EIP-AGRI Focus Group

Forest Practices & Climate Change

STARTING PAPER

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1. Introduction

EIP-AGRI Focus Groups collect and summarise knowledge on best practices in a specific field, listing problems as well as opportunities. They take stock of the state of play in research and practice and highlight possible solutions to the problems identified. Based on this, the Focus Groups suggest and prioritise innovative actions. They identify ideas for applied research and for testing solutions in the field, involving farmers, advisers, the industry and other stakeholders, and propose ways to disseminate good practices. Focus Group results provide new and useful ideas to solve practical problems and start new Operational Groups or research projects.

This discussion paper serves as background to prepare the first meeting of the EIP Focus Group on **New forest practices and tools for adaptation and mitigation of climate change**. For that purpose, the document aims to:

- Establish a common understanding about the scope of the Focus Group and its objectives and to provide a preliminary outline of existing knowledge to be shared with the Focus Group experts.
- Identify key questions for discussion at the first meeting taking into account the scope of the Focus Group.
- Make first suggestions on topics that could be elaborated by Focus Group members after the initial workshop.

2. Background of the topic

European forests are a crucial resource to provide multiple ecosystem services to society. Climate change including extreme events and associated disturbances affects the growth and stability of forests and could have severe consequences for forest ecosystem services provisioning. Consequently, managing forests to mitigate and adapt to climate change is a major challenge facing European forest management over the next decades.

The Paris Agreement recognises that forests will be crucial for achieving the long-term objective of balancing anthropogenic greenhouse gas emissions and removals by sinks by the second half of the century. EU forests currently sequester around 10% of annual EU emissions and their mitigation potential may increase in the next decades with the use of innovative practices and tools for forest management; however, it may also diminish if appropriate sustainable forest management practices are not put in place. Even if climate change will be limited according to the Paris Agreement, forest vulnerability will be increasing, especially due to more frequent and extreme weather events and disturbances. Thus forests adaptation to climate change and their ability to help mitigate climate change need be considered jointly.

At the same time, with increasing demand for renewable wood materials, renewable energy and potential of wood to substitute energy intensive materials, there is growing pressure on the forests to provide these products. Forest degradation due to climate change may also reduce the potential for the supply of other forest ecosystem services that are key for communities, e.g. water quality and supply and risks regulation. In addition, forests and the forest sector play a vital role in the sustainable development of EU rural areas, contributing to employment and economic growth and to landscape and nature conservation. Therefore, when considering new practices and tools for adaptation and mitigation of climate change, it is essential to adopt a holistic approach towards forests - integrating the economic, social and environmental dimensions – in accordance with the EU Forest Strategy [COM(2013)659].

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3. Scope of the EIP AGRI Focus Group

The Focus Group will address ways to enhance mitigation and adaptation potential of EU forests, while taking into account that forests provide multiple functions and services to EU citizens. The group should also consider trade-offs between mitigation and adaptation, as sometimes addressing mitigation in the short term may affect long-term adaptation capacity.

Overarching **QUESTION** of the Focus Group: **Which new management practices and tools can improve the climate mitigation and adaptation potential of EU forests?**

The Focus Group is expected to carry out the following main tasks:

1. Identify the main challenges and opportunities posed by changing climate patterns for sustainable forest management in the EU
2. Identify new practices and tools that maintain or increase the carbon sequestration and storage potential of EU forests in the long term while keeping their multifunctional role
3. Identify the needs of forest managers in relation to adaptation to changing climate patterns in the EU including research and innovation needs- as well as the most promising adaptation practices (e.g. by selecting species, provenances and varieties or specific sustainable forest management practices) while keeping the multifunctional role of EU forests
4. Identify new practices and tools (including the use of digital technologies) that contribute to improving resilience of forests ecosystems to extreme weather events such as droughts, forest fires, storms and heavy snows, considering all the actors involved in managing the risks resulting from more frequent extreme events
5. Analyse possible synergies and trade-offs between mitigation practices and long-term adaptation needs
6. Provide examples of practices and tools to improve mitigation and adaptation of forests, including through better stakeholder involvement and synergies with other sectors such as agriculture and tourism.
7. Propose potential innovative actions to stimulate the knowledge and use of management practices and strategies for improving EU forest's mitigation and adaptation potential and providing inspiration and ideas for Operational Groups and other innovative projects
8. Identify remaining research and innovation needs coming from practice associated to EU forests' mitigation and adaptation potential

4. Challenges and opportunities of climate change for sustainable forest management in the EU

Knowledge on climate change impacts in European forests and options for adaptation have been reviewed frequently in the scientific literature (Lindner et al., 2014; Lindner et al., 2010). There is a need, however to collect the knowledge particularly regarding regional evidence of already observed changes – both negative and positive, and how the knowledge on expected future impacts is perceived in practice. This information is not generally reflected in scientific papers. Building on this, it is important to discuss and analyse how mitigation and adaptation to climate change can be implemented in forestry practice. In doing that, it is imperative to recognize the big difference in expected climate change impacts and possible response options as presented in Table 1.

As climate change affects European forests in different ways, it is relevant to reflect on available regional evidence of shifts in species distributions and quantifications of growth declines (in drought exposed regions) or enhanced growth rates (in boreal forests and at higher elevations). Observations of new pests and diseases that could be associated with climate change would also be interesting to report.

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Whether or not local managers are willing to adapt forest management is strongly affected by their awareness about climate change and their believes if changes have already occurred (Blennow et al., 2012). Therefore, it is also interesting to hear how this perception is varying across Europe. Is this situation mainly affected by the climatic conditions, or is it affected by cultural and political factors as well?

Discussion questions

- ⇨ **In what way has climate change already affected forests and forest operations? Is there general awareness about projected climate change impacts among practitioners in the region?**
- ⇨ **Who is responsible for monitoring climate change impacts?**
- ⇨ **What monitoring procedures are employed in different regions/countries?**

Table 1. Overview of regional differences in climate change impacts and adaptation options

Biogeographic region	Effects of climate change	Possible adaptation measures
Boreal	Increased growth and productivity; difficult harvesting and reduced accessibility on non-frozen soils; more frequent storm damage	Choosing appropriate genetic material; species diversification; proper management to avoid wind throws
Temperate Oceanic Zone	Increased risks from storms, pests; more frequent droughts; changes in productivity; changes in species composition	Diversification of both species and age composition; choosing good genetic material
Temparate Continental Zone	Droughts cause decrease in productivity; spruce forest susceptible to pests and wind throws; successful regeneration will be more difficult; fire risk	Proper management of old and young stands to improve regeneration; intensive thinning to save water
Mediterranean	Increase in aridity; more frequent severe droughts; dieback of certain species; forest fires; biodiversity loss; soil erosion risk after forest fires	Proper management (thinning, pruning); longer rotation period; in areas prone to aridity intensive management to decrease canopy density
Mountainous	Increased productivity; increased run-off; shift in species composition; increased risk of pests, forest fire, wind throw	More geographically diverse management that increases tree generation speed and protective qualities and reduces risk of bark beetles

Climate change could be triggering more biotic and abiotic disturbances

A particularly important challenge associated with climate change is possible effect on forest disturbances (see Table 2). It is expected that climate change will increase the risk of different forest disturbances. Rising temperatures cause heat-stress to trees and affect insect population dynamics, making trees more prone to pest attacks. Wetter and none-frozen soils may reduce root anchorage of the trees and when exposed to strong winds, extensive wind throws can occur. Dry conditions can enhance forest fire risks, not only in the Mediterranean area, but also in the temperate continental and even boreal zones. With different adaptation measures, the risks of climate change can be managed at least to some extent.

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Table 2. Main disturbance factors in European forests and some possible adaptation options

Disturbances	**Most Affected Regions**	**Projected Changes**[2]	**Adaptation Measures**
Storms 	Boreal, Temperate Oceanic and Temperate Continental Zones	Northwards shift of storm tracks -> areas previously unaffected are affected Higher wind speeds -> affected areas are larger Possible increase in storm intensities	Better management: • Careful thinning • Manage canopy size by appropriate thinning
Pests 	Temperate Continental, Southern boreal and Mediterranean Zones	New pests in the area Migration of known pests to northern or higher elevation areas, e.g. bark beetle damage zones are rising in the mountains Shorter reproduction cycles	Better management[1]: • Sanitary loggings • Insect traps • Aim for healthy forest Mixed-species forest stands Suitable species and genetic material for stands
Drought 	Temperate Oceanic, Temperate Continental and Mediterranean Zones	Rainfall does not increase the same rate as temperature in summer -> limitations on water availability Precipitation expected to decrease in Mediterranean area	Better management[1]: • Thinning in relation to water availability • Avoid clear cutting to prevent water run-off Mixed-species forest stands Limitation of animal grazing to minimize soil compaction
Forest fires 	Temperate Continental and Mediterranean Zones	Areas affected by the forest fires are expected to increase Length of the fire risk season will increase	Better management[1]: • Appropriate thinning Fuelbreaks Mixed-species forest stands

[1] Chrysopolitou et al. (2014); [2] Lindner et al. (2010)

5. Understanding, adopting and optimizing climate change mitigation strategies in forest management

Forests play a crucial role in global biogeochemical cycles. The protection (reducing deforestation and forest degradation mainly in tropical forests), management and utilization of forests offer different ways that can support the mitigation of climate change (Fig 1). In Europe, three different types of mitigation strategies are most relevant:

- sequestration management with focus on increased carbon sinks in forest biomass and soils (through forest protection OR increased productivity),
- sequestration management with focus on increased carbon sinks in harvested wood products, and

- substitution management with focus on the use of bioenergy and wood-based products to replace fossil fuels and non-renewable materials.

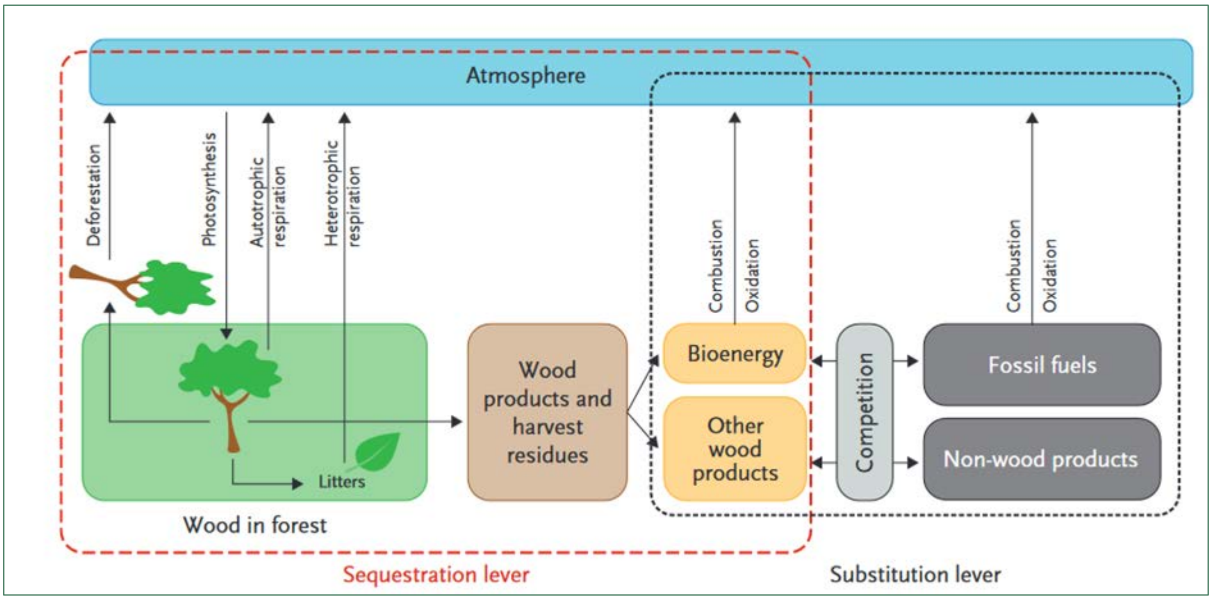

Figure 1. Forests and wood products as integral part of the global carbon cycle (Nabuurs et al., 2015). The diagram illustrates the flow of carbon between the atmosphere, biosphere and fossil reservoir. There are two main levers of climate change mitigation: sequestration and substitution. Sequestration means that $C0_2$ is bound from the atmosphere and stored in the biosphere for more or less long time. Living trees sequester carbon in the ecosystem and when they are harvested, the carbon continues to be stored in wood products. This delays the release of carbon back into the atmosphere, up to several decades or even centuries in the case of long-lived wood products. Substitution means that something non-renewable is replaced by wood as a renewable material or fuel. A good example for both levers is using wood in construction: wood material stores the carbon it had sequestered as a tree and it replaces concrete or steel, which both are associated with high Greenhouse Gas emissions in the production process. Yet, there is a trade-off between sequestration and substitution: if more trees are left in the forest to accumulate carbon in the ecosystem, there is less wood available to store carbon in wood products and to substitute any other material. Similarly, if wood utilization is intensified with a lot of additional bioenergy production, there is less carbon stored in the ecosystem. It is therefore meaningful to find a suitable balance, where both levers take place.

It is important to gather regional experiences to identify and discuss new practices and tools that maintain or increase the carbon sequestration and storage potential of EU forests in the long term, while keeping their multifunctional role intact. An important component of these are provisioning services and related forest-based value chains which create climate change mitigation potentials through carbon sinks in harvested wood products and substitution of fossil fuels and non-renewable materials with high greenhouse gas emissions.

Besides substitution and carbon sequestration in harvested wood products there are also many options for climate change mitigation through (changes in) forest management. Different ways of management sequester different amounts of carbon. Old-growth natural forests store most carbon, but carbon sequestration rates are lower than in commercial forests. Protective forests in steep mountain terrains are close to natural conditions and therefore generally carbon rich. Short-term carbon accumulation can be particularly high when management is discontinued in productive forests, as long as they are not subject to disturbances. Scenario studies with alternative resource use options (Kurz et al., 2016) suggest that the largest overall mitigation effect can be achieved in productive forests with high growth rates (i.e. high carbon sequestration), which are sustainably harvested to produce wood products with long life time and substantial substitution potential to displace greenhouse gas emissions (e.g. using modern wooden construction materials instead of concrete and steel; cf. Tollefson (2017)). Continuous cover forestry tends to increase carbon storage in living biomass compared to even-aged forest management, because the regeneration phase with low biomass density is avoided (Pukkala, 2014). Mixed species forest are more resistant to disturbances (Spiecker et al., 2004) and are in some cases more productive as well, because different species have complementary ecological strategies and are able to utilize the site potential more effectively (Pretzsch et al., 2015). Agroforestry is gaining renewed attention recently as it increases the carbon sequestration in agricultural systems and simultaneously provides timber, food and other ecosystem services (den Herder et al., 2017; Jose, 2009).

Box 1: Climate change mitigation through increased use of wood construction

Wood construction has many possibilities to mitigate climate change. Replacing steel, concrete and other energy consuming materials by wood averts larger energy consumption and consequent CO_2 emissions. According to best estimates, for each ton of wood products used instead of non-wood products, there is an average emissions reduction of approximately 2 tons of CO_2. Wooden material also acts as a storage for carbon as the carbon sequestered in the tree stays in the product for its life time. In addition, use of wood construction can also decrease material use, as wood is lighter than e.g. concrete and requires less strong building foundations. Moreover wood can be reused in other purposes later (cascading) (Hurmekoski, 2017).

EGOIN is a construction company in Spain that is specialised in wooden buildings. They are committed to use local timber from sustainably managed forests. Their products cover a range from single houses to large public buildings. EGOIN manufactures themselves the cross-laminated timber panels they use. Cross-laminated timber panels are fabricated by gluing together layers of timber boards with the grain running at right angles in the alternating layers. This way high quality building material can be made out of lower quality wood assortments.

Ysios Winery, Laguardia, Spain

Jose Cabeza

Wooden construction

Paul Brennan

As explained in Figure 1, there are a number of feedbacks between different climate change mitigation strategies and depending on regional circumstances, alternative strategies will be more or less feasible in a given region. Knowledge transfer across regions is nevertheless crucial to spread good practices.

Discussion questions

- **Which climate change mitigation strategies are practiced in different regions?**
- **How do these strategies affect ecosystem service provisioning, and how do they affect the rural economy?**

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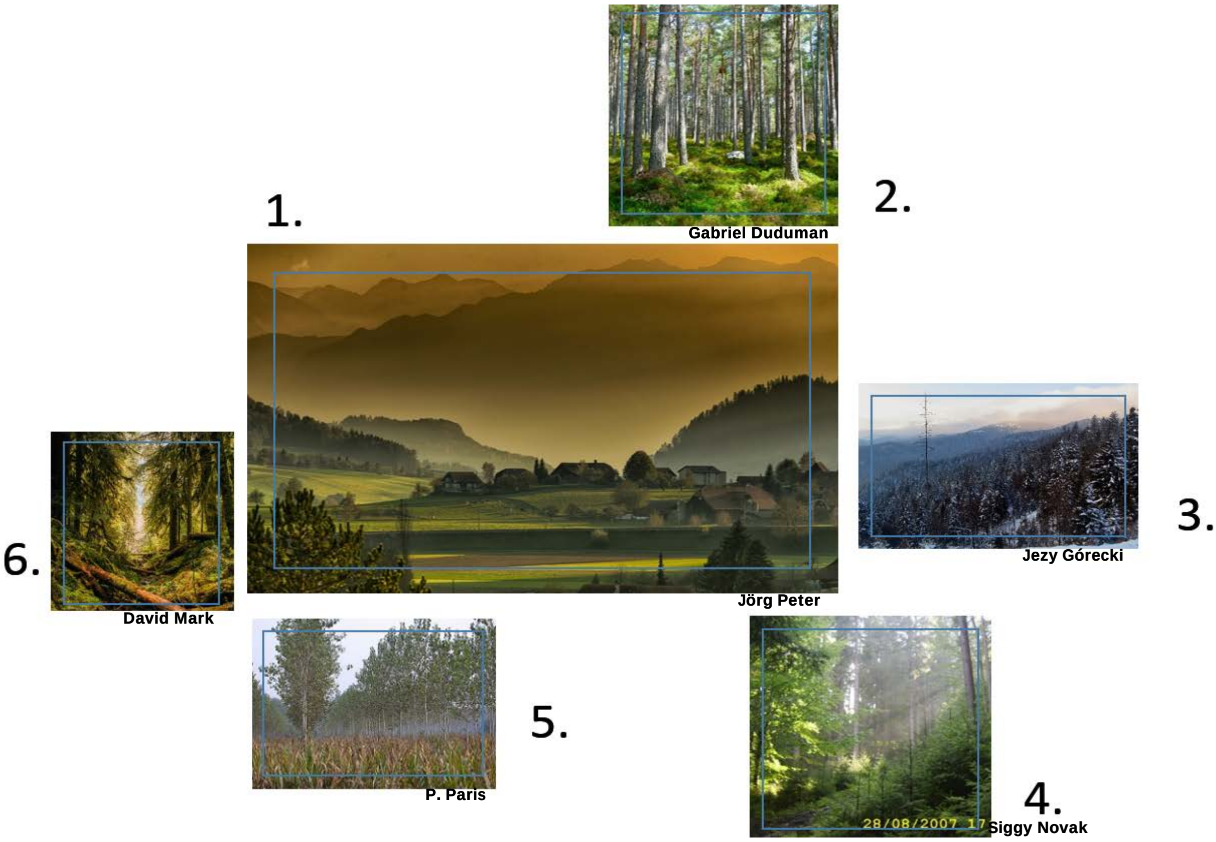
Box 2: Landscape forest management to support climate change mitigation

It would be wise to consider increasing carbon storage in forest and wood products as well as increasing carbon uptake at the landscape level. The "best" approach depends on the landscape properties and the owners' objectives. In a **landscape** (1) different types of forest management can be combined: **protected unmanaged forest** (6) and extensively managed **protective mountain forests** on steep slopes (3) are characterized by large carbon stocks. **Continuous-cover forestry** (4) can be practiced without clear-cuts to skip over the carbon release phase following clear-felling in even-aged forests and carbon stocks in remaining **age-class forests** can be expanded through an **extended rotation length** (2). As a cross-sectorial approach, **agroforestry** (5) allows to increase carbon sequestration in agriculture.



6. Adaptive forest management and increased forest resilience to respond to climate change

What is regionally the most suitable forest management to adapt to the impacts of climate change? Measures aimed at improving resilience of forests ecosystems to extreme weather events such as droughts, forest fires, storms and heavy snows will be particularly important as they enhance the adaptive capacity of the forest-based sector under climate change. It is useful to review and summarize scientific knowledge and practical experiences on the implementation of climate change adaptation strategies in forest management at the regional level. When doing this, the needs of forest managers and other stakeholders (for example those involved in disturbance risk management) in relation to adaptation to changing climate patterns in the EU have to be taken into account. Experiences on the most promising adaptation practices (e.g. by selecting species and provenances or specific sustainable forest management practices) and tools (including the use of digital technologies) are worth communicating, always keeping in mind both adaptation to climate change and more frequent extreme events as well as the multifunctional role of EU forests.

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Box 3: Example of a management response to a large scale disturbance event: storm Gudrun in Sweden

In January 2005, storm **Gudrun** destroyed 75 million m^3 of forest from an area of 270 000 ha in Southern Sweden. Damage occurred mainly in Norway spruce stands (80%). In the follow-up, Sweden's forest agency made the following management recommendations to prevent similar catastrophes:

- Regenerate mixed-species forest stands
- Apply early thinning
- No thinning after trees are more than 20 m tall
- Earlier clear cutting, with a preparation thinning 5-10 years before
- Give attention to site water management

The area replanted with subsidies was 91,000 ha. However, 87% were planted with spruce, only 3 % with broadleaves.

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A large number of possible adaptation strategies to respond to climate change in forest management have been identified in the scientific literature (Kolström et al., 2011). It is important to understand to what extent pro-active or reactive adaptation strategies are currently adopted, if this will (have to) change in the future, or if there is a need for a diversity of adaptation strategies. Another point of discussion might be on what aspects of climate change the adaptation measures will focus – mainly on expected gradual changes in temperature and precipitation or rather at changes in rare extreme events. In this context it is interesting to find out how forest resilience is understood across Europe. One possible definition is presented in Box 4.

Box 4: What is resilience?

Forest resilience is the ability of forest socio-ecological systems including the ecosystem, their users and the beneficiaries of forest ecosystem services, to adapt and respond to change and disturbances in a manner that critical interrelations (ecosystem services) between the systems are maintained.

Discussion questions

- ⇨ **What innovative climate change adaptation measures are used in your region/country?**
- ⇨ **How can resilience of forest ecosystems be increased in different regions?**
- ⇨ **Which tools are used to support adaptation practices? Are there barriers for adopting existing decision support tools?**

7. Synergies and trade-offs between climate change response measures

There are obvious synergies between climate change adaptation and mitigation measures. For example, it is crucial to regenerate forests with species and provenances that are suitable to the changed climatic conditions to ensure that the next forest generation is healthy and productive with high carbon sequestration rates. Adaptive management that minimizes disturbance risks is another example of an adaptation strategy that simultaneously maximizes mitigation potentials. However, there are also examples of measures that cause trade-offs. Such trade-offs can be found between climate change mitigation measures, as maximizing carbon sinks in the forests reduces the capacity of the forest-based sector to utilize wood and thereby enhance harvested wood product sinks as well as material or energy substitution potentials. Another trade-off could occur between short-term mitigation effects and long-term adaptation strategies when low intensity management for carbon sink maximization delays species replacement, or vice versa, when a reduced stocking density to mitigate disturbance risks leads to reduced forest carbon sequestration. Many of the synergies and trade-offs are also linked with distinct costs and benefits. Selecting a different species can imply large economic consequences which need to be carefully considered. In many regions it is the economically most important species that is most threatened by climate change. As shown in the example of Storm Gudrun (Box 3), forest owners may be quite reluctant to change forest management if this means planting a lower share of the species with highest economic value.

Discussion questions

- ⇨ **What synergies exist between climate change adaptation and mitigation measures in your region?**
- ⇨ **Are there trade-offs between alternative measures? How can they best be resolved?**

8. Best practice examples for improving EU forest's mitigation and adaptation potential

Best practice examples should be analysed to identify climate smart forestry measures that fit to the diverse forest conditions, value chains and societal needs across European regions. It is crucial to learn how to choose between alternative measures and to gain understanding on which measures can be combined to create synergies. In adaptive forest management it is important to analyse remaining uncertainties and to choose whether to select suitable species/provenances for the current or for the future expected climate. So far, such practical experiences in implementing climate change adaptation and mitigation in practice are very scarce. Sharing experiences on successful approaches is one way of providing decision support at the science-practice interface on when and how to implement specific adaptation measures. Another promising avenue in this domain is the review and further improvement of decision support tools that offer evidence-based decision support to policy and practice. Based on such activities innovative actions can be developed to share experiences and stimulate the use of management practices and strategies for improving EU forest's mitigation and adaptation potential.

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