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AGRICULTURE & INNOVATION



# EIP-AGRI Focus Group Forest Practices & Climate Change

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## 1. Summary

Climate change poses a major challenge to society in the 21st century. In 2018 we experienced extensive drought especially in Central and Northern Europe, deadly forest fires in Greece (and across the globe in California), fire damages in untypical regions including the UK, Latvia and Germany, as well as bark beetle damages that seriously threaten sustainable forest management in some central and east European countries.

The Intergovernmental Panel on Climate Change alerted the public that we need to step up our ambition to reduce greenhouse gas emissions if we wish to avoid dangerous climate change. Several reports underlined that achieving the Paris Agreement of December 2015 of limiting climate warming under 2 °C (preferably under 1.5 °C) will hardly be possible without effectively using the potential of forests and the forest sector to contribute to climate change mitigation.

This was the backdrop for the Focus Group on 'New forest practices and tools for adaptation and mitigation of climate change'. 20 experts from different regions in Europe gathered to identify forest practices & tools to tackle climate change and to explore successful experiences and innovation in practice. The group discussed how adaptation strategies are selected and implemented, collected experiences on the use of decision support tools at the science-practice interface and reflected on training approaches and ways of sharing experiences.

The challenges posed by climate change, although global, show strong regional differences. Considering the diversity of forest types and different management traditions across Europe, climate change adaptation and mitigation strategies must fit region-specific climate change projections and local circumstances. This report summarises the work of the Focus group. 10 Minipapers presented recommendations and innovative practices spanning a range of topics:

- ▶ Forest management at stand level
  - Small scale forest management
  - Climate smart silviculture and genetic resources
  - Decision Support Systems (DSS) and tools
- ▶ Scaling up management and tackling climate change risks
  - Integrated landscape management
  - Early warning and innovative risk management
- ▶ Fostering adaptation and mitigation by promoting good practices
  - Forest fires prevention
  - Economic incentives as trigger to promote adaptation: Climate Smart Silviculture and payment for ecosystem services (PES)
  - Innovative value chains to enhance climate change mitigation
- ▶ Knowledge exchange beyond the forest community
  - Science-Policy-Practice knowledge exchange
  - Effective communication for mitigation of climate change and adaptation to its impacts

The group identified a number of ideas for Operational Groups to bring innovation into practice:

- ▶ Explore methods to boost the use of broadleaf species by increasing their potential in forest regeneration
- ▶ Develop or gather resources and tools to foster local adaptation in forest management by enhancing awareness and peer to peer learning
- ▶ Test methods to improve assisted regeneration or afforestation in drought prone areas
- ▶ Develop a user-friendly early warning system on local forest health issues which can assess the situation and raise the alarm when necessary
- ▶ Explore ways to enhance landscape management by helping individuals to make decisions aligned with strategies to fight climate change
- ▶ Develop collective and effective plans to mitigate climate change effects (drought, forest fires), promote actions for ecosystem resilience and/or increase awareness of all actors
- ▶ Analysis of mitigation options along specific value chains (e.g. for pine) to improve carbon balance

To foster innovative practices in climate change adaptation and mitigation the following research needs were prioritised:

- ▶ Local/regional guidelines for the implementation of innovative silvicultural practices to adapt the forests to the expected future conditions
- ▶ How to make climate change adaptation incentives more effective and efficient?
- ▶ Study carbon dynamics related to the fire regime: forest species (fire prone vs resistant), land uses and practices (e.g. monocultures, agroforestry) and management options (e.g. wild vs prescribed fire)
- ▶ Evaluation of how to institutionalise knowledge exchange, including a forester exchange programme
- ▶ Participatory research on climate change effects and measures that can be taken at farm/plot level
- ▶ Characterisation of existing collective approaches effectively improving forest management in a context of climate change



## 2. Introduction

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 will pose major challenges for forest management in decades to come.

EU forests currently sequester around 10% of annual EU CO<sub>2</sub> emissions (Pilli *et al.*, 2017), however, it is predicted that the sink will decrease, partially due to the aging of forests in Europe (Nabuurs *et al.*, 2013). Innovative practices and tools for forest management will be needed to sustain and enhance the mitigation potential of forests to help achieve the ambitious targets of the Paris Agreement. Forest vulnerability will increase due to more frequent and extreme weather events. Therefore, two elements need to be considered together: the ability of forests to adapt to climate change and to help mitigate climate change.

An EIP-AGRI Focus Group was established in spring 2017 to explore the question “**Which new management practices and tools can improve the climate mitigation and adaptation potential of EU forests?**” 20 experts from different European countries were selected for their practical experience and technical knowledge on this topic (see [Annex 1](#)).

The experts met twice to exchange on forest practices and tools for adaptation to climate change and to explore successful experiences and innovation put into practice, focussing on:

- ▶ how adaptation strategies are selected and implemented
- ▶ the use of decision support tools to bridge scientific knowledge and practice
- ▶ training approaches and ways of sharing experiences.

The Focus Group prepared 10 mini-papers covering important aspects of forest practices and climate change, spanning the following topics:

- ▶ Increasing awareness on climate change and adaptation/mitigation
- ▶ Smart and sustainable silviculture and genetic resources
- ▶ Small scale forest management
- ▶ Techniques and practices to manage fire risk in the forest
- ▶ Landscape management to diversify strategies
- ▶ Knowledge exchange between research, industry and forest owners and/or managers
- ▶ Implementing adaptation strategies through economic incentives
- ▶ Innovative value chains that generate material and energy use
- ▶ Prevention, early warning and innovative risk monitoring
- ▶ Regional experiences with Decision Support Systems

All mini-papers are available at the [Focus Group webpage](#).

### 3. State of play

The challenges posed by climate change to sustainable forest management in Europe show strong regional differences (Table 1), ranging from enhanced growth and productivity mainly in the north and at higher elevations, to increased and more frequent drought stress and mortality expected elsewhere (Lindner *et al.*, 2014). Considering the diversity of forest types and contrasting management traditions across Europe, climate change adaptation and mitigation strategies must fit the region-specific climate change projections and local circumstances.

Furthermore, it is expected that climate change will increase the risk of different forest disturbances (Seidl *et al.*, 2017). Rising temperatures cause heat-stress to trees and affect insect population dynamics, making trees more prone to pest attacks. Wetter and non-frozen soils may reduce root anchorage, which can favour extensive windthrows. Dry conditions can enhance forest fire risks, not only in the Mediterranean area, but also in the temperate continental and boreal zones. With different adaptation measures, the risks of climate change can at least be managed to some extent (Table 2).

**Table 1: Overview of regional differences in climate change impacts and selected adaptation options**

Biogeographic region	Effects of climate change	Possible adaptation measures <sup>1</sup>
<b>Boreal</b>	<ul style="list-style-type: none"> <li>– Increased growth and productivity;</li> <li>– Difficult harvesting and reduced accessibility on non-frozen soils;</li> <li>– More frequent storm, fire and insect damage.</li> </ul>	<ul style="list-style-type: none"> <li>– Adapt management regimes to accelerated growth rates;</li> <li>– Develop harvesting technology and transport logistics with reduced soil impact;</li> <li>– Shorten rotation length and more stable stand structure.</li> </ul>
<b>Temperate Atlantic Zone</b>	<ul style="list-style-type: none"> <li>– Increased risks from storms, pests;</li> <li>– More frequent droughts;</li> <li>– Changes in productivity;</li> <li>– Changes in species composition.</li> </ul>	<ul style="list-style-type: none"> <li>– Diversification of both species and age composition;</li> <li>– Choose appropriate genetic material;</li> <li>– Shorten rotation length.</li> </ul>
<b>Temperate Continental Zone</b>	<ul style="list-style-type: none"> <li>– Drought-induced productivity decrease;</li> <li>– Spruce forest susceptible to pests and windthrows;</li> <li>– More frequent regeneration failure;</li> <li>– Increased fire risk.</li> </ul>	<ul style="list-style-type: none"> <li>– Proper management of old and young stands to improve regeneration;</li> <li>– Intensive thinning to save water.</li> </ul>
<b>Mediterranean</b>	<ul style="list-style-type: none"> <li>– Increased aridity with more frequent severe droughts;</li> <li>– Dieback of certain species leading to biodiversity loss;</li> <li>– Increased forest fire hazard and subsequent soil erosion risk.</li> </ul>	<ul style="list-style-type: none"> <li>– Decrease canopy density in dry areas through regular management (thinning, pruning);</li> <li>– Longer rotation period;</li> <li>– Adopt prescribed burning or other fuel management techniques.</li> </ul>
<b>Mountainous</b>	<ul style="list-style-type: none"> <li>– Increased productivity;</li> <li>– Increased run-off and soil erosion;</li> <li>– Shift in vegetation climax and species composition;</li> <li>– Increased risk of pests, forest fire, windthrow.</li> </ul>	<ul style="list-style-type: none"> <li>– More spatially diverse management that increases tree regeneration speed and protective qualities and reduces risk of bark beetles.</li> </ul>

<sup>1</sup> This list is not comprehensive and some measures, such as increased landscape diversity, can be applied in all biogeographical regions.

**Table 2: Main disturbances in European forests and projected changes**

Disturbances	Most Affected Regions	Projected Changes
<b>Storms</b> 	Temperate Oceanic, Southern Boreal and Temperate Continental Zones	<ul style="list-style-type: none"> <li>– Northwards shift of storm tracks increases the risk in previously unaffected areas;</li> <li>– Higher top wind speeds result in increased storm intensities;</li> <li>– Increased spatial extent of storms with longer storm tracks affecting larger areas and reaching further into Eastern Central Europe.</li> </ul>
<b>Pests</b> 	Temperate Continental, Southern Boreal and Mediterranean Zones	<ul style="list-style-type: none"> <li>– New pests in the area;</li> <li>– Migration of known pests to northern or higher elevation areas, e.g. bark beetle damage zones are increasing in the mountains;</li> <li>– Shorter reproduction cycles;</li> <li>– Intense incidents of tree dieback.</li> </ul>
<b>Drought</b> 	Mediterranean, Temperate Continental, Temperate Oceanic, and Boreal Zones	<ul style="list-style-type: none"> <li>– Rainfall distribution more variable resulting in more frequent and extended drought periods;</li> <li>– Precipitation expected to decrease in Mediterranean leading to reduced water availability.</li> </ul>
<b>Forest fires</b> 	Mediterranean, Temperate Continental and Boreal Zones	<ul style="list-style-type: none"> <li>– Areas with forest fire risk will increase drastically, putting forests at risk across most of Europe;</li> <li>– Length of the fire risk season will increase;</li> <li>– Heat waves and strong winds will lead to more devastating extreme wildfire events.</li> </ul>

## a. Good practices and implementation degree

### Adaptation to climate change

**Table 1** presents examples of adaptation measures targeted at major climate change challenges in different European regions. Measures to improve forest ecosystem resilience 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. Many possible adaptation strategies to respond to climate change in forest management have been identified in scientific literature (Kolström *et al.*, 2011).

One major distinction can be drawn between **pro-active and reactive adaptation strategies**. Extreme events or major disturbances can trigger a reactive response. However, in view of the long management cycles in forestry, it is crucial to shift to pro-active measures that include forward-looking and adaptive management strategies (Yousefpour *et al.*, 2017). The large uncertainties about the regionally expected climate change impacts can be dealt with by using a diversity of adaptation strategies at the level of management districts or

within the landscape. Another important consideration is how to address both the expected long-term gradual changes in mean climate conditions as well as more frequent extreme events. Furthermore, the choice of adaptation strategies needs to reflect the expected regional change in mean temperature and precipitation. Measures aiming at enhancing the natural resilience of forests with close to nature silviculture (Brang *et al.*, 2014) are more likely to succeed if climate change can be limited. With unabated climate change it is likely that active management changes will be required such as introducing new provenances or species, e.g. from warmer locations.

Practical experiences exist on the implementation of climate change adaptation strategies in forest management at the regional level, but these are not always documented. Experiences on the most promising adaptation practices and tools need to be shared and communicated to support adaptation to climate change and more frequent extreme events, to safeguard the multifunctional role of EU forests.

## Mitigating climate change

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

- ▶ sequestration management aiming to increase carbon sinks in forest biomass and reduce loss of carbon from soils (through forest/soil protection OR increased productivity);
- ▶ sequestration management with focus on increased carbon sinks in harvested wood products;
- ▶ substitution management with focus on the use of bioenergy and wood-based products to replace fossil fuels and non-renewable materials.

Sequestration and substitution are complementary levers of climate change mitigation:

- ▶ **Sequestration** means that CO<sub>2</sub> is bound from the atmosphere and stored in the biosphere for a certain period of time. Living trees sequester carbon in the ecosystem and, after harvest, carbon continues to be stored in the 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 also is an alternative to concrete or steel which 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 other material. Similarly, if wood utilisation is intensified with a lot of additional bioenergy production, there is less carbon stored in the ecosystem. It is therefore important to find a suitable balance between carbon sequestration in forests and the use of wood to substitute other materials.

There are also many options for climate change mitigation through **forest management** and different types of management affect forest carbon sequestration and emissions. For example:

- ▶ Old-growth natural forests store the most carbon, but their rates of additional carbon sequestration are usually lower than in commercial forests.
- ▶ Discontinuing management in productive forests can result in significant carbon sequestration in the short-term as long as not counteracted by natural 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.
- ▶ Choosing the best available forest genetic resources and optimised management regimes have significant potential to increase forest productivity (Rytter *et al.*, 2016).

- ▶ Continuous-cover silviculture 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 forests are more resistant to disturbances (Spiecker *et al.*, 2004) and they can sometimes be more productive because complementary ecological strategies of the species allows the site potential to be used more effectively (Pretzsch *et al.*, 2015).
- ▶ Forest management can also contribute to preventing or minimising disturbance-related emissions, for example through appropriate species selection, reducing wind exposure or fuel management (Jandl *et al.*, 2015).
- ▶ Agroforestry is gaining renewed attention recently as it provides timber, food and other ecosystem services while simultaneously increasing carbon sequestration in agricultural systems (Jose, 2009; den Herder *et al.*, 2017).

## Synergies between adaptation and mitigation

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 altered climatic conditions to ensure that the next forest generation is healthy and productive, which will also ensure high carbon sequestration rates.

**Adaptive management** that minimises disturbance risks is another example of an adaptation strategy that simultaneously maximises mitigation potential. However, there are also examples of measures that cause trade-offs. One of these trade-offs is the example described above, of maintaining standing forest biomass as a way to sequester carbon, versus harvesting and using the wood to substitute other materials.

Another trade-off may occur between short-term mitigation effects and long-term adaptation strategies, for instance when low intensity management for carbon sink maximisation 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 to distinct costs and benefits. Selecting different species can have big economic consequences which need to be carefully considered. In many regions, the species which is economically the most important is also the most threatened by climate change, for example spruce in Europe.

## b. Success factors and constraints

The IPCC<sup>1</sup> stated that progress had been made in creating science-based knowledge about climate change and its effects. However, adaptation action is lacking (IPCC, 2012), which can only be overcome by **operational science-practice-interfaces**. Scientists often do not implement adaptation or mitigation measures in practice. Foresters may not always be able to use the scientific findings, which are often complex or confusing, or even contradictory. Overall, there are several conditions for success, which are affected by constraints that need to be overcome to successfully implement climate mitigation and adaptation actions in forestry:

<sup>1</sup> IPCC: The Intergovernmental Panel on Climate Change (<http://www.ipcc.ch>)

Key conditions for success	Constraints
<b>Scientific knowledge and proven experience, tools and practices</b>	<ul style="list-style-type: none"> <li>- Limited knowledge of the nature and magnitude of current and/or future climate risks and vulnerabilities; difficulty to evaluate the uncertainties</li> <li>- Lack of scientific knowledge and precedents (i.e. successful practice cases) in the implementation of adaptation measures; especially at the landscape scale</li> </ul>
<b>Climate change awareness and risk perception of decision-makers, and their communication needs (see mini-paper 1)</b>	<ul style="list-style-type: none"> <li>- Decision-makers need education on climate change to understand the potential effects of climate change so that they can take measures to adapt</li> <li>- Decision-makers, including forest-owners, need clear communication that meet their needs</li> <li>- Decision-makers require adequate knowledge of risk perception and its drivers to design effective decision support and communication actions</li> <li>- Resistance to change established management routines</li> </ul>
<b>Long term effects and economics of the adaptation actions</b>	<ul style="list-style-type: none"> <li>- Decision-making and planning processes tend to focus on the short-term perspective and lack of routines to handle long-term change</li> <li>- Prohibitive immediate costs of identified adaptation measures that limit the forest-owners' economic capacity to take action</li> <li>- Lack of economic incentives to support provisioning of forest ecosystem services negatively affected by climate change</li> </ul>
<b>Policies and legislation</b>	<ul style="list-style-type: none"> <li>- Absence of policies, regulations, norms or guidelines that encourage the departure from the status quo</li> <li>- Legal or regulatory restrictions that represent real impediments to the adoption of measures in forestry</li> <li>- Lack of a mandatory policy framework at the European level</li> </ul>

There are also natural and socio-economic drivers that affect the uptake of climate change mitigation and adaptation actions. For example, adaptive forest management is often triggered by natural disturbances or extreme events. Following storm damages with subsequent bark beetle infestation there is a window of opportunity to change species composition in forest restoration.



**Bark beetle attack on forests damaged by an ice storm in Hotedršica (Slovenia)**

## 4. What can we do? Recommendations

Clearly, adaptation and mitigation of climate change is a complex issue and optimising forest management to these ends requires different approaches, which are adapted to the specific situation.

The next section compiles some recommendations and ways forward. They are grouped into the following topics, which have been further developed by the Focus Group in the [mini-papers](#):

- ▶ Forest management at stand level
  - Small scale forest management
  - Climate smart silviculture and genetic resources
  - Decision Support Systems (DSS) and tools
- ▶ Scaling up management and tackling climate change risks
  - Integrated landscape management
  - Early warning and innovative risk management
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### a. Forest management at stand level

#### Small scale forest management

Nearly half of European forests are privately owned and the property rights held by private forest owners are very diverse across Europe (Nichiforel *et al.*, 2018). Moreover, the average size of many of these forest holdings is very small which may impose significant management constraints, making them less viable economically. Therefore many of these small private forests are essentially unmanaged. Moreover, during recent decades the population in rural areas has decreased a lot and significant changes occurred in their behaviour and the social needs towards forest. This has brought about considerable changes in forest practices and use, and in people's attitudes and values towards forests.

Real adaptation to climate change occurs at the local level, and because of the high variation of forests and forest owners, there cannot be one strategy of adaptation/mitigation but several, adapted to local conditions and circumstances. Therefore, in order to be effective, small-scale forest management planning must include different stakeholders, address the rights of the owner, be participatory by its nature and consider the 'economic landscape' of each owner.

In the case of very fragmented small forest holdings, climate change adaptation and mitigation strategies may be implemented through forest cooperatives or other collaborative efforts. Due to scaling-up effect, an efficient wood production/carbon sequestration in the multitude of small holdings could provide a considerable contribution to rural livelihood and employment, not to mention biodiversity. Also, when small units are managed together, marketing, silvicultural work and all management needs may be more effective and efficient. In several countries therefore, forest management associations or cooperatives are supporting forest owners in practical forestry issues, from seedling provision to forest management or selling the wood. Furthermore, climate related issues can be integrated into other training activities on forest management and silvicultural practices.

### Inspiration: Supporting small scale forest management in UK and Finland

'[Small Woods](#)' is a registered UK charity offering support, advice and training. Their focus is on supporting woodland owners and improving management.

The Finnish website "My forest" or "[Metsään.fi](#)" is a portal offering the latest information to forest owners on their properties. Several tools are available for compartment-wise forest management, including digital yield tables to estimate the growing stock, potential harvest volume and timber value.

[TAPIO Maastotaulukot](#) is a handy mobile application providing specialist advice for field work, replying to questions such as: Is it time for a thinning? How valuable is a tree? Or, should I protect the environment surrounding a stream?

See [mini-paper 10](#) for further information and more examples on support for small forests

## Climate-smart silviculture and genetic resources

Forest management practices in Europe are very diverse. Even so, even-aged, mono-species plantations with regular silvicultural management dominate much of European production forestry. Recently this system has been criticised for its high susceptibility to pests and diseases, limited resilience to climate change and also societal pressure against clear-felling of forests. As explained in [mini-paper 4](#), today, a range of alternatives and good practices can contribute to overcome these limitations.

For example, **close-to-nature silviculture**, which is already practiced in many countries and continues to gain support, is widely recognised to be more effective in adapting forests to climate change (Brang et al, 2014: O'Hara, 2014). It promotes the use of natural and/or site-adapted tree species in mixed forests, aims to diversify the vertical and horizontal stand structures, promotes natural regeneration and avoids large clear cuts.

Even so, **even-aged silviculture** can also be practiced sustainably. In boreal regions with large forest areas that would naturally be affected by forest fire and pest outbreaks as part of their regeneration cycle, even-aged management is considered close-to-nature. Results of the 11<sup>th</sup> National Forest Inventory in Finland show that more than four out of five Finnish trees are the result of natural regeneration. This illustrates the importance of natural forest dynamics even in the intensive forest management regimes practised in Scandinavian boreal forests. Plantation forestry is also practised in limited areas in Europe, especially in the Atlantic regions from Portugal to Ireland. These forests have a low resilience to disturbances, but due to short rotations, they offer more frequent options to adapt the tree species selection to the changing climate.

**Climate smart silviculture** should employ "precision" silviculture with optimised intensity of cuttings, stand density and rotation length, aiming at enhanced forest resilience. This includes timely and proper management of young stands adapted to the local conditions to maintain the vitality, resistance and health of forests and the resistance of trees to wind and snow-induced damage. For future forest stands to survive and best fulfil their multiple functions it is important to maintain and, where possible, improve adaptive potential to cope with gradual changes and extreme events.

In addition to their management, the adaptive potential of forests relies heavily on the forces of natural selection. This is why **genetic resources** are of significant interest and increasing importance in the quest for species and populations that show better potential for adaptation to climate change or subsequent effects of climate change, e.g. more disease pressure.

### **Inspiration: Utilising genetics know-how to select trees for the future**

Cork oak (*Quercus suber*) and holm oak (*Quercus ilex*) are being studied in Portugal and Spain to find provenances that are more resistant to drought stress and pests and diseases associated with climate change.

European Silver fir (*Abies alba*) is one of the most productive and ecologically valuable trees that will likely play an increasingly important role under future climate change conditions. Recent research has shown evidence of growth increment, amongst others, due to increases in mean summer temperatures.

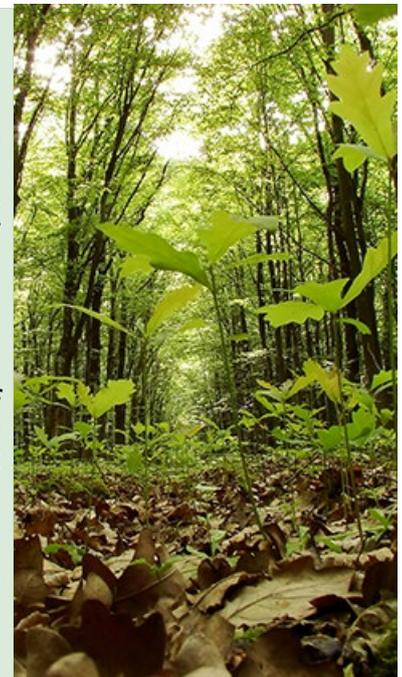
Forest management decisions on the use of artificial regeneration and choice of suitable forest reproductive material need to be based on information about the expected climate (change) patterns for a particular region, so as to ensure stand vitality in the long-term. For this, provenance trials provide unique insights to guide adaptive forest management. Their outcomes to date indicate the availability of a wide range of options in the choice of appropriate forest reproductive material, including its use through assisted migration of species. One example is the EU-funded project FORGER.

### **Inspiration: [FORGER project](#)<sup>2</sup> guides adaptive forest management**

Provenance trials in forest genetic studies consist of planting trees from different origins in a common site to assess the performance of such tree populations across a range of conditions. The simultaneous action of natural selection, gene flow and other genetic effects in their area of origin lead to different behaviours within the same species, defined as provenances of seeds or plants.

Based on this analysis of tree performance in provenance trials, FORGER developed projections of future responses of some of the most popular trees in Europe (*Picea abies*, *Pinus sylvestris*, *Fagus sylvatica* and *Quercus petraea*). Results aim to make better use of the genetic resources within the forest community in a climate change context, for example by using the right provenance of seeds and plant, so as to adapt to the future climate conditions in the different sites.

Results have been disseminated through different kinds of materials with key recommendations regarding genetic resources, targeted to different actors such as [policy makers](#) and [forest managers](#).



## **Decision Support Systems**

A Decision Support System (DSS) consists in general of software with a database system or reference tables, a knowledge (modelling) system and a user interface with prediction and/or simulation capabilities. In this regard, in relation to climate change, we can group these tools within groups: adaptation, mitigation and risk analysis of forest and forest management.

There are several [DSS in use in the forestry sector](#) to inform decisions concerning **adaptation to climate change**. They support, e.g., how to approach species diversification or support with 'assisted migration' and 'genetic evaluation'. These tools are designed to answer questions such as a) Which species will grow well on this site in future, given the ground conditions and what we know about a given species? b) What will the

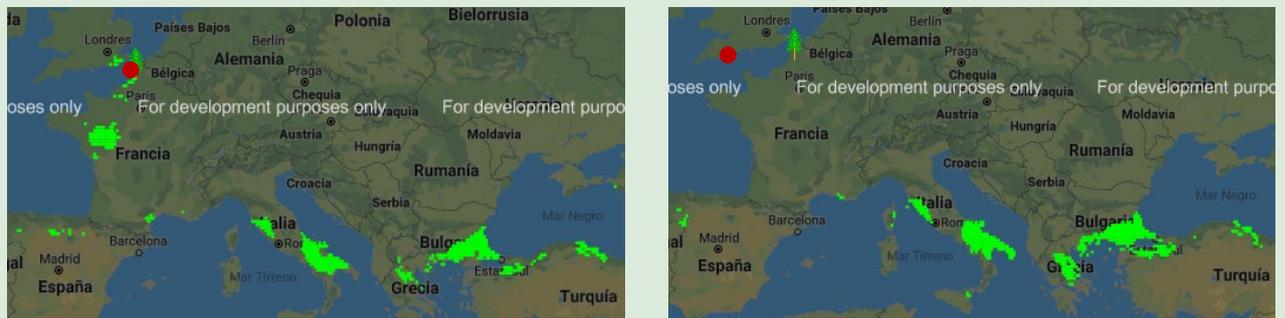
<sup>2</sup> Matyas, Cs. and Kramer, K. 2016. FORGER Policy Brief

projected future climate be like at a given location in a given year? c) What are the risks to this stand from climate change? d) How will the future climate impact the growth of current stands?

Examples of this are the Climate Matching Tool or the [Ecological Site Classification ESC-DSS](#) in the UK.

### Inspiration: The [Climate Matching Tool \(CMT\)](#) helps you to find the right provenance of your future trees

By modelling and comparing climate scenarios, CMT identify regions where forest reproductive material may be suitable for adapting forestry to reduce the impacts of climate change through assisted migration. The images below show an example for the Amiens area (see red dot). The green areas are locations identified by the tool where the current climate is most similar to the future climate expected in Amiens in 2050 and 2080 respectively.

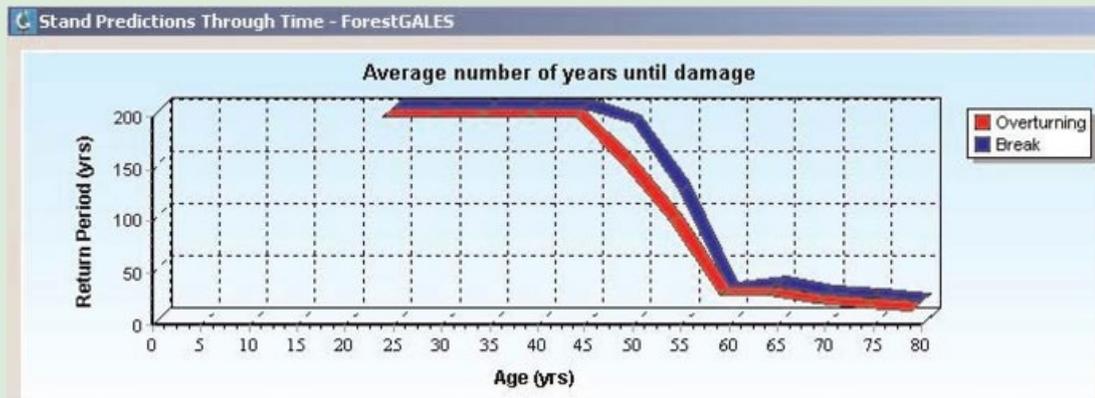


On the other hand, the DSS addressing **mitigation of climate change** by the forestry activity, mainly focuses on the evaluation of the carbon sequestration in the stand and the type of wood products, to estimate the expected carbon storage through substitution with non-wood products.

Finally, another set of DSS assesses specific risks to current stands and climate change impacts (e.g. dieback or water vulnerability) for future stands. Such DSS are highly variable depending on country, species, risk and scale over which the risk is considered. This is the case, for example, for ForestGALES from United Kingdom (see below).

### Inspiration: [ForestGales](#) assess the risk of wind breaks in Britain

ForestGALES software estimates the probability of wind damage to any conifer stand in the United Kingdom. This figure below shows results from single stand projections through time using the ForestGALES software<sup>3</sup>. The graphics window indicates the return period in years for damaging storms at intervals throughout the rotation. Typically, as the trees grow older and taller, the risk of wind damage increases and the return period therefore decreases.



Furthermore, to successfully manage forests in a context of climate change, as indicated in [mini-paper 1](#) education and/or professional advice for owners and forest managers is critical. Several tools have also been developed to support climate change extension services to deliver education and advice, mainly oriented to forest owners, such as those in [Sweden](#). Using a DSS to inform decisions concerning adaptation of forests to the changing climate enables the user to learn and consider a wider range of options and scenarios than would otherwise be possible. Outputs can be fed into forest management planning directly, so that decisions about future suitability of species, planting, management options, etc. can be taken into account at the planning stage.

Even so, some skills are required to be able to interpret the results and apply them to practice; many DSS still remain specialist research tools and they are not accessible to most forest managers. A common weakness of current tools and systems is the lack of validation of output data and a need to increase real world application. For systems which have been designed to work across a wide geographical area, users reported constraints on local accuracy, which can reduce confidence and limit real world application. Case study examples of application, training and 'hand-holding' by experts can, however, help to overcome some of these constraints and demonstrate how the DSS outputs can be applied in realistic forestry settings. Attention should be given also to language barriers through use of appropriate terminology, explanation of key terms and acronyms. Finally, DSS should complement, not replace local knowledge.

Find more detailed information on DSS in [mini-paper 7](#).

## b. Scaling up management and tackling climate change risks

### Integrated Landscape Management

Tackling climate change in forests starts by correctly managing the individual stands. However, to fully succeed, forest management needs to be upscaled, ensuring that individual decisions are aligned with a territorial approach to the challenge.

Managing forested landscapes for successful climate change adaptation and mitigation poses many challenges. Increasing uncertainty due to climate change means increasing complexity of decision-making processes.

<sup>3</sup> Source: User manual. ForestGALES. A wind risk decision support tool for forest management in UK. Version 2.5 (2015). Forestry Commission

Diversifying management with a multi-sectoral view on the management of forest landscapes can support the provision of different goods and ecosystem services, reduce the risk of economic loss at landscape level and create other benefits.

Each decision-maker involved in land management (forests, agriculture, water streams...) has to make numerous decisions every day. Some can be short-lived and easily modified if the results are not as expected but others have long-lasting impacts and their consequences may even affect future generations. For this, computer models can be used to assess the probability of future events and, in the face of adopting different strategies, the planning process could look to minimise trade-offs or, based on different stakeholder needs, make the necessary choices.

Below is a list of good practices on landscape management, contributing to fight climate change (extracted from [mini-paper 5](#)):

- ▶ It is impossible to eliminate uncertainty about the future of forests, but **more robust data and information could improve the prediction models**, making them perform satisfactorily over many plausible future scenarios (rather than just one).
- ▶ **Diversifying management strategies** across the forested landscape could help to reduce the risk of economic or ecological loss. Furthermore, for landowners, incorporating risks into forested landscape management implicitly leads to diversified management strategies at the landscape level.
- ▶ **Heterogeneous forested landscapes (mosaic)** can provide a broader spectrum of ecosystem services and help conserve biodiversity. Mosaics improve soil protection (for example, creating natural barriers to erosion), pollination, recycling of nutrients and water regulation (Baudry 2014). Moreover, landscape mosaics are more resilient to climate change and other pressures than larger homogeneous areas.
- ▶ **Incorporating properly identified stakeholders into the planning process** of landscape management can bring a lot of benefits locally as well as for society as a whole. Stakeholder needs should be considered in the planning processes and management solutions should encompass a fair distribution of benefits and incentives. Communicating and explaining the results of the landscape planning is another crucial element of integrated forested landscape management. Here, standards for effective communication can be applied (see [mini-paper 1](#)).



## Early Warning and Innovative Risk Management

In recent years, several innovative methods and systems for forest protection have been implemented in European countries. These include for example early warning systems for forest fires or a systematic pest monitoring in susceptible forest types such as monocultures of Scots pine in Poland and Eastern Germany. As explained in [Chapter 3. State of play](#), both forest fires and pests and diseases are amongst the main threats posed by climate change.

Over the past few years, **unmanned aerial vehicles (UAVs)**, commonly referred to as drones, have grown in popularity within the forestry sector, as they contribute to reducing field works, especially for data collection and measurements. UAVs are becoming more cost-effective and their performance is constantly improving. Aerial images taken by drones can be used in a wide variety of analyses and applications (e.g. analysis of water, snow, hail, storm and fire damage, monitoring insect outbreaks, determining the extent of dead wood, optimising skid trails in mountainous areas, counting game, measuring forest sites and trees, creating 3D surface models).



Multicopter (UAV) detecting bark beetle infestation in Thuringia, Germany. Photo: Carmen Rudolph

When increasing the scale, the use of the **satellite imagery** enables a damage assessment at local and regional scales (e.g. by automatic detecting defoliated areas by insects), a rapid mapping of windfall areas and helps to produce pre and post-storm situation maps.

### Inspiration: Using images from drones or satellites to detect and map damages in forests

Forestry Authority of Brandenburg/Germany uses RapidEye-satellite imagery of the forest to create forest damage and change maps that can be used to navigate to the infestation sites and to delineate infestation risk areas for the next vegetation season.

In Ireland, Copernicus Land Monitoring Service data, an Earth Observation service funded by the European Union, is used to develop an earth observation system for forest damage monitoring in forests. It provides geographical information on forest extent, type, state and damage, thereby supporting rapid countermeasures and sustainable forest management.



Finally, forest fires can cause extensive damage, especially (but not only) in areas suffering from a prolonged dry-season. It is imperative to drastically reduce the occurrence of forest fires and damage in forest ecosystems and neighbouring areas due to the loss of human lives, forest capital, private property and public infrastructure. Moreover, they cause an extensive environmental degradation with the release of large amounts of greenhouse gases (further accelerating climate change) and smoke particles that lead to air pollution.

To fight forest fires, a few strategies can be followed, one of them is the early detection of the fire spots. One example of the technologies for such purpose, is the FireWatch System.

### Inspiration: The **FireWatch-System** for automated early detection of forest fires

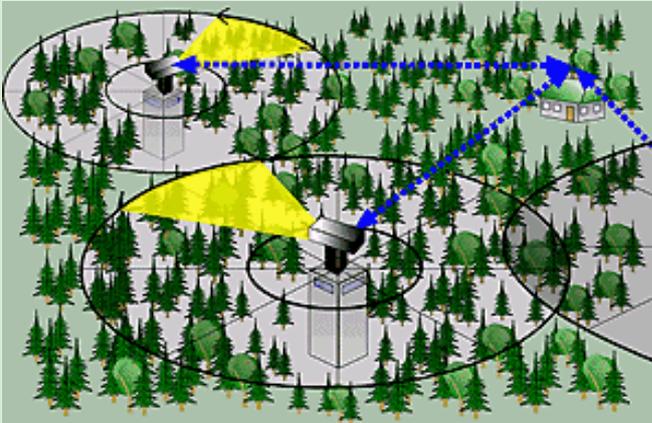


Figure Automated Forest Fire Monitoring System "Fire Watch". Sectors and images are shown on a monitor; the detected fire location is identified on a topographical map. (Source: IQ wireless Ltd)

The **FireWatch-System** for automated early detection of forest fires uses an optical sensor originally developed by the German Aerospace Centre for a space mission. More than 300 systems have been installed in Germany, other states in Europe and abroad. The sensors (cameras) are mounted on high infrastructures as towers, and are able to distinguish barely detectable smoke clouds. As soon as the camera spots what may be smoke, it acquires images and sends them to the forest fire centres, where the coordinates of the fire are automatically determined and shown on a map.

As a result of the installation of FireWatch, the early detection and fast deployment of the fire service, the average forest area destroyed by fire is reduced.

For further information on these examples and get to know other initiatives, see [mini-paper 3](#).

## Fostering adaptation and mitigation by promoting good practices

### Forest fires and their relation to climate change

Reducing forest fire risk can be achieved, not only by early detection of fire outbreaks, but also by applying prevention and suppression measures. Prevention measures discussed in this Focus Group, included the management of forest biomass, landscape management, the reduction of fire outbreaks and informing/educating the public.

Regarding reducing the risk of forest fires, several good practices are listed in [mini-paper 8](#), including short and long-term initiatives:

- ▶ Short-term initiatives: forest management is very important and considers for example planning and rigorously implementing thinning, creating/maintaining forest fire prevention strips and promoting the plant species whose residues are less prone to ignition.
- ▶ Other short-term prevention measures include the clearing of accumulated biomass by mechanical means or animals (silvopastoralism) and the use (when and where applicable) of prescribed fire. Below some examples of good practices on control and management of biomass, applicable by foresters and/or farmers.

### Inspiration: Good practices on biomass control for forest owners (and farmers) silvopastoralism and agroforestry by [AGFORWARD project](#) and [EURAF](#)



Grazing livestock removes understory biomass while providing extra income to the farmer through meat and dairy products. Regeneration is accomplished by protective measures (tubes and wire-nests in this picture). Photo by A. Pantera.



Alley cropping, the agroforestry practice by which trees are planted in rows and the intermediate space is used for low-height crops such as vegetables and cereals, are excellent forest fire strips. Photo by D. Kitsikopoulos. Source AGFORWARD 2017b.

- ▶ When considering the long term initiatives, meaning those which cannot be accomplished within a year, normally require a more strategic and even territorial approach. In [mini-paper 8](#) some key aspects are highlighted, for example, the education and information of the general public, the need of improving land-use planning to tackle or prevent land-use conflicts or adopt a more holistic approach regarding afforestation (selection of adequate species, conversion of marginal or abandoned agricultural lands)

### Inspiration: Good practices on biomass control at landscape level in Portugal

The [ZIF -Zonas de Intervenção Florestal](#) (Forest Intervention Zones) is a Portuguese initiative looking at the effective management of private forest lands with special focus on forest fire prevention and small land owners. They assure, for example the establishment and collaborative maintenance of fire breaks.

### Inspiration: Information and education for education and information on forest fires

- ▶ [Fireparadox](#), apart from conducting research on forest fires, compiled several resources to disseminate project findings and communicate about forest fires, such as demonstration sites, handbooks and simulators. It also has a "Children's corner" with materials (videos, posters, booklets) for educational purposes.
- ▶ [CeaseFire](#) is a Portuguese platform that collects and distributes relevant information on forest fires as maps, weather forecasts and forest data. By crossing weather forecasts with vegetation and orography, it estimates the probability or risk of fire. Data can be consulted online or downloaded.

## Economic incentives as triggers to promote adaptation

Economic incentives (forest climate finance) are important in forestry because measures to support climate mitigation and adaptation often require investments which may be too high for the forest-owners.

Climate targets can be achieved through **Climate Smart Forestry**<sup>4</sup>. With the right incentives and investments, a significant contribution can be expected from EU forests, forestry and the forest-based industries in order to address climate issues. Economic incentives are very important to overcome the short-term focus of decision-makers. Forest managers may be encouraged to respond to climate change through incentive schemes, such as PES (payment for ecosystem services) or markets that require a certain level of socio-environmental responsibility from the producers and their immediate buyers.

Many of the recommendations for climate friendly mitigation and adaptation practices make sense on their own. However climate finance may have a pivotal role to foster large scale management changes (Canaveira *et al.*, 2015) as it can be used to:

- ▶ overcome non-financial barriers, e.g. by facilitating training and capacity building to cover knowledge and information gaps;
- ▶ overcome resistance to innovation, e.g. provide an incentive to change practices that have been common in a certain region for extensive periods of time;
- ▶ provide financial viability to alternative practices, e.g. replacing “bad” (but short-term profitable) practices with practices which are better adapted to climate change;
- ▶ cover losses associated with temporary restrictions to current practices, e.g. excluding grazing until soils or forest densities recover;
- ▶ finance the information and monitoring system to measure the costs and the climate benefits introduced by the measures.

**Mini-paper 2** provides an overview of existing economic incentives for implementing adaptation strategies and on how to develop and improve efficient incentives that promote the engagement of forest-owners to forest adaptation practices.

### **Inspiration: the UK's Woodland Carbon Code rewards land owners who contribute to carbon sequestration**

The UK's Woodland Carbon Code, a voluntary government-backed standard for woodland creation projects was launched in 2011. It allows project developers to quantify and account for the carbon dioxide sequestered, using best available scientific knowledge. A third-party validation and verification process ensures high quality carbon standards. By the end of 2016, 243 projects were registered, creating over 16,000 hectares of woodland. Selling the rights to the carbon captured by Woodland Carbon Code certified woodlands can provide new income for landowners, potentially supplementing other income streams from timber, woodfuel and sporting activities.

<sup>4</sup> Gert-Jan Nabuurs, Philippe Delacote, David Ellison, Marc Hanewinkel, Marcus Lindner, Martin Nesbit, Markku Ollikainen and Annalisa Savaresi. 2015. A new role for forests and the forest sector in the EU post-2020 climate targets. From Science to Policy 2. European Forest Institute.

### Inspiration: the Portuguese Carbon Fund and Extensive Grazing – Support through EU rural development funds

The **Terraprima project** 'Shrubland management as a tool to sequester carbon for agroforestry areas' was a national payment for environmental service (PES) project funded by the Portuguese Carbon Fund. The project aimed to ensure soil protection in the Mediterranean areas by changing the mechanical control system on the land while also improving carbon sequestration. According to results of the project, shrub control with shredders rather than harrows, contributes better to soil conservation in *montado* (dehesa) areas, while decreasing flammable biomass and enhancing soil carbon storage. In line with the previous example, in the frame of the project, all landowners adhering to this good practice were compensated for enhancing carbon sequestration.

### Innovative Forest Value Chains to enhance climate change mitigation

Wood is traditionally used as a construction material, as an energy source and as raw material for other products (cellulose, fibres, etc). Some of these new products and value chains have been explored in other EIP-AGRI events such as the workshop '**New value chains from multifunctional forests**' and the Focus Group on '**Sustainable mobilisation of forest biomass**'.

Rational use of limited wood resources demands continuous innovation. Recently, wood use in the building sector advanced considerably through various innovations such as glulam or cross-laminated timber products (e.g. wood beams and rafters), pre-fabricated wood components in high-rise building, and (thermally) modified wood in facades and decking. Many of these products contribute to climate change mitigation by substituting greenhouse gas emissions from concrete and steel products.



**Wood in complex multi-functional public building: Sport Arena and Baseball stadium in Joensuu, Finland. Photo by Jan Kašpar**

Biorefineries represent another major innovation in the forest sector, producing a wide range of bio-based products, from textile fibres, wood-based biomaterials in the automotive industry, to wood-based pharmaceuticals and cosmetics.



### **Inspiration: Wearing and carrying wood in your daily life?**

Finland is one of the leading countries on innovations on wood-based products and several initiatives are already in place, such as:

**PAPTIC®** is a packaging solution from wood-fibres, a new Finnish alternative material to plastic and paper. As a first application is being used for carrier bags and flexible packaging.

**Metsä Group** or **Spinnova** are Finnish companies investing in technology and innovation on wood-base textile fibres for clothing among other potential uses.

Technology innovation in forest value chains and industry standards may also provide feedback on management practices and the type of wood or woody biomass needed. Innovation in forest operations is limited especially by the operation costs and labour demand. Current efforts focus specifically on enhancing resource availability and minimisation of environmental impacts. In Europe, wood related innovation seems stronger in Northern countries compared to Eastern or Southern countries.

## **c. Knowledge transfer beyond the forest community**

### **Science-Policy-Practice knowledge exchange**

Adaptation to climate change will require a wide range of practices. Good practice examples show that to tackle the upcoming challenges in times of climate change, it is important to implement scientific findings locally and to exchange knowledge (practical and scientific) on a local, regional, national and European level. There are already different approaches to learning from each other's knowledge and experiences throughout the EU, all of them using the positive effects of social learning. The following box highlights some of these approaches. You can find more detailed information on them and some other examples in [mini-paper 6](#).

#### **Inspiration: Training, capacity building & competence centres**

Training courses in '[Ecological Site Assessment](#)' in the UK have been running for over a decade, demonstrating a decision support tool for species suitability assessment based on site characteristics and climate change projections

The Cork and Cork Oak Competence Centre in Portugal provides a meeting point for actors from academia, NGOs, diverse stakeholders and public administration. It aims to identify and promote essential issues as research needs, barriers or opportunities of the sector or needs of cork oak production.

### Inspiration: Platforms and Networks to speed up knowledge exchange

The **RMT AFORCE** in France is a network covering research, forest management, education and training. It aims to accelerate transfer of knowledge, share decision support tools and foster innovations to adapt forest to climate change since 2009.

The **Climate Change Accord** in the UK describes 'adaptation in action' case studies in the forestry, nursery and land management sectors to inspire others to act now.

KoNeKKTiW is a community of practice project operating in Germany and Austria collecting (and translating) scientific knowledge and producing information material with the practitioner in mind.

The **European Forest Risk Facility** is an innovative platform of exchange and knowledge transfer on forest disturbances, risk prevention and management. It connects experts from science, practice and policy across Europe and facilitates expert exchanges and good practice guidance with support from national (SURE, KoNNEKTiW) and EU funded projects (NetRiskWork, PLURIFOR).

## Effective Communication for Mitigation of Climate Change and Adaptation to its impacts

A substantial knowledge gap exists between science and individual decision-makers in European forestry with respect to forests and climate change (e.g. Blennow et al. 2012). To help build an adaptive and mitigation capacity to deal with climate change in European forestry, innovation is needed to make science-policy-practice communications more effective. Good decisions require good information. Which methods of communication, then, lead to adequate climate change action?

The Focus Group experts proposed an approach to **two-way communication** that can improve communication for adequate climate change action through **evidence-based standards for adequate communications**. Adequate communications **contain the information the users need, can access and comprehend** (see Fischhoff et al. 2011). "Evidence-based" means that it **builds on factual knowledge** and that evidence on its effectiveness can be provided. The approach proposed requires new knowledge on the decision-makers' understanding and perception of the effects on, and what works in, the local environment. Based on this, standards for adequate communications can be produced. These new standards can be used by communicators such as authorities, extension services and scientists to bridge the knowledge gaps identified between science, policy and practice (see [mini-paper 1](#)).

#### Standards for adequate communication:

- ▶ Integrate knowledge on how the local environment is affected by climate change and evidence-based communication
- ▶ Build climate adaptation and mitigation capacity of the decision-makers (including forest-owners)
- ▶ Provide flexible effects on decision-making which is crucial for successful decision-making in a changing world
- ▶ Help to design effective climate change policies.

A good example on how to effectively communicate climate change is the case of the Swedish Forest Agency

**Inspiration: Adequate communication, specifically targeted to the forest manager/owner**

Funded by the EARDF, the Swedish Forest Agency has conducted extensive extension services in relation to climate change during 2009-2015 (Eriksson et al. 2017). More than 25,000 Swedish private forest owners and forest professionals have participated in educational activities or received advice in relation to climate change and forests. Leaflets, books, films, an internet-based course, and an easy [decision-support tool](#) for different forestry objectives and parts of Sweden have been made available (Eriksson et al. 2017).



## 5. Seven ideas for Operational Groups

Seven ideas for Operational Groups (OGs) were elaborated by the Focus Group.

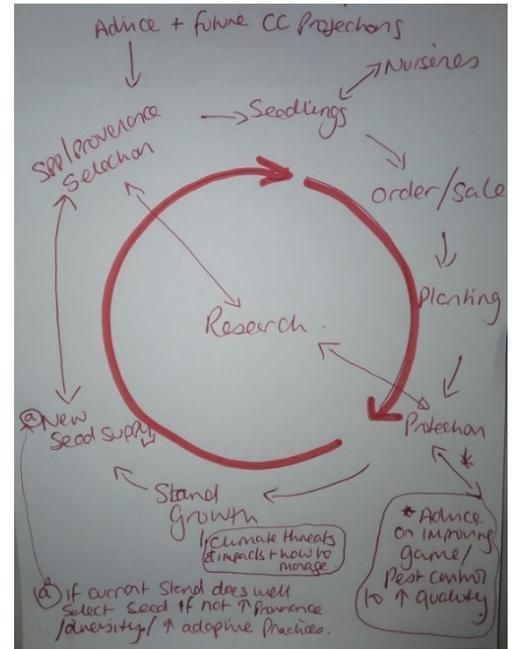
### IDEA 1: METHODS TO INCREASE THE USE OF BROADLEAF SPECIES IN FOREST REGENERATION

**Motivation:** Mixed-species forest stands are more resilient to climate change, but regeneration of broadleaf tree species often represents a bottleneck due to various reasons including browsing by game. Therefore, artificial regeneration methods and good practices are required to supplement natural regeneration with suitable, high-quality seeds and seedlings adapted to the local conditions.

**Description and activities:** The activities will consist of an analysis of the seed supply chain and forest management decision-making in given local conditions. It generally consists of production of seeds and seedlings in nurseries (nursery techniques, quality, adaptive properties), their supply/marketing, planting (planting design), protection (game, pest control), seed collecting from mature stands, identification and selection of suitable species/provenances/seed lots for regeneration in view of climate change predictions for the local area. Such analysis will lead to recommendations for adjustment and improvement of the seed supply chain and its components in the studied area.

**Actors involved:** forest owners/managers, agencies, nurseries, researchers

**Expected results and outcomes:** better methods leading to enhanced use of broadleaved tree species in forest regeneration, improved overall resilience of forests.



simple diagram of the seed supply chain and forest management decision-making for artificial regeneration

### IDEA 2: ADOPT LOCAL ADAPTATION IN FOREST MANAGEMENT THROUGH DSS, RECOMMENDATIONS, GUIDELINES AND AWARENESS RAISING

**Description and activities:** Identify the “champions of change” and best practices of local adaptation to boost peer to peer learning. These “champions” are practitioners who are very active and open to participate in research activities, demonstrations or dissemination activities.

Engagement of researchers and managers to identify good practices and design demonstration sites. Tailoring those Decision Support Systems (DSS), recommendations and dissemination materials.

Preparation of materials to raise awareness and enhancing communication at different levels and through different channels: journals for practitioners, education, associations, local forestry administration, farmers associations and similar.

**Actors involved:** Researchers, forest managers, forest-owners’ associations, farmers’ associations or similar.

**Expected results and outcomes:** Increase the adaptation and uptake of best practices and better awareness of the upcoming changes. Local forest owners or managers, advisers and in general end-users would be the main beneficiaries.

### IDEA 3: METHODS TO IMPROVE ASSISTED REGENERATION/AFFORESTATION IN DRY AREAS

**Motivation:** To increase the plant survival rate in forest regeneration (overcome new drought patterns caused by climate change: longer dry periods and more intensive droughts).

**Description and activities:** Test and demonstrate new techniques to overcome drought periods (e.g. soil cover as mulch plates or 'water box', water management etc). Perform economic assessment.

**Actors involved:** Forest owners associations, extension services, research entities, international organisations or consultants (e.g. from Africa), private companies (providers of boxes or other new tools).

**Expected results and outcomes:** Guidelines and demonstration sites.

### IDEA 4: DEVELOPMENT OF EARLY WARNING SYSTEM APPLIED TO FORESTS (RELATED TO PESTS, VITALITY LOSS) MAINLY BASED ON REMOTE SENSING TECHNIQUES

**Motivation:** To tackle forest tree mortality and secondary infections (pests/diseases) an assessment of the vitality decay, which are frequently reported by forest-owners as major concerns.

There is a lot of existing knowledge and experiences on early warning systems from remote sensing images like Landsat or RapidEye. However there is a new opportunity with the open access to new satellite data from Sentinel which could be valuable also as reference data to introduce forest insurance options, which are currently lacking for forest pests.

**Description and activities:** Decodify/elaborate the remote sensing data, making them applicable to the forest through the creation of a user-friendly system to assess tree vitality or detect (or foresee) pest damages. In addition, having this information decoded, there could be a chance to produce damage maps at different scales or risk assessment maps predicting impacts and elaborate guidelines according to these new findings. Even so, this is perhaps beyond the scope of the OG and something to be tackled by researchers in the future.

The direct beneficiaries of the results would be forest landowners and managers. But general public or local/regional administrations could also use this information to better carry out decision-making.

**Actors involved:** forest owners and associations, extension services, research entities, IT companies and forest authorities, insurance sector.

**Expected results and outcomes:** user-friendly system to assess tree vitality and risk assessment based on Sentinel images. Furthermore, if possible, damage maps and guidelines to prevent or mitigate climate change impacts.

### IDEA 5: LANDSCAPE MANAGEMENT AND GOVERNANCE FOR THE INDIVIDUALS

**Motivation:** Landscape management starts with individual actions, so it is necessary to set a governance system to allow and help individuals to make appropriate decisions so as to enhance landscape management in the context of climate change.

**Description and activities:** development of management tools and resources for individuals to contribute to landscape management in the context of climate change (e.g. deal with other people's needs, regulations, etc).

**Actors involved:** farmers, forest owners, associations, public administration.

**Expected results and outcomes:** governance systems, adequate communication, integrative management tools.

### IDEA 6: ADAPTIVE FOREST MANAGEMENT PLANS ADDRESSING CLIMATE CHANGE RISKS AND OPPORTUNITIES

**Motivation:** Aim of the OG is to improve awareness on risk and opportunities posed by climate change in a specific area, to test and validate models assessing climate change impacts on forest and to enhance decision making by forest owners or managing authorities.

**Description and activities:** 4 activities: Development of user models, evaluation of climate change risks, selection of appropriate adaptive and mitigation measures and finally creating a local network to involve all forest actors and boost mitigation and adaptation uptake.

**Actors involved:** local foresters, NGOs, scientists, consultants, local community, industry and forest related enterprises.

**Expected results and outcomes:** collective and effective forest management plans to mitigate climate change effects (drought, forest fires, ...), promote actions for ecosystem resilience, increase awareness of all actors, feedback of needed information.

### IDEA 7: COLLABORATIVE ANALYSIS OF MITIGATION OPTIONS ALONG SPECIFIC VALUE CHAINS

**Motivation:** To find out which are the options for improving carbon balance along a specific value chain (e.g. for pine). This can be related to offsetting emissions, energy efficiency, residues re-use, circular economy, etc.

**Description and activities:** Analysis of the particular value chain and the performance of all actors involved in order to detect points where these actors can better perform so as to enhance carbon balance.

**Actors involved:** Researchers (providing tools and existing knowledge), forest owners, service contractors, industry, retailers and consumers.

**Expected results and outcomes:** Good practices, tools, guidelines for all actors (and their interlinkages) within the wood value chain, so as to improve the carbon balance.



Experts developing and presenting their ideas for Operational Groups.

## 6. Priorities on research needs from practice

The Focus Group compiled a list of 30 research needs coming from practice and ranked them according to their importance. The following table reflects the results of the voting, listing the top research needs from practice according to the group.

Future local/regional guidelines for the implementation of innovative silvicultural practices towards adaptation

- What to do and where?
- Demonstration plots network of silvicultural practices (with intense monitoring and data analysis to produce information for landowner forest management)
- DSS at the local scale (farm) (how is the forest today and what will be expected in the future in the farm with a risk assessment tool regarding changing species, practices and economics)

Climate change adaptation incentives should be user-oriented:

- Under which conditions (social, political, and economic) do forest owners initiate change?
- What kind of incentives exist/are needed for different owners?
- How to set-up long term commitments and funding for integrated forest management adaptation in small landownership?

Study carbon dynamics (biomass/fuel) related to the fire regime as these are affected by forest species (fire prone to fire resistant), land uses (monocultures, rewetting wetlands, reforestation and practices (agroforestry), and management options (e.g. wildfires versus prescribed burning).

Evaluation of how to institutionalise knowledge-exchange, including a forester exchange programme

Participatory research on climate change effects and measures that can be taken at local farm and forest-owner level (quick surveys and reports).

Efficiency and characteristics on existing collective arrangements for promoting improvements in management and in climate change measures.

Furthermore, the Focus Group has identified an urgent need to put together, analyse, describe in a standardised format and disseminate sustainable practices that can improve the climate change adaptation and mitigation potential of forests in the EU. A number of such practices and tools are highlighted throughout this document.

## 7. Annexes

### Annex 1: List of members of the Focus Group

<b>Name of the expert</b>	<b>Profession</b>	<b>Country</b>
<u><a href="#">Horst Alexander</a></u>	Forester	Austria
<u><a href="#">Ventura Ana</a></u>	Land owner; Forester; Researcher	Portugal
<u><a href="#">Pantera Anastasia</a></u>	Land owner; Forester; Researcher; Representative of an NGO; Other type of activity	Greece
<u><a href="#">Stover Daniel</a></u>	Farmer; Land owner; Forester	United Kingdom
<u><a href="#">Doblas Miranda Enrique</a></u>	Researcher; Representative of an NGO	Spain
Tsartsou Evangelia	Forester	Greece
<u><a href="#">Atkinson Gail</a></u>	Researcher	United Kingdom
<u><a href="#">Schwichtenberg Guido</a></u>	Forester	Germany
<u><a href="#">Holmberg Gunilla</a></u>	Farmer; Land owner; Forester	Finland
<u><a href="#">Kašpar Jan</a></u>	Researcher	Czech Republic
<u><a href="#">Turok Jozef</a></u>	Advisor	Slovakia
Picos Juan	Advisor; Expert from agricultural organisation, industry or manufacturing; Researcher	Spain
Ecker Jörg	Forester; Civil servant	Germany
<u><a href="#">Blennow Kristina</a></u>	Researcher	Sweden
Silva Maria da Conceição	Expert from agricultural organisation, industry or manufacturing	Portugal
Sarvaš Milan	Advisor	Slovakia
Calado Nuno	Forester	Portugal
Picard Olivier	Forester	France
Valentar Veronika	Land owner; Forester; Representative of an NGO	Slovenia
Blujdea Viorel Nelu Bellmondo	Researcher	Romania
<b>Facilitation team</b>		
Lindner Marcus	Coordinating expert	Germany
Guimarey Fernández Beatriz	Task manager	Spain
<u><a href="#">Raa Iiri</a></u>	Backup	Estonia

You can contact Focus Group members through the online EIP-AGRI Network. Only registered users can access this area. If you already have an account, [you can log in here](#). If you want to become part of the EIP-AGRI Network, [please register to the website through this link](#)

## Annex 2: List of published mini-papers

MP	Topic	Contributors
MP 1	<u>Effective communication for Mitigation of Climate Change and Adaptation to its Impacts</u>	Kristina Blennow (Coord.), Viorel Blujdea, Milan Sarvaš, Guido Schwichtenberg, and Evangelia Tsartsou
MP 2	<u>Implementing adaptation strategies through economic incentives</u>	Nuno calado (Coord.) Ana Ventura, Juan Picos
MP 3	<u>Prevention, early warning, innovative risk monitoring</u>	Jörg Ecker (Coord.), Viorel Blujdea, Conceição Silva, Nuno Calado, Evangelia Tsartsou, Guido Schwichtenberg
MP 4	<u>Climate smart silviculture &amp; genetic resources</u>	Conceição Silva (Coord.), Gunilla Holmberg, Jozef Turok, Daniel Stover, Alexander Horst
MP 5	<u>Integrated management of forested landscape in the face of climate change</u>	Jan Kašpar and Enrique Doblás (Coord.), Kristina Blennow, Evangelia Tsartsou, Alexandre Horst
MP 6	<u>Knowledge exchange through platforms, networks, or competence centres that link research, practitioners, industry and forest owners</u>	Guido Schwichtenberg & Olivier Picard (Coord.), Juan Picos, Ana Ventura, Gail Atkinson, Nuno Calado, Enrique Doblás Miranda, Evangelia Tsartsou, Jörg Ecker
MP 7	<u>Decision Support Systems &amp; Tools</u>	Gail Atkinson (Coord.), Olivier Picard, Jan Kašpar, Enrique Doblás-Miranda, Gunilla Holmberg
MP 8	<u>Techniques and practices to manage fire risk in the forest (biomass management, Silvopastoralism)</u>	Anastasia Pantera (Coord.), Enrique Doblás, Kristina Blennow, Conceição Silva, Viorel Blujdea
MP 9	<u>Innovative Wood-based Value Chains - "shift to smart wood"</u>	Viorel N.B. Blujdea (Coord.), Gunilla Holmberg, Juan Picos
MP 10	<u>Small scale forest management</u>	Gunilla Holmberg (Coord.), Daniel Stover, Veronika Valentar, Ana Ventura

### Annex 3: Full list of research needs

This table compiles the full list of research needs. It includes the number of votes and the mini-paper (MP)/topic on which it was proposed.

Rank	Title	Votes
1	MP 4 - Smart and sustainable silviculture & genetic resources, tree seed sourcing <ul style="list-style-type: none"> <li>• Future local/ regional guidelines for the implementation of innovative silvicultural practices towards adaptation</li> <li>a) What to do and where?</li> <li>b) Demonstration plots network of silvicultural practices (with intense monitoring and data analysis to produce information for landowners forest management)</li> <li>c) DSS at the local scale (farm) (how is the forest today and what will be expected in the future in the farm with a risk assessment tool regarding changing species, practices and economics)</li> </ul>	10
2	MP 2 - Implementing adaptation strategies through economic incentives <ul style="list-style-type: none"> <li>• Climate change adaptation incentives should be user-oriented:               <ul style="list-style-type: none"> <li>▪ Under which conditions (social, political, and economic) do forest owners initiate changes?</li> <li>▪ What kind of incentives are there/are needed for different owners?</li> <li>▪ How to set-up long term commitments and funding for integrated forest management adaptation in small landownership?</li> </ul> </li> </ul>	8
3	MP 8 - Techniques and practices to manage fire risk in the forest <ul style="list-style-type: none"> <li>• Study carbon dynamics (biomass/fuel) related to the fire regime as these are affected by forest species (fire prone to fire resistant), land uses (monocultures, rewetting wetlands, reforestation and practices (agroforestry), and management options (e.g. wildfires versus prescribed burning).</li> </ul>	6
4	MP 6 - Knowledge exchange <ul style="list-style-type: none"> <li>• Evaluation of how to institutionalize knowledge exchange, including a forester exchange program</li> </ul>	5
5/6	MP 10 - Small scale forest management <ul style="list-style-type: none"> <li>• Participatory research on climate change effects and measures that can be taken at local farm, and forest owner level. (Quick surveys and reports).</li> </ul>	4
5/6	MP 10 - Small scale forest management <ul style="list-style-type: none"> <li>• Efficiency and characteristics on existing collective arrangements; for promoting improvements in management and in climate change measures.</li> </ul>	4
7/8	MP 7 - Decision Support Systems <ul style="list-style-type: none"> <li>• New Decision Support system for mixed stands.</li> </ul>	3
7/8	MP 9 - Innovative value chains that generate material and energy use <ul style="list-style-type: none"> <li>• Adjusting forest management practices to maximize supply toward long life wood products and bio-economy needs</li> </ul>	3
9-13	MP 2 - Implementing adaptation strategies through economic incentives <ul style="list-style-type: none"> <li>• How to set up monitoring that is simple, credible and affordable to identify, measure and control services or payment schemes regarding forest adaptation?</li> </ul>	2
9-13	MP 7 - Decision Support Systems <ul style="list-style-type: none"> <li>• How to better communicate risk and uncertainty and work with uncertainty in such as ways as to a) level behaviour to adapt/mitigate to climate change / increase use and application of DSS/DST.</li> </ul>	2
9-13	MP 7 - Decision Support Systems <ul style="list-style-type: none"> <li>• A new repository of DSS/DST with search facility to identify what DSS/DST can answer which climate change question – perhaps with GIS map of geographical coverage of the DSS/DST.</li> </ul>	2

9-13	MP 3 - Prevention, early warning, innovative risk monitoring <ul style="list-style-type: none"> <li>Remote Sensing/Satellite imagery: How to provide access to analysed data.</li> </ul>	2
9-13	MP 5 - Landscape management to diversify strategies, landscape mosaics <ul style="list-style-type: none"> <li>How to quantify the trade-offs between ecosystem services at the landscape scale, considering climate change projections?</li> </ul>	2
14-24	MP 1 - Communication to increase awareness on CC and Adaptation, Mitigation <ul style="list-style-type: none"> <li>Standards for the adequacy of communications for groups of individuals identified.</li> </ul>	1
14-24	MP 1 - Communication to increase awareness on CC and Adaptation, Mitigation <ul style="list-style-type: none"> <li>Local examples of standards for the adequacy of communications for groups of individuals identified.</li> </ul>	1
14-24	MP 1 - Communication to increase awareness on CC and Adaptation, Mitigation <ul style="list-style-type: none"> <li>Methods for evaluation of communication efficacy.</li> </ul>	1
14-24	MP 2 - Implementing adaptation strategies through economic incentives <ul style="list-style-type: none"> <li>How to create voluntary markets, in order to engage companies/persons and collect private funding to set up payment schemes (models, tax implications, applications, etc)? 1</li> </ul>	1
14-24	MP 8 - Techniques and practices to manage fire risk in the forest <ul style="list-style-type: none"> <li>Is necessary to investigate how forest related policies and its implementation influence fire regimes (positively or negatively such as education, incentives and subsidies, communication, abandonment of forest, rangelands and agricultural areas,) and propose solutions. In general, more attention should be given to anthropogenic factors when generating landscape projections.</li> </ul>	1
14-24	MP 8 - Techniques and practices to manage fire risk in the forest <ul style="list-style-type: none"> <li>Research and technical efforts (DSS) should aim at identifying areas that have not previously faced high fire risks (northern/central European countries and mountains), and therefore may have low vegetation resilience, but might suffer from forest fires due to climate change.</li> </ul>	1
14-24	MP 3 - Prevention, early warning, innovative risk monitoring <ul style="list-style-type: none"> <li>How to transfer best practice examples to other regions/states.</li> </ul>	1
14-24	MP 3 - Prevention, early warning, innovative risk monitoring <ul style="list-style-type: none"> <li>Define data for insurances for drought and pest damages.</li> </ul>	1
14-24	MP 5 - Landscape management to diversify strategies, landscape mosaics <ul style="list-style-type: none"> <li>Which kind and scale of governance will enhance the delivery of ES and agreement between different stakeholders at the landscape level?</li> </ul>	1
14-24	MP 5 - Landscape management to diversify strategies, landscape mosaics <ul style="list-style-type: none"> <li>Real comparisons between single and landscape management benefits</li> </ul>	1
14-24	MP 6 - Knowledge exchange <ul style="list-style-type: none"> <li>Recommendations about forest reproductive materials for the future climate change models</li> </ul>	1

## Annex 4: Other ideas for Operational Groups

This list of ideas arose during the Focus Group meetings, but have not been selected for further development.

- Demonstration sites to show and try genetically determined treatments (thinning, tending, harvesting, etc) for adaptable species.
- Game management under climate change challenges.
- Demonstration plots for climate-smart forest management, contributing to test management practices, increase knowledge of forest managers and owners and raise awareness.
- Investigate and establish a Valonia oak (*Quercus ithaburensis* subs. *macrolepis*) process plan that would include a storage facility, an acorn cup separation and grinder, acorn peeler and grinder, production of flour and pacher, etc. This may enhance farmer income from trading the acorns but also providing incentives to local population to conserve these forests and protects them from illegal lumbering. An additional contribution to protecting the environment would be the use of organic dyes to leather industry to replace the chemical ones.
- Increase the use of important species facing climate change, for example, encouraging forest management, avoiding abandon of small forests, developing new products.

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**The European Innovation Partnership 'Agricultural Productivity and Sustainability' (EIP-AGRI)** is one of five EIPs launched by the European Commission in a bid to promote rapid modernisation by stepping up innovation efforts.

The **EIP-AGRI** aims to catalyse the innovation process in the **agricultural and forestry sectors** by bringing **research and practice closer together** – in research and innovation projects as well as *through* the EIP-AGRI network.

**EIPs aim** to streamline, simplify and better coordinate existing instruments and initiatives and complement them with actions where necessary. Two specific funding sources are particularly important for the EIP-AGRI:

- ✓ the EU Research and Innovation framework, Horizon 2020,
- ✓ the EU Rural Development Policy.

**An EIP AGRI Focus Group\*** is one of several different building blocks of the EIP-AGRI network, which is funded under the EU Rural Development policy. Working on a narrowly defined issue, Focus Groups temporarily bring together around 20 experts (such as farmers, forest owners, advisers, researchers, up- and downstream businesses and NGOs) to map and develop solutions within their field.

**The concrete objectives of a Focus Group** are:

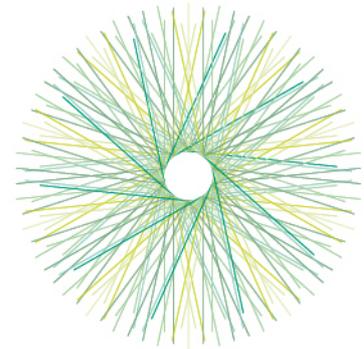
- ✓ to take stock of the state of art of practice and research in its field, listing problems and opportunities;
- ✓ to identify needs from practice and propose directions for further research;
- ✓ to propose priorities for innovative actions by suggesting potential projects for Operational Groups working under Rural Development or other project formats to test solutions and opportunities, including ways to disseminate the practical knowledge gathered.

**Results** are normally published in a report of the launch of a given Focus Group.

**Experts** are selected based on an open call for interest. Each expert is appointed based on his or her personal knowledge and experience in the particular field and therefore does not represent an organisation or a Member State.

\*More details on EIP-AGRI Focus Group aims and process are given in its charter on:

[http://ec.europa.eu/agriculture/eip/focus-groups/charter\\_en.pdf](http://ec.europa.eu/agriculture/eip/focus-groups/charter_en.pdf)



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