ALTERNATIVE MODELS AND ROBUST DECISION-MAKING
FOR FUTURE FOREST MANAGEMENT

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ALTERFOR - FOREST MANAGEMENT OPTIONS FOR THE GREEN DEAL?

ALTERFOR POLICY BRIEF No. 2


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The Paris Agreement relies on European forests to contribute to climate mitigation and bioeconomy. An increased supply of forest products is expected, whereas principles of Sustainable Forest Management (SFM) should still be observed.

The EU Horizon 2020 project ALTERFOR investigates new ways of managing European forests to meet these upcoming challenges. To achieve these ambitious aims at the EU level it is necessary that adequate measures are taken by EU Member States with highly varying biophysical and socio-political conditions.

CONTENTS

This policy brief is to relate the findings of the project ALTERFOR to the ongoing debate on how to use European forests. Specifically, it addresses consequences of different routes that European forestry could take in terms of production, protection, and climate change mitigation.

ALTERFOR KEY FACTS

Project title: Alternative models and robust decision-making for future forest management

Project duration: 54 Months (01/04/2016 - 30/09/2020)

Ten case study areas in: Germany, Italy, Ireland, Lithuania, the Netherlands, Portugal, Slovakia, Sweden, and Turkey

Funding Scheme: The European Union's Horizon 2020 research and innovation programme (grant agreement No 676754).

The grant totals EUR 4,000,000.

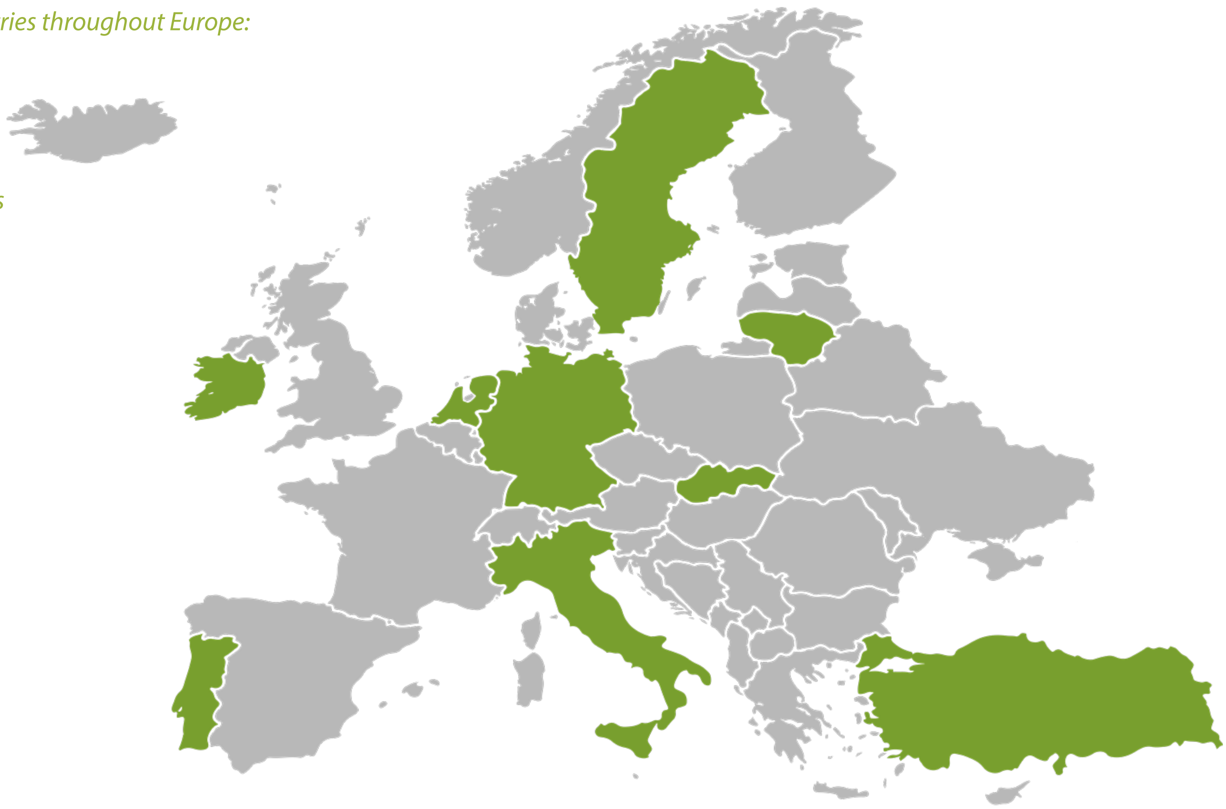
1 EUROPEAN FORESTS AMIDST GROWING CONTROVERSIES

European forests provide a range of products and services, crucial for the well-being of citizens of the European Union (EU). Among the prime demands put on the forest ecosystem are climate mitigation and biodiversity. These demands are directly linked to the EU Green Deal and the strategies therein, like the Biodiversity Strategy, the Bioeconomy Strategy, and relevant parts of the EU Climate Action. The forest management models that are developed in ALTERFOR rest on work in 10 case studies in 9 European countries, carefully selected to represent different bio-geographic, socio-economic and policy aspects (Figure 1).

The management of European forests is subject to controversy. Opinions are formed around the role played by forests in climate change mitigation and associated consequences for the provision of other ecosystem services. Various stakeholder groups have expressed their positions on the future of European forests and the possible impacts of EU policies on forests. In 2018, for example, a group of international scientists turned to the European Parliament with a plea to protect European and global forests from the risk of a possible overexploitation due to bioenergy demand, with corresponding implications for benefits associated with multifunctional forest

Figure 1:
ALTERFOR involves 10 case studies in 9 European countries throughout Europe:

Germany
Italy
Ireland
Lithuania
The Netherlands
Portugal
Slovakia
Sweden
Turkey



management (Searchinger et al., 2018). A recent paper by JRC (Ceccherini et al., 2020) reported that an abrupt increase in harvested forest area over Europe after 2015 has, according to the authors, been driven by the expansion of the wood and bioenergy market, and may seriously hamper climate mitigation as well as other forest-based ecosystem services. The paper has already fuelled discussions among scientists and other stakeholder groups and will probably contribute to animating the debate around strategic policy choices. Many opinion letters and position papers have recently been published by various organizations - forest owners, wood and paper industry, environmental organizations – with respect to the potential approval of the EU Biodiversity strategy for 2030. There is a growing interest in EU forest policies addressing global deforestation and its relation to products imported and consumed within the EU (EU Commission, 2019a; EU Commission, 2019b). This is also framed within the Green Deal, which has direct and indirect implications for agriculture and forestry activities within the EU, including links with EU policies like the Common Agricultural Policy and the recently approved EU Farm to Fork Strategy.

The EU policy framework implies that many different sectors influence forest management (Winkel, 2017). The Green Deal – through its holistic approach to biodiversity, climate change mitigation, and bioeconomy – promises to make strategies more consistent. However, there are indications that different strategies still tend to go in diverging directions (Hetemäki, 2020). The key point appears to be whether forests should be used more intensively for climate change mitigation through the production of harvested wood products (HWP) to store carbon and provide biomass alternatives to carbon intensive fossil fuel; or if forests should instead be used as carbon sinks to increase the absorption of Green House Gases (GHG). Importantly, the choices made will affect other services, such as biodiversity and recreation, and have implications for the resilience of forest ecosystems in general.

The main purpose of this policy brief is to relate the achievements of EU Horizon 2020 research and innovation project ALTERFOR to the ongoing debate on how to use European forests. Specifically we address what the consequences are of these strategic choices, as they relate to the forest management models developed in ALTERFOR. Furthermore, we address what may take to implement alternative forest management models?

Our policy brief begins with a short description of the research process. Thereafter, results are presented from landscapes in, Germany, Lithuania, and Sweden respectively, that exemplify the main features of the forest management models assessed, and the ensuing outcomes for forest harvest, biodiversity and climate change mitigation (Biber et al. 2019). Next, we show the results from upscaling to the EU level, which combines data from all 10 ALTERFOR cases (Lauri et al. 2020 and Di Fulvio et al. 2020). This forms the basis for a discussion of what can be learnt from ALTERFOR with respect to current and emerging EU strategies.

2 RESEARCH METHODOLOGY

ALTERFOR is based on two overarching principles. Firstly, that we can learn by combining knowledge from different parts of Europe and, secondly, that new management models are only of practical use if they have a chance to be implemented. The first principle is realized in the work plan of ALTERFOR with a high degree of interactivity among project partners and with extensive on the

ground discussions with practitioners (see e.g. https://alterfor-project.eu/travellab.html). The second principle rests on a high degree of stakeholder involvement and liaison with influential agents following the RIU methodology (Research-Integration-Utilization).

The work is conducted at three administrative and spatial grains: stand, landscape and EU. Current stand management prescriptions were mapped and developed further taking into account different national and regional traditions. The landscape level strategies were composed of stand management prescriptions, as different combinations of current and novel approaches. Strategies differed with respect to where and the extent to which different stand management prescriptions were allocated in the landscape. The landscape level strategies of each case were developed in close cooperation with stakeholders involving, among other activities, two one-day workshops. Thus, the strategies were not theoretical constructs but rather alternatives that were deemed to be feasibly implemented, and that in most cases do not require major changes to institutional frameworks like Forestry Acts and land owner structures. The management models from the cases were thereafter scaled up to encompass the whole of the EU.

All analyses were carried out under the conditions specified by three different scenarios developed by International Institute of Applied Systems Analysis (IIASA) on the basis of IPCC climate change scenarios (O'Neill et al., 2017; van Vuuren et al., 2011). The IIASA scenarios described production, demand and trade on global scale. The focus here in this policy brief is on the so-called GLOBAL BIOENERGY scenario characterized by ambitious climate policies at both EU and global level resulting in +1.5o Celsius higher by 2100 compared to pre-industrial temperature levels. This scenario is consistent with the Paris agreement and that which would put the most pressure on forest resources.

3 CASES

3.1. CASE-SPECIFIC FOREST STRATEGY

The three cases – from southern Sweden, Lithuania and Germany (Bavaria) – were chosen as examples, since they largely overlap with respect to the same basic forest management issues, i.e. balancing wood production with environmental values. This is not the only trade-off between forest ecosystem services, but it underlies much of the forest debate in these respective countries, including the use of forests for climate change mitigation. Two strategies are presented for each case; one that favors wood production and the other with a primary focus on biodiversity. Here these will be termed Production and Multifunctional strategies, respectively. A comprehensive overview of needs and means for all cases is given in Annex I.

With respect to the metrics used, "wood production" refers to wood volumes harvested over time. For biodiversity, there are a number of individual metrics (e.g. proportions of broadleaf trees, large trees, tree age) of relevance to habitat availability. This is illustrated here by the share of the total standing volume consisting of deciduous trees. The prevalence of broadleaf trees in production forests is an important issue for all three cases, and also relates to other biodiversity indicators. The climate change mitigation service of forests is presented by the net

carbon balance in forests, HWP, and avoided emissions summed over the projection period. This period extends from 2010 to 2100.

Strategy production	Strategy multifunctional
Augsburg (DE)	
The strategy focuses on maximizing wood production for material use and energy production. This means maintaining the existing conifer forests and managing them even more for maximized production, while mixed and deciduous stands are transformed into coniferous ones.	The aim is to promote uneven-aged mixed species forests. Since the forest is currently dominated by coniferous monocultures, this means forest transformation. The main deciduous tree species to be promoted is European beech.
Kronoberg (SE)	
Silviculture follows procedures for high wood production (i.e. no failure in regeneration, only planting (with coniferous species)), all stands are subject to pre-commercial thinning, harvest at minimum harvest age, and Hybrid larch and clones of Norway spruce are introduced, and repeated fertilization of Scots pine stands takes place.	Scots pine is planted where appropriate (appropriate game control is in function), as is oak. Spruce-Birch admixture is established and the area of uneven-aged management is expanded.
Telsiai (LT)	
Minimum allowable rotation age based on economic criteria, i.e. substantially lower than according to today's legislation.	The strategy aims to increase the proportion of deciduous tree species; existing silvicultural prescriptions are adjusted to favor deciduous tree species.

3.2. CASE RESULTS

The Kronoberg and Telsiai cases employed mixed strategies (ie both production and biodiversity goals) and therefore the results are not radically different from current practice (see Figure 1). In the case of Augsburg, researchers and stakeholders instead developed pure strategies (production or biodiversity goals) that in subsequent analyses could be combined into mixed strategies for the landscape. Another difference between strategies is that Kronoberg follows the harvest volumes predicted by the IIASA scenario for Sweden, whereas Augsburg and Telsiai cases are more the result of the co-developed stand management prescriptions, which disregarded the exact quantitative demands of IIASA scenarios. In the Augsburg case for instance, this led to large initial harvest volumes of mature forest when the Production strategy is applied, due to the past accumulation of large amounts of old forest.

The strategies produce the intended outcome. This means that harvest volumes are increased with the Production strategy and deciduous trees are more prevalent with the Multifunctional strategy. For the entire 90-year period the net carbon balance is

not very different for any of the cases with alternative management, even though the distribution on different carbon balance components is very different in the Augsburg case. For all cases there is a tendency for the buildup of forest stock with Multifunctional strategy to compensate for the more intensive harvest activities in the Production strategy. Alternative management yields a better carbon mitigation effect over the projection period, except for Telsiai, where current management with long rotations and subsequent saw timber output results in a more favorable balance for current management.

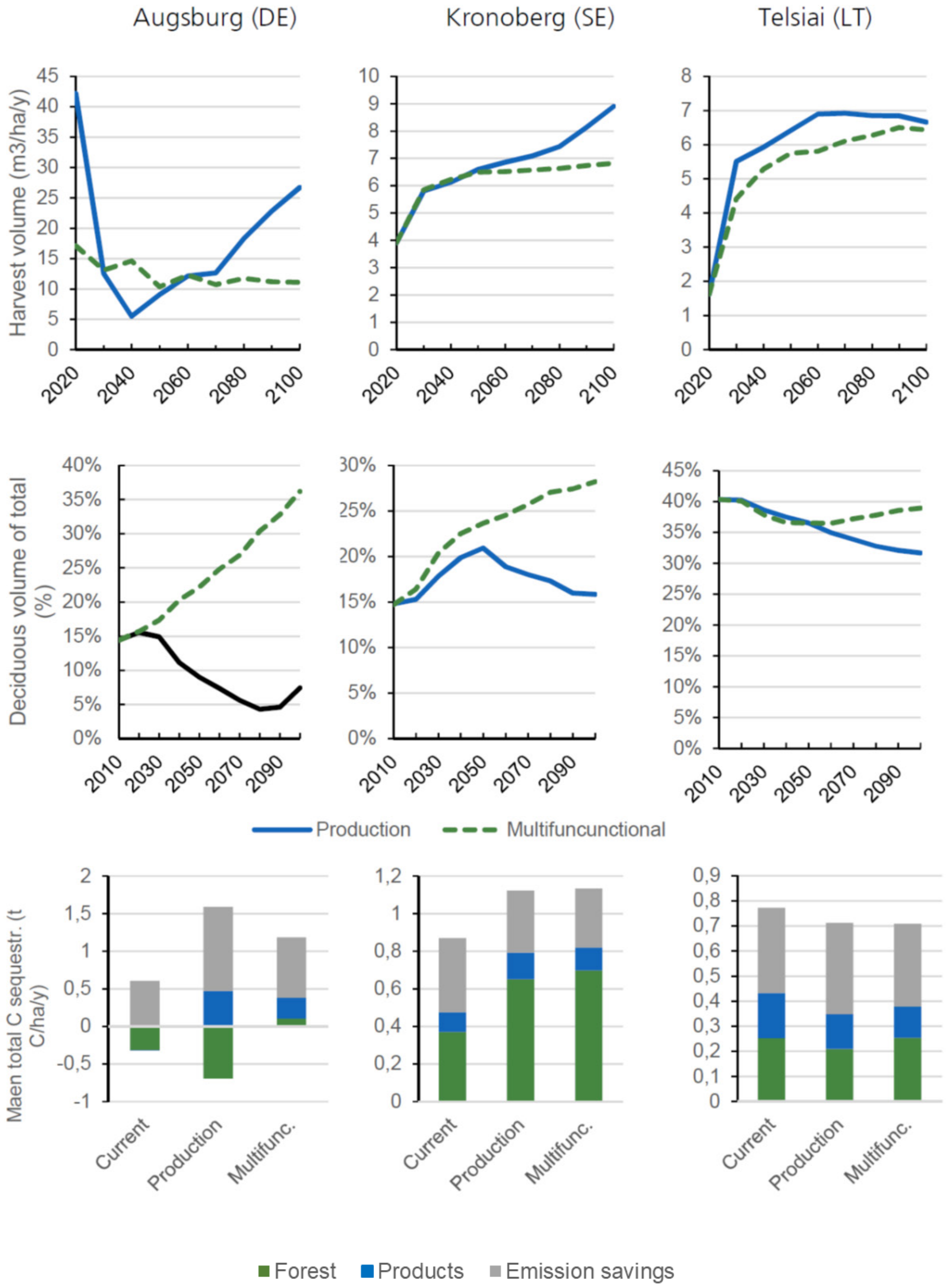


Figure 2: Some central characteristics of strategies Production and Multifunctional, and for the carbon balance, also current standard management, Current. The carbon balance is calculated as the average from 2010 to 2100 of yearly stock changes for forest and products and savings from substitution in various forms. (Multifunctional for Kronoberg is based on growth of another climate scenario with the result that harvest and carbon mitigation figures are overstated.)

4 UPSCALING

4.1. UPSCALING METHODS AND FOREST MANAGEMENT STRATEGIES

Translating or upscaling the results for a period of 90 years (2010-2100) from the cases, representing about 1% of the forest area in EU28 + Turkey, to the entire EU28 was a huge step. Whereas the landscape projections of the previous section were conducted with DSSs designed for each case, the pan-European calculation was done with one system, the Global Biosphere Management Model (GLOBIOM), developed at IIASA. GLOBIOM is a global spatially explicit partial equilibrium model of agricultural and forest sectors. In this study, the globe was represented by 58 economic regions (28 in EU28 and 30 outside EU28). The forest sector representation includes forestry, forest industry modules and bioenergy modules (Lauri et al. 2019). Equilibrium in product markets is achieved by balancing the activities in the sector with trade of products between the economic regions.

The purpose of the EU level analysis was to assess the outcome of forest management strategies in terms of harvests, how that was reflected in trade patterns – in particular between EU28 and the rest of the world (ROW) – and impacts on species loss. We also assessed the economic impact for forest owners following either of the strategies considered. The alternative forest management strategies were composed of three primary management models: production-oriented management (PM), multifunctional management (MM), and set asides (SM). In addition to the management models PM, MM, and SM, forests could be managed according to the current management model, CM. PM, MM, and SM could be applied in different proportions on a total of 79 Mha, or 50% of the forest area in EU28, that was considered suitable for all three models. The area for alternative management models was increased gradually by the same amount each year such that it sums to 79 Mha in 2100; the area that was not allocated to alternative models is managed according CM. The other 50% EU28 forest area is largely unmanaged or managed with low intensity, and a smaller share is under intensive management. The analyses with GLOBIOM involved the following steps.

Associating the rest of EU28 forests with cases: This was carried out by assigning each NUTS2 region to one of the 10 cases. The assignment was guided by a similarity measure based on forest and other nature conditions and socio-economic indices. Some NUTS2 was too different to any case to be assigned a case and thus maintained management with CM.

Assigning GLOBIOM properties to a case: The basis for the GLOBIOM calculations is the CM, i.e. all forest land is managed with CM. The effect of altering management from CM to either of PM, MM or SM was modelled by shifting the property of CM regarding available roundwood, logging residues, and share of non-coniferous volume. Thus, going from CM to PM meant that the available roundwood increased on average by 20%, that residues remained the same and that non-coniferous was reduced between 9% and 42% (depending on the case). The corresponding figures for switching to MM was a reduction in roundwood availability by about 10%, a 50% reduction of residues, and an increase in non-conifers tree volume between 2% and 56%. For SM, there was zero change in roundwood and residue availability, and no change in non-conifer tree species volume compared to CM. This explication

should also make it clear that the recipes for PM and MM respectively, are different in different cases. PM was a design aimed at a high production economy, whereas MM aims to satisfy a broader range of ecosystem services. By definition, MM has lower production and (almost everywhere) less advantageous economic outcomes. PM and MM stand for outcomes associated with certain management interventions to achieve objectives, not specific stand management prescriptions. For instance, MM may in one case builwd exclusively on uneven-aged management, whereas it may instead mean a combination of species mixtures under even-aged management in another case.

Running GLOBIOM: With the properties of all forest in the EU28 set, the GLOBIOM was run with different strategies, i.e. specified proportions of PM, MM, and SM (see table 1). Where in the EU28 the models were allocated, was determined by GLOBIOM based on economic criteria.

Table 1: Prescribed proportions of different management models over EU28 for area suitable for alternative management

Strategy name(*)	CM	PM(**)	MM	SM
CM100	100	0	0	0
PM100	0	100	0	0
PM75MM25	0	75	25	0
PM50MM50	0	50	50	0
PM75SM25	0	75	0	25
PM50SM50	0	50	0	50

(*) % PM and % MM or SM, like PM75MM25 = Productive Management on 75% of suitable area and Multifunctional Management on 25%.
(**) Technically, PM100 is not prescribed but is the management model that is chosen on economic grounds if no other restrictions are imposed.

4.2. UPSCALING RESULTS

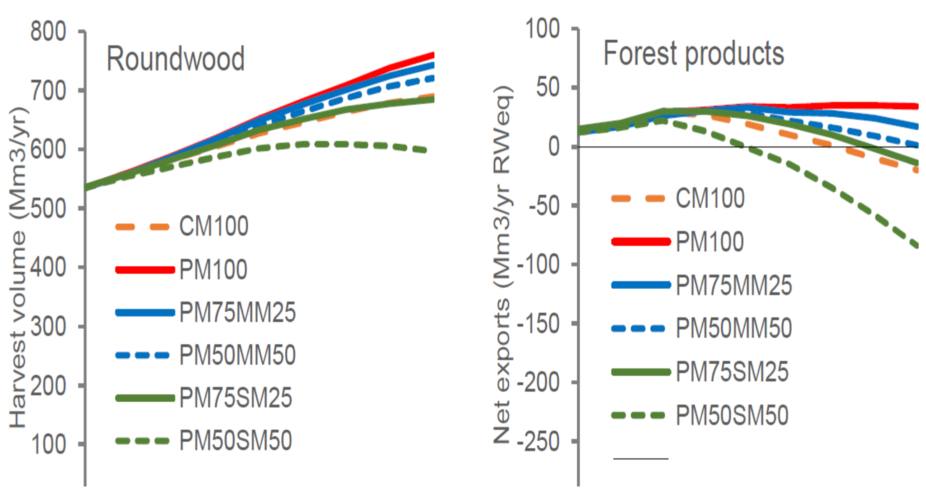


Figure 3: EU28 roundwood harvests and forest products net exports.

The inertia that characterizes the forest ecosystem and the gradual introduction of alternative forest management models means that differences between strategies need a few decades to be noticeable. The modest drop in productivity for MM causes the total harvest to deviate from the maximum PM100 trajectory only when SM management is enforced (PM50SM50, to a lesser degree for PM75SM25). The harvest volumes are combined with consumption to give the net trade volumes. Due to expected increases in consumption, harvests do not cover the EU28 demand in the second half of the century for management models with 25% or more SM. Current management will not suffice either to cover EU28 in the long run.

The kind of climate mitigation balance that is presented for the cases is not available from GLOBIOM. However, judging from the cases, a reasonable conclusion is that the differences between strategies should not be big; for EU28 reduced harvests and increased imports are, to a large degree, compensated with forest stocking.

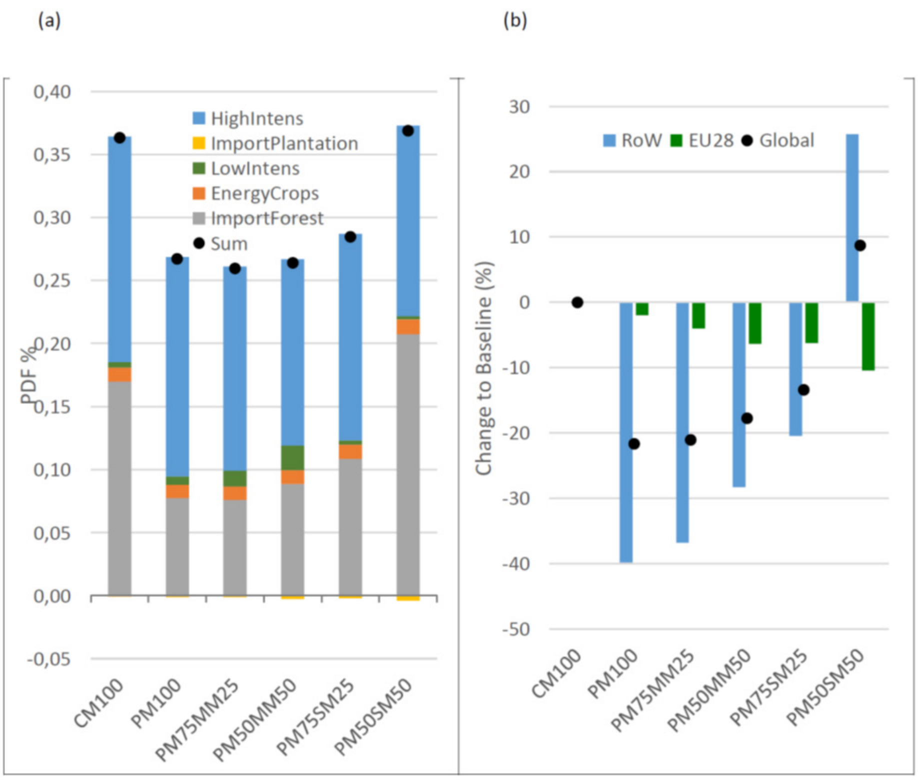


Figure 4:
(a) Total EU28 biodiversity footprint from internal land use and imported to the EU28 under the different climate mitigation and mitigation scenarios by the year 2100, calculated in the condition of considering previous land uses occupied by energy crops and imported energy plantations. PDF = disappeared fraction of global species. (b) Trade-offs between biodiversity loss from EU land use (Internal EU28), global biodiversity loss from land use imported from the rest of the word (RoW) and global footprint (Global= sum of the previous ones) in the different AFMs and climate scenarios by year 2100, as compared to the Baseline.

Biodiversity is measured by the resultant fraction of global species that are projected to disappear (PDF). This indicator is based on the development of the EU28 forest management areas and energy crops areas, as well as forest areas and plantations in RoW embedded in imported forest products. This biodiversity indicator is a very course measure for the impact of forestry on biodiversity and is here best used for comparing alternatives. What can be interpreted from the results is that introducing more production oriented methods in the EU28, like PM management, could contribute negatively to EU biodiversity, but positively to biodiversity at global scales, compared to current practices. This outcome is justified by the lower wood import from RoW in the PM management scenario (PM100) and valid under the assumption that a significant share of external wood products will be imported from tropical and subtropical countries with relatively high forest biodiversity. The magnitude

of the improvement is maintained if some of the PM management is substituted with MM management. The effect of setting aside is that more species are affected outside and less inside EU28 with the global net effect being negative. The reason for global biodiversity to benefit from a high production level in EU28 is due to the relation between species richness in the land affected by imports of woody biomass in ROW and the production forests of EU28. In the year 2100, this quota was 1.2-1.8. This means that Europe generally imports wood (directly or indirectly through forest products) from areas that were richer in biodiversity and more vulnerable to biodiversity loss than in Europe (such as tropical and subtropical areas). This development is based purely on economic convenience, where tropical and sub-tropical regions are able to supply up to 40% of the future imported wood demand, given an expected expansion of the forest sector in those regions. The introduction of market mechanisms like forest certification for harvested wood products supplied from tropical areas (i.e. avoiding direct and indirect deforestation) or trade policies interventions prioritizing wood import from boreal and temperate regions would reduce the EU28 biodiversity footprint from wood imports and be more favorable to a larger expansion of set aside areas in EU28 than in our current results.

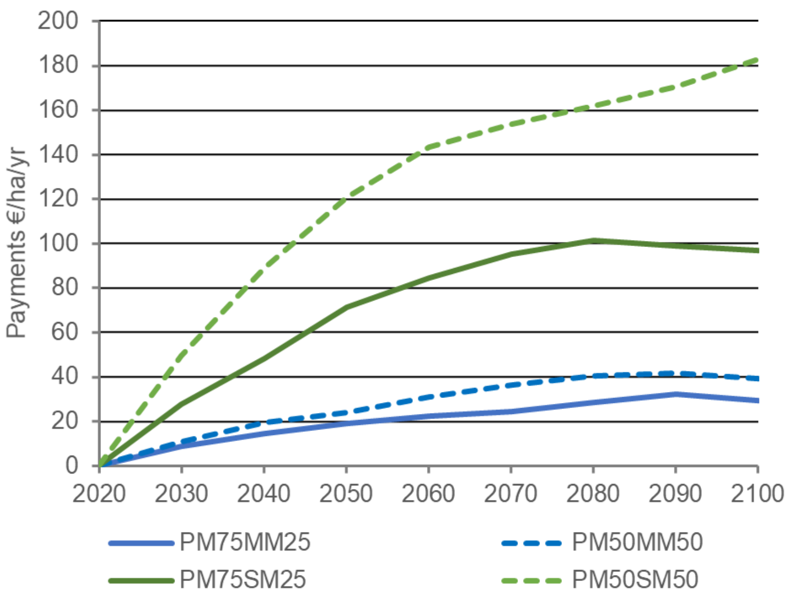


Figure 5:
Payments for alternative forest management strategies

GLOBIOM is based on general assumptions regarding how markets function and the economic motifs of agents in the forestry sector. The model therefore gives insights in the costs of changing behavior, if effected by economic incentives. Figure 4 shows the compensation to forest owners for them to take 1 ha and shift it from PM to MM or SM. The compensation increases over most of the coming century, since as the area of MM or SM increases, areas more expensive to shift has to be allocated. Setting aside 1 ha is, not surprisingly, several times more expensive than turning a PM ha into a MM ha.

5 POLICY IMPLICATIONS

5.1 POLICIES THAT CONCERN FORESTRY – WHAT IS AT FOCUS?

The European Commission recently released the European Green Deal, a new growth strategy including a set of actions and policies aimed at achieving climate neutrality - i.e. an economy with net-zero greenhouse gas emissions - by 2050. The European Green Deal builds on the idea that there is a need to rethink policies for clean energy supply across multiple sectors and in order to achieve this, it is essential to increase the value given to protecting and restoring natural ecosystems, the sustainable use of resources and improving human health. A range of policy areas are related to these goals and other social, economic, and environmental objectives are found under this umbrella. The Green Deal roadmap highlights policies and strategies related to forests and the forest sector such as energy supply, circular economy, building and renovation, and preservation and restoration of ecosystems and biodiversity. The more specific aims and means are found in the different documents covering each specific area.

One mainstay of the Green Deal is the EU Biodiversity Strategy for 2030. It deals with strengthening the protection of valuable ecosystems, restoration of degraded ecosystems, ecological corridors, and governance frameworks that should improve the strategy's implementation. One of more tangible proposals is strict protection of 10% of EU land; the strategy mentions all of EU's "remaining primary and old-growth forests" to fall into that category. Furthermore, the strategy calls for protecting at least 30% of the land with "specific focus on areas of very high biodiversity value or potential". The Biodiversity Strategy forebears that the Forest Strategy will include "… planting at least 3 billion additional trees in the EU by 2030, in full respect of ecological principles …". It can also be noted that the "use of whole trees and food and feed crops for energy production – whether produced in the EU or imported – should be minimized", with reference to the 2018 Renewable Energy Directive.

Another pillar of the Green Deal is the New EU Forest Strategy that, according to the roadmap, is expected to be completed in 2020, and will mirror the midterm review of the 2013 EU Forest Strategy. The key objectives behind the updated strategy "… will be effective afforestation, forest preservation and restoration in the EU so as to increase the potential of forests to absorb and store CO2, promote the bioeconomy and reduce the impact and the extent of fires, while protecting biodiversity. The strategy will cover the whole forest cycle and promote the numerous ecological and socio-economic services forests provide…". In this statement, one may sense a shift of priorities compared to the 2013 Forest Strategy, in which the prominence given to the role of forests as a producer of biomass, job creation and rural development is raised, whereas biodiversity is not directly addressed. It would seem that the 2013 Forest Strategy leaned more towards the Bioeconomy Strategy and the new Forest Strategy leans more towards the Biodiversity Strategy. This also partially overlaps with the shift observed in the 2018 version of the Bioeconomy Strategy, that seems to be less biomass-focused with a broader view of the bioeconomy concept.

The debate around strategies that in one way or another affects the management of EU forests is lively. One of the main messages from Winkel (2017) is the lack of coordination of sectorial policies and strategies. Although many policy tools influence the forest sector both within and outside the EU, ultimately there is no common cross EU forest policy. There is thus untapped potential with regards to cross-sectoral cooperation, multi-level approaches, and recognition of the full range of value chains. The Green Deal would seem to offer positive steps in this direction, by gathering strategies under one umbrella. However, an analysis of the different elements of the Green Deal by Hetemäki (2020) points to a number of inconsistencies that, to some extent, echoes the critique presented by Winkel (2017). The main point is a missing link between forests and the bioeconomy. The Green Deal, according to Hetemäki (2020), focuses on forests only for protection and as a carbon sink and evades the role of forests for substitution and HWP sequestration, and for job creation. The Green Deal initiatives do not recognize and take advantage of regional differences across the EU, in ecological as well as socio-economical terms. A different view was issued by a group of international researchers, urging the European Parliament to frame legislation that prioritizes forests for carbon accumulation. Both in the scientific dis-course and the strategic documents of the EU, one can trace the two priorities; limit harvests to promote biodiversity and forest as a sink, vs. intensify harvesting and further use forests in the bioeconomy and for substitution and HWP sequestration.

5.1 INSIGTS FROM ALTERFOR

From the debate over the EU forest strategy one could get the impression that these are two opposing alternatives. From the perspective of ALTERFOR, things look a lot more complex and there are no black and white alternatives to discover. The results from ALTERFOR show that there is no easy fix whatever the objectives are. The next paragraphs will shortly touch on EU level and case level outcomes, followed by a reflection on the stakeholder process necessary for attaining the results, and concluding with a few words on implementing alternative forest management models.

Turning one ha of current management, CM, to the alternative PM will favour production and disfavour biodiversity, and vice versa for MM and SM. Thus, there are available means to go in various directions. To address the strategies of the Green Deal, a realistic option is to combine the alternative management models. It is, for instance, possible to let 25% productive forest successively be set aside (SM) and still have the same harvest as with current management, if the remaining 75% follows PM. Wood production at similar levels could also be achieved using a strategy involving 75% MM and 25%PM. Thus, these combined strategies have limited impact on wood production, would decrease required compensation payments and leakage effects compared to the others, while still improving carbon sink and limiting the loss of biodiversity, as compared to the baseline. This outcome is possible because the EU wood production loss due to expansion of MM or SM is compensated by sufficient increase of PM on the rest of the suitable area. Blending strategies properly could make it possible to reach the target of 30% protected land area by 2030.

If harvests are limited to a substantial degree, the EU will most likely enter a situation with net imports, i.e. you export emissions and ecosystem degradation outside

the EU while waiving domestic C emission savings due to substitution effects. An immediate increase of protected forests, as have been proposed, may cause greater negative global effects on biodiversity than implicated by the GLOBIOM analyses; the latter assume a gradual increase of set aside areas and time for introduction of the more efficient alternative production methods (PM). These considerations are connected to discussions around forest resources outside of Europe that are heavily affected by EU policies as well as trade and consumption patterns.

The EU level results show that if a broad range of objectives are sought for (e.g. production, jobs, climate change mitigation, and biodiversity), alternative management models could make a difference compared to current standard management. We also need to find a proper mix among those models. Those lessons are also demonstrated at the case level. The two different strategies, Production and Multifunctional, are developed to be implementable and include therefore a mix of different stand and landscape level measures (the two Augsburg strategies are extremes that are meant to be combined to yield the kind of balanced bundle of ecosystem services that political and other processes may lead to). The net carbon balance over the 90-year horizon is not very different for any of the cases. This suggests a considerable leeway to steer management in different directions without jeopardizing the capacity of forests to contribute to climate change mitigation. However, there is an issue with when effects occur. For example, if considering the more extreme outcomes form the Augsburg case, the sequestration effect of set asides is initially big, but shrinks towards 0 in the long run (100 years), as there is a limit in the amount of C that can be stored by plants. In contrast, strategies that include harvesting wood, as long as they are sustainable, have a C emission saving effect that lasts over time.

Overall, the work in all 10 ALTERFOR case studies brought interesting insights with respect to the potential implications of alternative approaches to forest management. To a large part, these outcomes emerged due to three aspects of the development process. First, stakeholders were brought in at an early stage in the process. Their insights regarding the problems that needed to be solved and what would and would not work in practice were pivotal to formulating alternative forest management approaches that could be realized. Second, priority was given to influential stakeholders, and linking the development of silvicultural alternatives to ongoing political processes, whenever possible. This raised the likelihood for implementation of alternative forest management practices. Third, consideration of forest management alternatives encompassed both the stand and landscape level. Because of this it was then possible to build landscape strategies based on the selection of a range of different stand management options.

Thanks to the chosen model for bridging the gap between science and practice, the alternative management models should have a higher chance of being implemented. There are however considerable hurdles that vary a lot between different parts of Europe. The fact that stakeholders have a stake in the alternatives does not mean that all important stakeholders embrace all possible alternatives. Where opinions are strong and divided, the policy process could still come to a stalemate. This is typically the situation in Germany. In Lithuania, authorities have to accept less rigid controls, even it that runs contrary to public opinion. In Sweden, one condition for successful implementation relates to game control, a controversial issue by itself. In the previous policy brief from ALTERFOR (Policy Brief 1, 2018) the situation

in Slovakia, the Netherlands, and Portugal was analysed. To achieve a positive change in Slovakia, the key challenge was to reduce state steering, and to allow more autonomy to decision makers including forest owners and managers. The situation in the Netherlands and Portugal is the opposite, i.e. forest owners have a large degree of freedom to manage their properties. This may call for a higher degree of involvement of governments and authorities to develop the coordinating instruments necessary to make policy implementation possible.

ALTERFOR highlighted some possible outcomes of forest management alternatives on multiple scales, from the stand scale to the landscape, and finally, to the EU as a whole. The elaborate work with stakeholders also exposed the practical hindrances to the implementation of forestry alternatives. The implementation capacity is heavily dependent on local contexts and conditions, from the personal motivations of a single forest owner, to power struggles in national policy arenas. Given the outlined complex tradeoffs between timber production, biodiversity and carbon balance, it can be recommended that future efforts to upgrade EU forest strategy avoids radical shifts towards any extremes, and instead focus on innovative and incentivizing mixes of policy tools, if synergetic effects across sectors are to be raised.

Inspired by the successful experience of the EU Cost Action FACESMAP, ALTERFOR uses Travellab, an innovative format for cross-regional learning. Instead of a conventional scientific excursion, Travellab contains a targeted field trip where scientists meet local stakeholders. This is preceded by a preparatory session illuminating local and national contexts; and complemented by a round-table session where stakeholders and scientists debate hot forestry topics. Travellab thus goes well beyond narrow technical discussion of certain silvicultural methods, providing important insights into socio-economic contexts, stakeholders' power and interests, and the overall capacity to implement alternative forest management. The format was first tested in Zvolen, Slovakia (2016) and, following the successful event, was implemented in Galway, Ireland (2017) and Porto, Portugal (2018). Due to its solution-oriented approach and high recognition among local stakeholders, this unique format is expected to generate a long-term impact, inducing the implementation of the desirable silvicultural approaches locally and nationally.

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ANNEX

Summary of major aims, silvicultural methods to meet those aims, and the obstacles to get the methods implemented in ALTERFOR countries. The numbers in parentheses under 'Alternative Methods' refer to the corresponding aims.

CASE	AIMS AND NEEDS	ALTERNATIVE METHODS	OBSTACLES
Germany I Brandenburg	1. Higher demand for wood and energy 2. Find balance among all ES 3. Higher cultural services 4. Higher environmental values	(1) Scots pine timber and energy (2,3) Biodiversity-centred management of pine (4) Oak biodiversity set-aside	- Stakeholders with strong and directly opposite perceptions of forest management and goals - Powerful stakeholders (often NGOs) argue for some ES in conflict with other ES
Germany II Bavaria		(1) N. spruce timber and energy (2,3) Biodiversity-centred management of spruce (1) Beech biodiversity set-aside	
Ireland	1. Less fertilisation 2. Higher environmental values 3. Higher wood production 4. Bigger share of broadleaves	(1,3) Lodgepole pine (LP) fibre production (1,2) Lodgepole pine wilderness/ biodiversity (2,3,4) Sitka spruce under birch nurse	- Uncertainty about how low-density LP stands might develop - Costly to build roads in non-commercial forests - Finding suitable sites for Sitka spruce and birch
Italy	1. Higher environmental values 2. Keep/increase recreational, cultural services 3. Higher combined ES value 4. More timber and biomass	(2,1,3) Recreational selective management (4) Uniform shelter-wood and coppice	- Improper management can increase invasive species - High cost for tending - Local communities not used to shelterwood
Lithuania	1. Higher economic efficiency 2. Better adaptiveness to climatic and social changes 3. Maintain high environmental and social values	(1,2) Adaptive rotation ages (2,3) Care for deciduous trees (2,3) Non clear-cutting	- Too rigid steering by state - Old scientific "truths" - Outcomes of natural regeration hard to predict - Public opinion
The Netherlands	1. Maintain high environmental and social values 2. Higher wood and energy production	(2) Management for wood biomass (2) High value timber (1) Park management (1,2) Climate-resilient management	- Owners' will and knowledge - Low profitability - Lack of scientific knowledge - High browsing pressure
Portugal	1. Reduced fire risk 2. Higher environmental values 3. Higher production of sawtimber	(1,3) Pine and oak with long rotations. (1,2) Cork oak (1,2) Riparian deciduous forest	- Fragmented ownership - Unprofitable management - Lack of coordinated landscape management
Slovakia	1. Less drought damage and reduced risk of storm damage 2. Higher economic efficiency	(1) Multifunctional partly uneven-aged management (1,2) Even-aged mixed species stands	- Excessive steering by state - Excessive management restrictions - Insufficient technologies
Sweden	1. Higher environmental values 2. Maintain/increase wood production 3. More varied forests	(2) Sitka spruce and Douglas fir (1,3) Spruce-Birch mixtures (1,3) Border zone management (1,3) Selection systems	- Owners' will and knowledge - High browsing pressure - Lack of scientific knowledge
Turkey	1. Higher water quality 2. Higher wood production 3. Higher environmental values 4. Improved visual quality	(1,2,3,4) CCF - Continuous Cover Forestry	- Poor road network - Lacking technical and managerial support - Need for training of foresters

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