeconomy strategy... Meeting renewable energy targets means burning Europe’s harvest... [and] forest exploitation cannot continue at the current rate”.

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⁵ <https://www.ksla.se/aktivitet/forskningsresultat-om-skog-ar-inte-alltid-evidens/>

Box 14.1 (continued)

In a response to Ceccherini et al. (2020), also published in *Nature*, 33 scientists from 13 European countries provided evidence that threw into doubt the conclusions of the JRC study (Palahí et al. 2021). They demonstrated that the large reported harvest changes resulted from methodological errors. These errors related to satellite sensitivity having improved markedly over the period of the assessment, as well as to changes in the forests associated with natural disturbances—drought- and storm-related dieback and treefalls—that are often wrongly attributed to timber harvests. Palahí et al. (2021) stated that: “We argue that the reported changes reflect analytical artefacts, with (1) inconsistencies in the forest change time series, (2) misattribution of natural disturbances as harvests, and (3) lack of causality with the suggested bio-economy policy frameworks”. In addition to Palahí et al. (2021), some European organisations responsible for providing national forest statistics voiced serious concerns that the Ceccherini et al. (2020) results were in conflict with official data on forest harvests (see, also, Wernick et al. 2021). Even after these concerns and pointing out the errors, the European Commission continued to refer to Ceccherini et al. (2020) as a basis for policy planning related to EU forests, such as biodiversity and climate policies.⁶

The seminar and example of an erroneous scientific paper, as well as similar lessons learnt from science-policy work (Pielke 2007; Parkhurst 2017; Hetemäki 2019), should raise awareness that we be critical, and understand the different interests that may lie behind producing science-based evidence and its publication and use. For example, different interest groups and non-governmental organisations are always fighting for the attention of policy-makers and the media, and they have great skills in searching for and selecting (i.e. cherry-picking) the scientific papers that support their specific agendas, using only those to lobby politicians and gain the media spotlight (Herajärvi 2021). Scientists may also have their own agendas, which may affect their selection of research topics and their scope, as well as fine-tuning the messages they deliver. In summary, not all science-based evidence, its publication and use, are equally neutral, robust and helpful - even if these are published in the most esteemed science journals.

The answer to the above challenges is not to do less science or use less science-policy information and dialogue, but to do it better. For this, several actions can be helpful. First, make science-policy work holistic and multidisciplinary. The problems we are facing are becoming evermore complex, such

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⁶For example, the Commissioner for Environment, Virginijus Sinkevičius, still referred to Ceccherini et al. (2020) results as important and valid in an interview by the main Swedish newspaper Dagens Nyheter, 14 June 2021. <https://www.dn.se/debatt/tillsatt-en-skogsberedning-for-att-bromsa-polariseringen/>

Box 14.1 (continued)

as the nexus between forests, biodiversity, climate change and the bioeconomy. However, science has become ever more specialised and focused on very specific and detailed questions, since this is how science advances. It has to set so-called system boundaries and exclude some factors from the analysis for it to be manageable. Given these drawbacks, there seems to be no other way to escape from this narrow and partial perspective than to produce holistic and multidisciplinary science-policy reviews, assessments and synthesis studies, and tailor these to a format that decision-makers can absorb.

To inform policy-making, there is a need for more cooperation among scientists to synthesise cross-disciplinary and multi-perspective science knowledge. It would also be desirable if this could be carried out by scientists with different values, and not only among those who are like-minded. This is what, for example, the IPCC, IPBES and UN International Resource Panel seek to do. They synthesise and contextualise multidisciplinary, global scientific knowledge for better informed decision-making. Such works should become the norm rather than the exception also at the national level. However, to be able to do such work, new funding is needed. Science-policy work is not research, as such, but rather the synthesis of existing research. Therefore, it will not generally be able to draw resources from research funding institutions. There is also a need to develop new funding mechanisms for science-policy work.

In summary, for better-informed science-policy-making, there is an increasing demand for greater cooperation in synthesising cross-disciplinary and multi-perspective science knowledge. Moreover, when policy-makers and the media use science information, it is important for them to be able to carefully assess the robustness of the information and find out if it has broad support in the science community.

Therefore, it is important that the people who work in, and make a living from, forests and the forest-based sector are engaged and treated in a just way, so that they feel ownership of, and are willing to contribute effectively to, the transition.

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