Forest Research

Which role for planted forests in Europe?
or
Plantation Forests in Europe: Challenges and Opportunities.

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Why plantation forests?

Plantation forests →

Development objectives - UN SDGs, EU and national

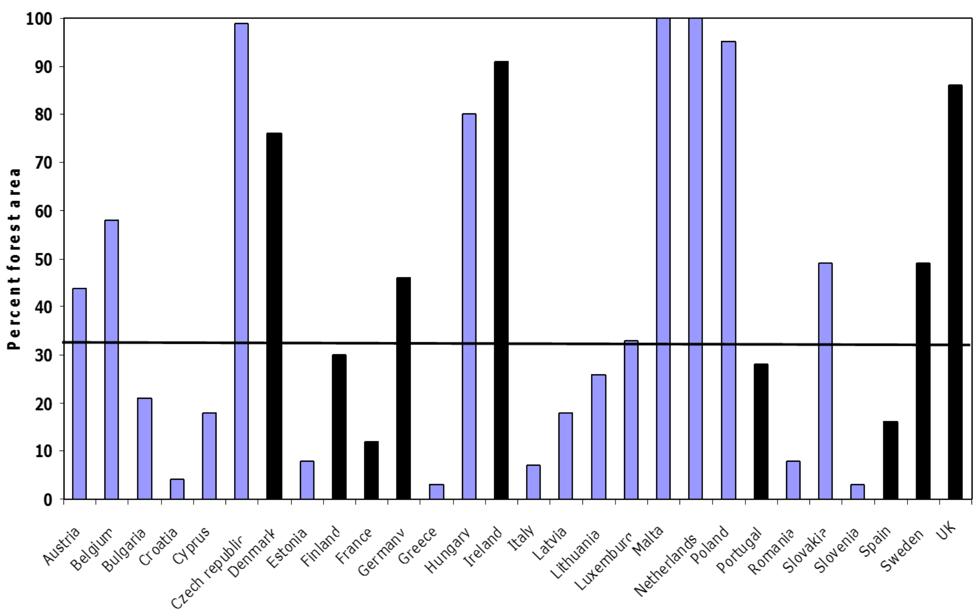
socioeconomic, meeting future demand including biomass energy & the bio economy.

Climate mitigation – FCCC, EU climate & energy framework, INDCs

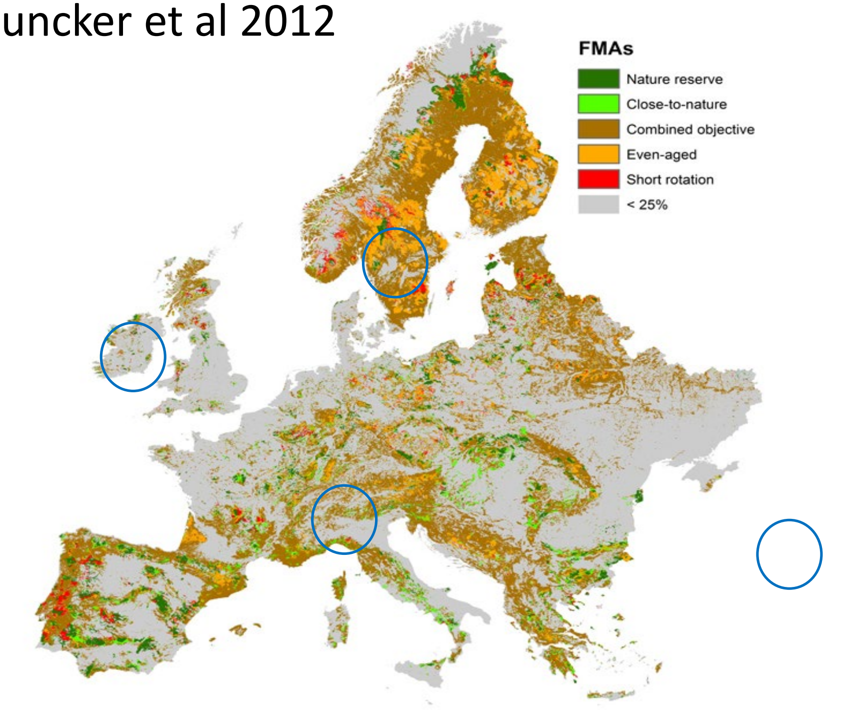
Environmental targets - biodiversity and plant health under CBD, ICPP EPPO etc.

Our definition - Forest plantations in Europe defined as forests established through planting and/or deliberate seeding and which are being actively managed primarily for timber production

Planted forest area (%) by EU Member State - after FAO Forest Resources Assessment 2015



Duncker et al 2012



Our 4 case studies Ireland, Sweden, Italy & Georgia

Structure of our study / thesis

Framework

Land availability

Economics (support, confidence in future returns…)

Governance, regulatory and institutional framework

Knowledge & technical advice.

Practical considerations

Genetic capital

Silviculture – sustainability & land use impact

Management of risk biotic and abiotic

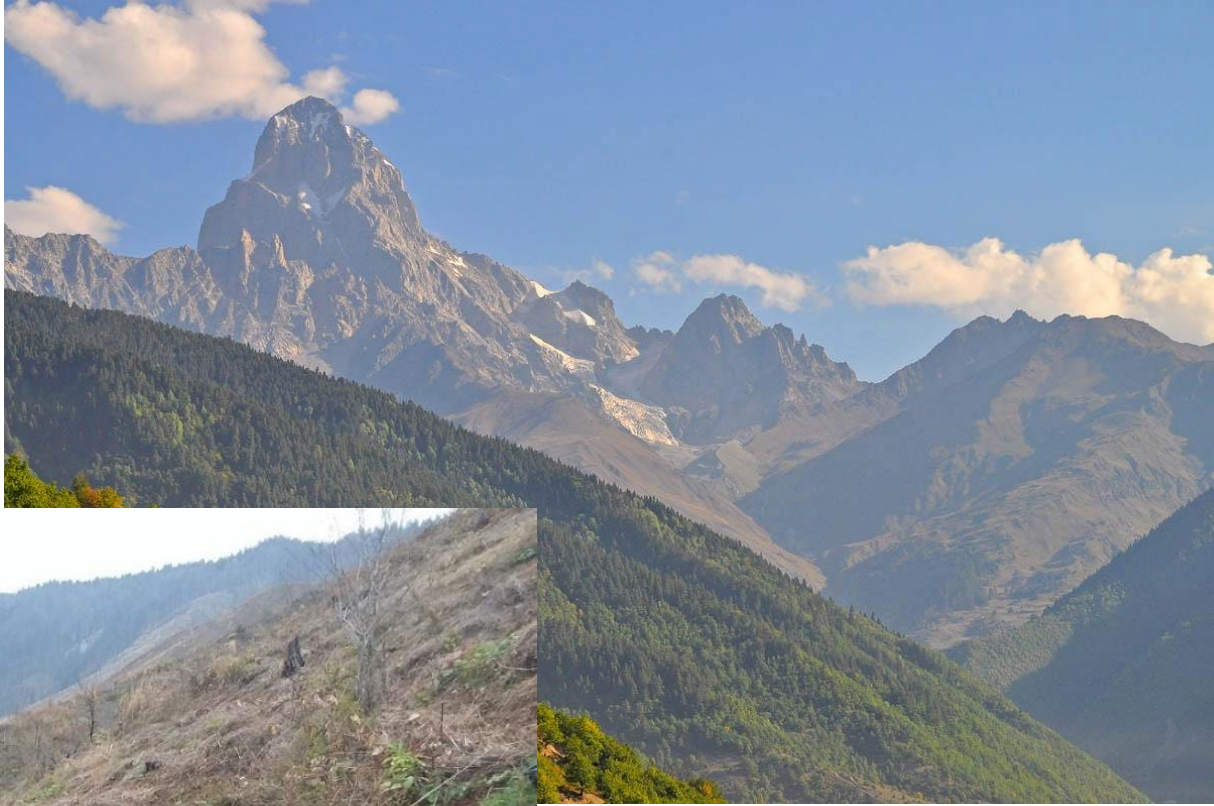
Ecosystem services

Social engagement

Outcomes / future

Sustainable plantation forests meeting society's needs

(development/economic, climate mitigation & environmental)


Land use impact exercise

Impact scores estimate distance from natural state (natural = 0; max. impact = 100). They are proxies for the order (exergy or negentropy) of the system (maximum in natural state and 0 at thermodynamic equilibrium)

	Poplar Italy	Spruce Sweden	Pine Georgia	itka spruce Irelan	ropland Belgium	Comments
1. Ecosystem structure						
1.1 Vegetation structure						
1.1.1 Above-ground biomass	60	40	30	50	95	Biomass is an essential feature of ecosystem structure, creating microclimate, habitats, etc. Essentially the rotation length determines the average standing biomass.
1.1.2 Leaf Area Index	50	20	40	40	75	Leaf Area index is related to the height and the layeredness of vegetation, and determines the filtering capacity of the vegetation for light, rain, dust, etc. Tree-based systems have higher LAI. Average
1.1.3 Free Net Primary Productivity	70	60	40	50	80	FNPP is the fraction of the total net primary productivity that is not harvested, and that stays in the ecosystem for natural ecosystem processes. It will be typically higher in plantation forests than in c
Vegetation Impact	60	40	37	47	83	Average of the 3 vegetation structure indicators
1.2 Biodiversity						
1.2.1 Loss of plant species richness	80	50	40	70	90	Can be done for any taxa, here for plant species. The effect is very context dependent.
1.2.2 Non-native canopy cover	90	0	0	70	95	The idea is that native species have a co-evolved network of specialized associated species. Cover of different layers (tree, shrub, herb) are counted together. In this example both maize and interam
1.2.3 Biocide use	70	0	0	10	90	Biocides are harmful for the food web. The impact includes the factors % of the area treated, intensity and frequency of the treatment.
1.2.4 Fertilizer use	40	0	0	15	80	Fertilizers disturb the natural plant nutrition, and may lead to eutrophication. The impact includes the factors % of the area treated, intensity and frequency of the treatment
1.2.5 Use of irrigation or drainage	20	0	0	30	10	Changing the natural water conditions may be harmful for the natural system. The impact includes the factors % of the area treated and intensity of the irrigation/drainage applied. In poplars and ma
Biodiversity Impact	60	10	8	39	73	Average of the 5 biodiversity indicators
2 Ecosystem function						
2.1 Soil						
2.1.1 Soil work	15	3	2	8	90	Ploughing leads to loss of soil organic matter, macropores, etc. The impact includes the factors % of the area treated, depth and frequency of the intervention.
2.1.2 Soil erosion	5	1	0	2	30	Sediment loss leads to decreased site quality, and causes off-site damages. The more permanent canopy cover and rooting of forests has a larger control over sediment loss than croplands, which ma
2.1.3 Loss of cation exchange capacity	30	20	10	20	40	CEC is the storage capacity for excheable nutrients, like Ca, K, Mg. CEC is mainly determined by soil texture (more or less invariable for a given site) and soil organic matter.
2.1.4 Loss of base saturation	0	30	10	30	0	Base saturation is an indicator of soil fertility. Poplars keep soils fertile, and in cropland BS is controlled by fertilization.
Soil Impact	13	14	6	15	40	Average of the 4 soil indicators
2.2 Water balance						
2.2.1 Loss of evapotranspirative cooling	10	0	0	10	40	The evapotranspiration level of the natural system is in balance with the water flow in the aquatic system. Slightly increased ET like in poplars or clearly decreased ET like in cropland (because of low
2.2.2 Loss of soil infiltrability	20	10	5	15	30	Infiltration is important for plant growth and refilling of aquifers. Poplar plantations will have good infiltration rate but lower infiltration due to increased ET. Croplands will have reduced infiltration r
Water impact	15			12.5	35	Average of the 2 water indicators
Overall land use impact	**37**	**21**	**17**	**28**	**58**	In the plantation forest the impact is only half of that in the cropland due to less frequent and less intensive interventions, leading to a more close to nature structure and function

Questionnarie plantation forests for poplar plantations in Northern Italy

1 Po Valley, Northern Italy.

2. The reproductive material is represented by selected clones

3. The main production goal is poplar rotary veneer for plywood panels

4. The average rotation length is 10 years, with a range from 8 to 12 years.

5. The silvicultural system is clearcutting

6. The average spacing is 6 x7 m

7.The normal site preparation before planting is represented by ploughing at a depth of 40-50 cm followed by harrowing.

8. At planting: 120 kg per ha of P_2O_5 and 250 Kg per ha of K_2O. Subsequently: 90, 90 and 120 kg ha^{-1} of N applied at the first, second and third year from planting, respectively.

9. The majority of poplar plantations are not irrigated. Many of plantations are established in floodplains and experienced flooding during periods of high river discharge. Only few plantations are irrigated and the watering volumes vary greatly along with water availability.

10. Weeding is carried out by 2-3 mechanical interventions (harrowings) realized at the 1st, 2nd 3rd , 4th and 5th year after planting.

11 The use of biocides depends on the clone used in the plantations. With susceptible clones (e.g. clone I214) 2 treatments per year are needed throughout the rotation against Marssonina using mancozeb, together with an insecticide applications against Phleomyzus passerinii when needed.

18. Plantations are pure poplar plantations with an average size of 4.6 ha

19. Plantations are established with one tree species. Natural forests of the region includes about 5-10 tree species depending on the site. Anyway, at the present the Po Valley is very poor in natural forests because they had been replaced by agricultural crops.

20. The common MAI achieved varies from 17 to 20 m^3 ha^{-1}

Data collection from our 4 case studies.

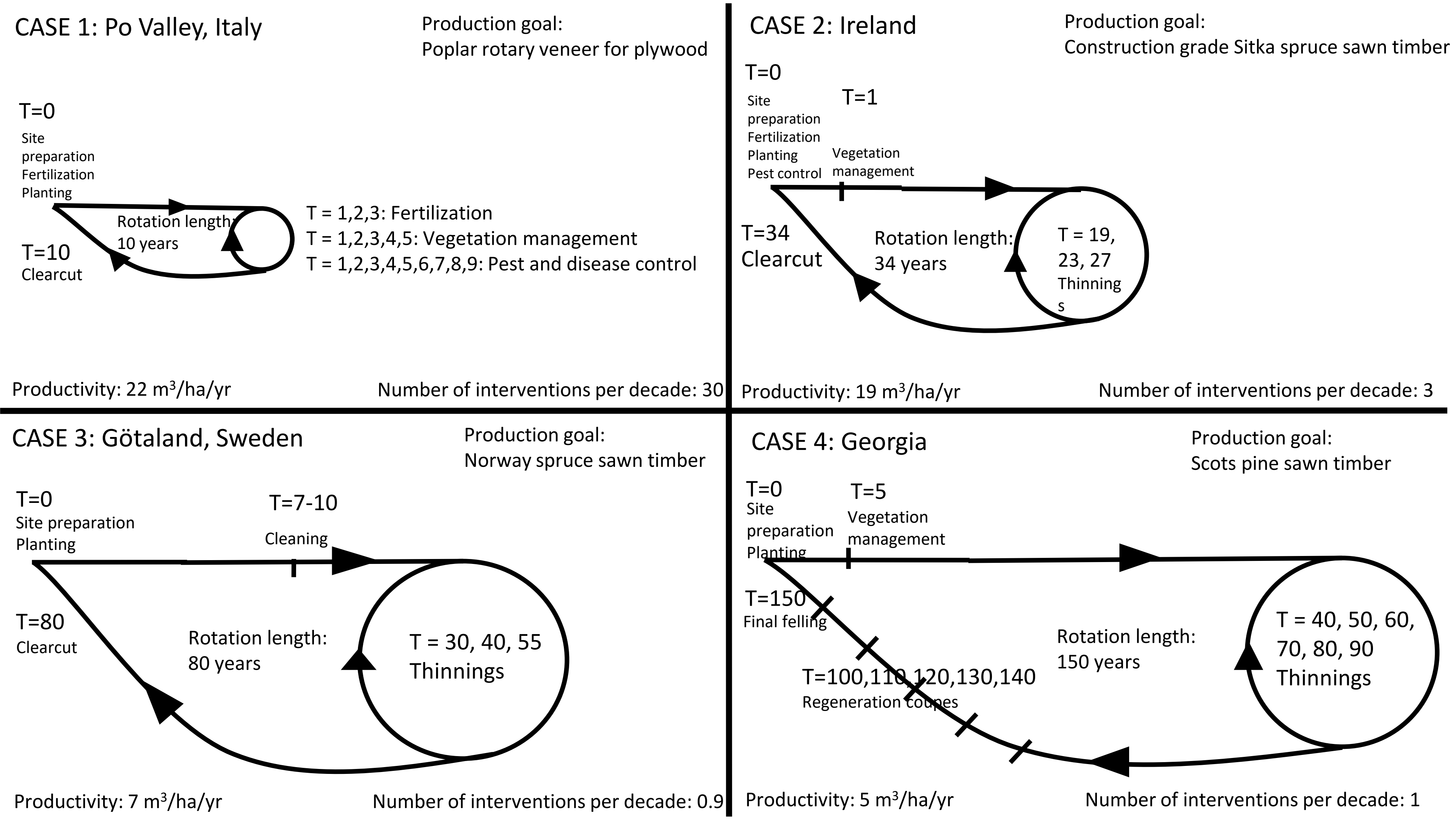


Fig 1. Silvicultural cycle summaries for our 4 plantation forestry systems – ordered by increased rotation length and decreased production intensity

Land use impact assessment of the case study plantations shown in Fig. 1 (LCA method of Peters et al. 2003). Land use impact (LUI) scores are estimated deviances from the natural state (natural = 0; maximum impact = 100). LUI is evaluated for each of several indicators for **average vegetation, biodiversity**, **soil** and **water** impacts as shown below and are then averaged for each impact.

	Hybrid poplar Italy	Sitka spruce Ireland	Norway Spruce Sweden	Scots Pine Georgia	Cropland Belgium
- Above-ground biomass	*60*	*50*	*40*	*30*	*95*
- Leaf Area Index	*50*	*40*	*20*	*40*	*75*
- Free Net Primary Productivity	*70*	*50*	*60*	*40*	*80*
Average Vegetation Impact	**60**	**47**	**40**	**37**	**83**
-Loss of plant species richness	*80*	*70*	*50*	*40*	*90*
- Non-native canopy cover	*90*	*70*	*0*	*0*	*95*
- Biocide use	*70*	*10*	*0*	*0*	*90*
- Fertilizer use	*40*	*15*	*0*	*0*	*80*
- Use of irrigation or drainage	*20*	*30*	*0*	*0*	*10*
Average Biodiversity Impact	**60**	**39**	**10**	**8**	**73**
-Soil work	*15*	*8*	*3*	*2*	*90*
- Soil erosion	*5*	*2*	*1*	*0*	*30*
- Loss of cation exchange capacity	*30*	*20*	*20*	*10*	*40*
- Loss of base saturation	*0*	*30*	*30*	*10*	*0*
Average Soil Impact	**13**	**15**	**14**	**6**	**40**
-Loss of evapotranspirative cooling	*10*	*10*	*0*	*0*	*40*
- Loss of soil infiltrability	*20*	*15*	*10*	*5*	*30*
Average Water impact	**15**	**12.5**	**5**	**2.5**	**35**

Land use impact assessment of the case study plantations shown in Fig 1 (LCA method of Peters et al. 2003). LO/FU (in ha.year/m^3) is the land occupation (LO) in ha.year needed to produce a functional unit (FU) of 1 m^3 of harvested wood, and is the inverse of the productivity. **Overall LUI** scores are averaged for Vegetation, Biodiversity, Soil and Water – as shown in the last table (natural = 0; maximum impact = 100). **The land use impact per functional unit** (LUI per FU) is calculated by weighing (multiplying) the LO/FU with the overall LUI.

	Hybrid poplar Italy	Sitka spruce Ireland	Norway Spruce Sweden	Scots Pine Georgia	Cropland Belgium
LO/FU	0.045	0.053	0.143	0.200	NA
Overall LUI (averaged vegetation, biodiversity, soil and water impacts)	37	28	17	13	58
LUI per FU	1.665	1.484	2.431	2.600	NA

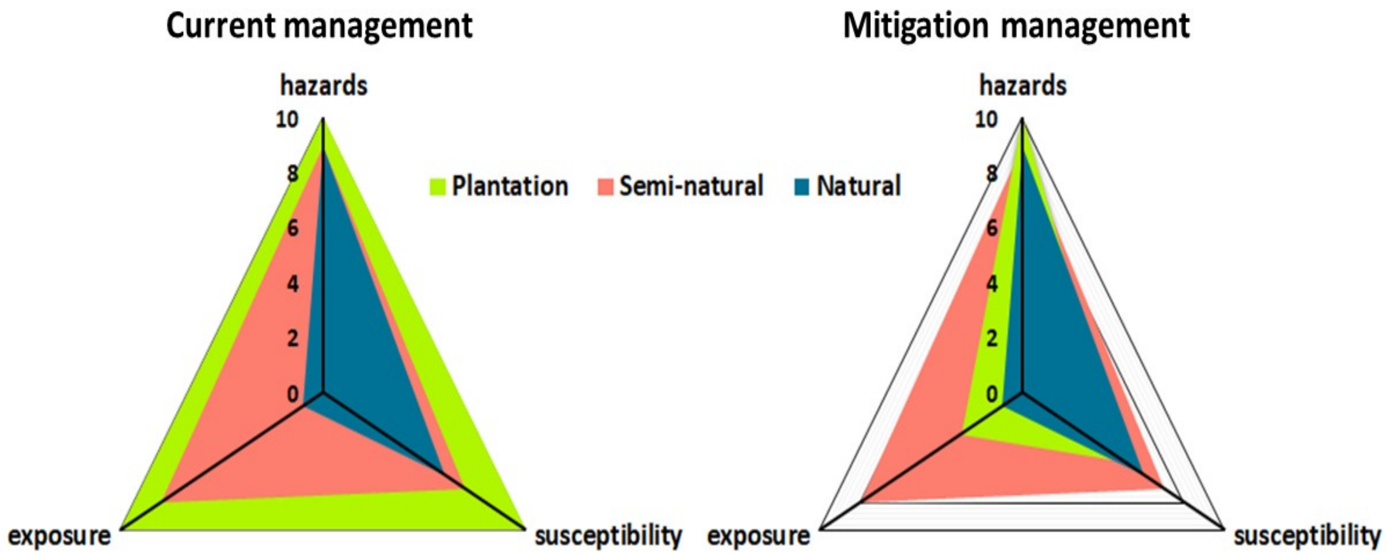


Figure 2 Schematic representation of biotic and abiotic risks associated with plantation, semi-natural and natural forests, with the relative importance of the three components of risks (hazards frequency or severity, forest stand susceptibility to hazards and exposure to damage caused by hazards) under current (a) or mitigation management (b).

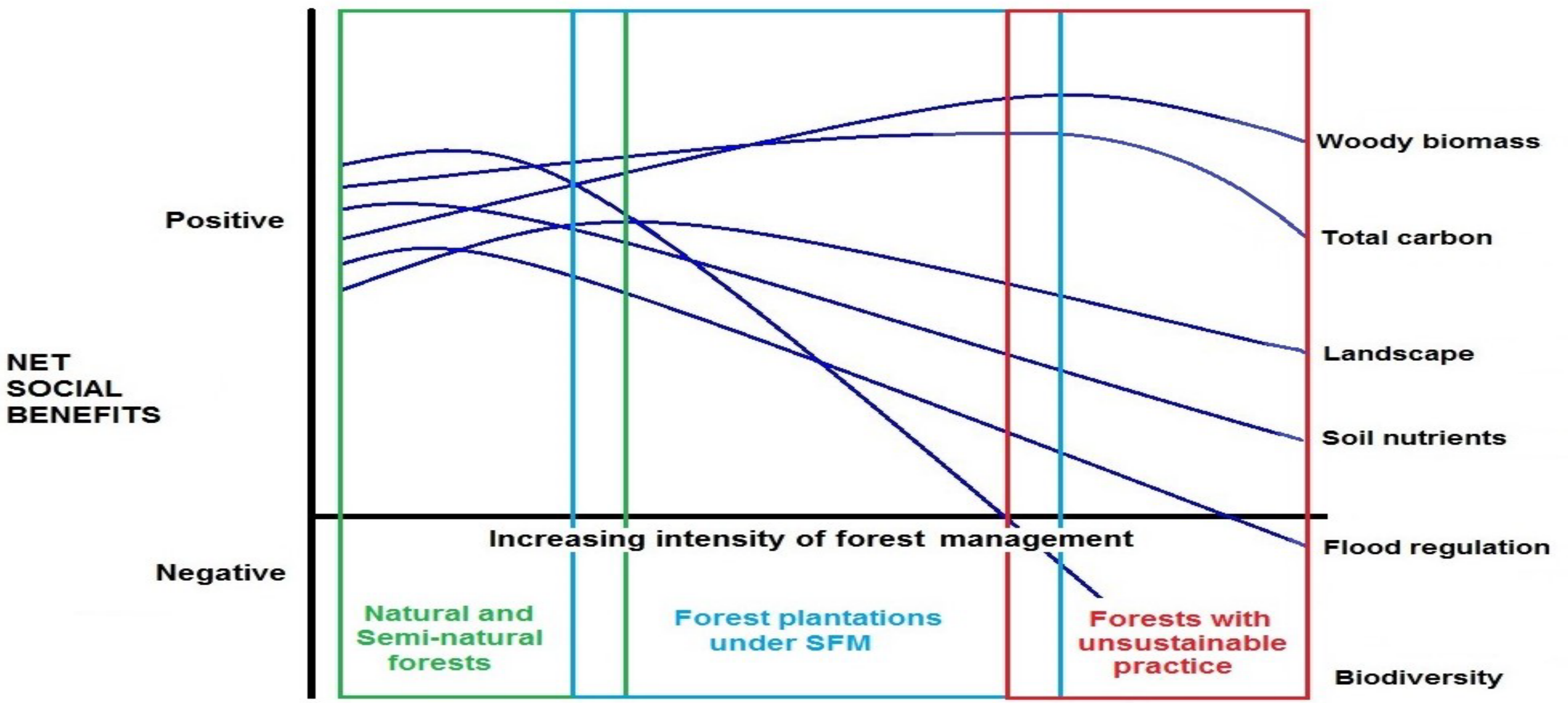


Figure 3 A theoretical model showing how management intensity effects the delivery of ESs. The shape of impact curves will vary with location, type of management and other factors. Management can be designed to achieve different balances and trade offs in the delivery of ecosystem services. Modified from Nijnik *et al* 2015.

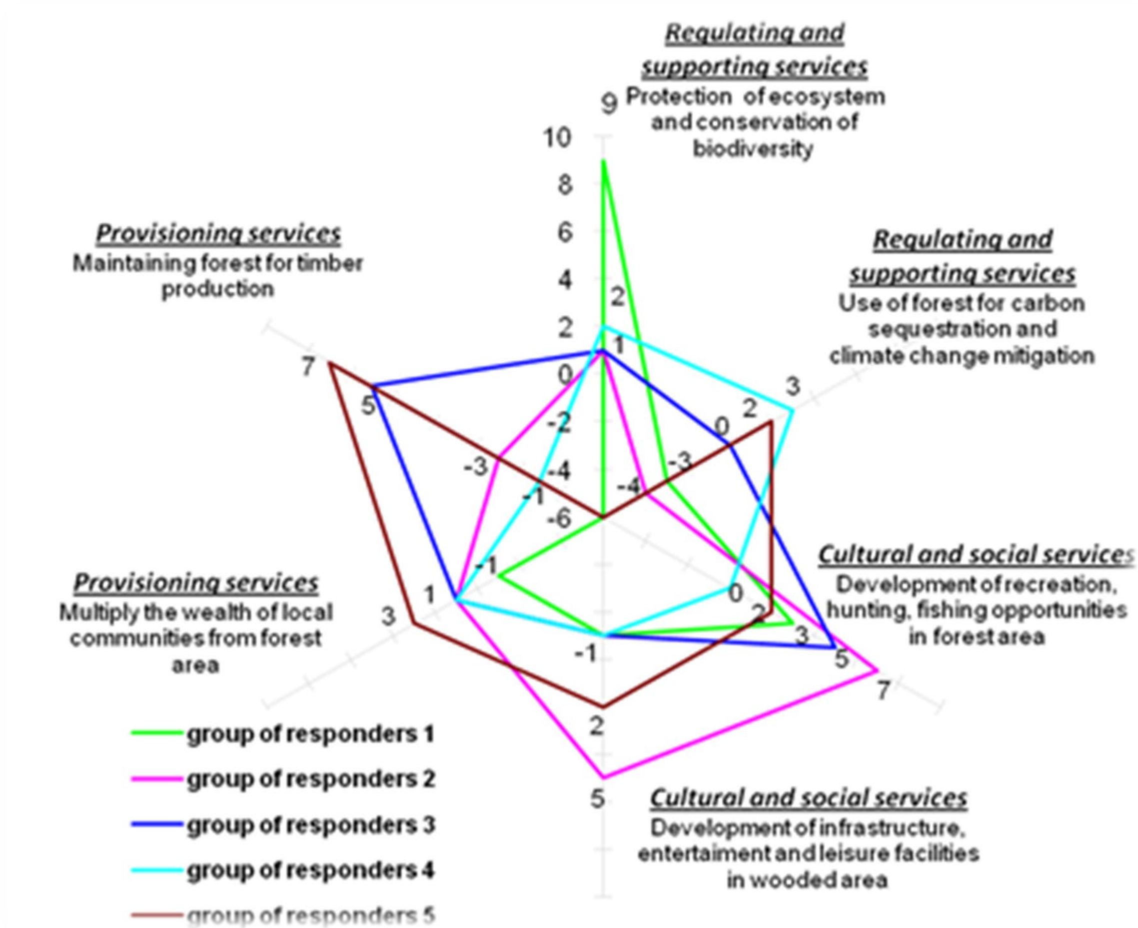


Figure 4: Heterogeneity of stakeholder preferences with regard to forest ecosystem services and the trade-offs, as identified by the Q analysis. Source: Nijnik et al. 2016

- Research, guidance and regulation will continue to be required on the identification and production of forest reproductive materials for plantations. FRMs should be selected for their production ability & for their ability to enhance the capacity of the forest to adapt to climate change.

- Plantation forestry systems have a clearly lower land use impact than intensive agricultural systems.

- When expressing impact per functional unit, the impact of intensive forestry systems decreases, because they have higher productivity. This shows that **land sharing and land sparing approaches are partly interchangeable**: more intensive systems have more impact per unit of land, but have impact for the same amount of product. But there is an optimum beyond which further intensification does not contribute much to increase productivity, while strongly harming the environment, including adjacent or downstream ecosystems.

- <u>Awareness</u>: Plantation forest managers should know that all risks are currently increasing, due to growing abiotic (drought, storms), biotic (native and exotic pests) and financial (market volatility) hazards;

- <u>Adaptation:</u> To mitigate risk, adaptation of forest plantation management is necessary. The first option is to improve resistance by increasing plantation diversity. The second option is to reduce the exposed standing volume by intensifying thinning and harvesting regimes.

- Plantations even if focusing on wood provision contribute strongly to regulating and social ecosystem services, especially carbon sequestration and recreation.

- We must understand local social/institutional and economic contexts and seek to factor the non-market goods and services of forest plantations more effectively into decision making.

- Acknowledging multiplicity of relevant stakeholders, heterogeneity of their perceptions and of the role of social innovations is important for designing and implementing sustainable forest policy measures to govern the development of forest plantations.

In Europe plantation forestry already plays a significant role in meeting environmental, economic and climate policies and **going forward investment could enhance these contributions further.** Both research and policy measures are need to support the establishment, ongoing sustainable management (SFM) and utilization of plantation forests.

Thank you

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