SUPPLY, DEMAND AND INNOVATIONS OF FOREST ECOSYSTEM SERVICES IN EUROPE

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Governing and managing forests for multiple ecosystem services across the globe
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INTRODUCTION

European forests contribute in multiple ways to society's well-being (Miura et al., 2015, Bottaro et al., 2018)....
...commonly referred as Ecosystem Services (ES, MEA 2005)

We consider ES supply as the components of a provided ES based on biophysical properties, ecological functions and social properties in a particular area and over a given period (Burkhard et al., 2012).

As for ES demand we consider it as the level of a given ES required or desired by human society (Wolff et al., 2015).

- ES are inter-related in synergistic and trade-off interactions (Bennett et al., 2009)
- The differences in quantity and quality between supply and demand of ES are called ES mismatches (Geijzendorffer et al., 2015).

INTRODUCTION

WHY MAP ES SUPPLY & DEMAND?

- can be used as a decision making tool to make rational and grounded FES management decisions

WHY MAP INNOVATIVE MECHANISMS (IM)?

- promoting FES - ideally in areas with high societal demand potential and potential to increase supply
- spatial targeting - single-most important policy mechanism design issue (Wunder et al., 2018)

WHAT DO WE DO HERE?

- Map FES supply, demand and IMs as seen by forest owners and managers
- First European FES mapping based on primary data

QUESTIONNAIRE OVERVIEW

Questionnaire answered for a forest familiar to a respondent – either by owning it or managing it

- **Introduction questions**
  - Ownership and management status of the forest
  - Size of the forest
- **Point location of the forest (on a map)**
- **Supply and demand of forest ecosystem services** (11)
- **Forest management and income**
  - Alignment of forest management with societal expectations
  - Distribution and importance of forest income from FES groups
  - Relation between forest income and cost of FES provisioning by group
- **Innovative mechanisms** (based on Van Lancker et al, 2016 & Lovric et al, 2019)
  - Type of innovation (10)
  - Level of innovativeness
  - Factors supporting and impeding IM development

Visual analogue scale

Separately for the most economically important one and most innovative one

RESERACH DESIGN

Targeted population: Forest owners and managers

Sampling frame: forest owners and managers with active ties to their associations

Distribution:

Research team → questionnaire distribution emails → European State Forest Association (EUSTAFOR); Confederation of European Forest Owners (CEPF); European Landowners Association (ELO); European Federation of Municipal and Local Community Forests (FECOF) → Direct emails; Newsletter; Website item → Members of EUSTAFOR, CEPF, ELO and FECOF

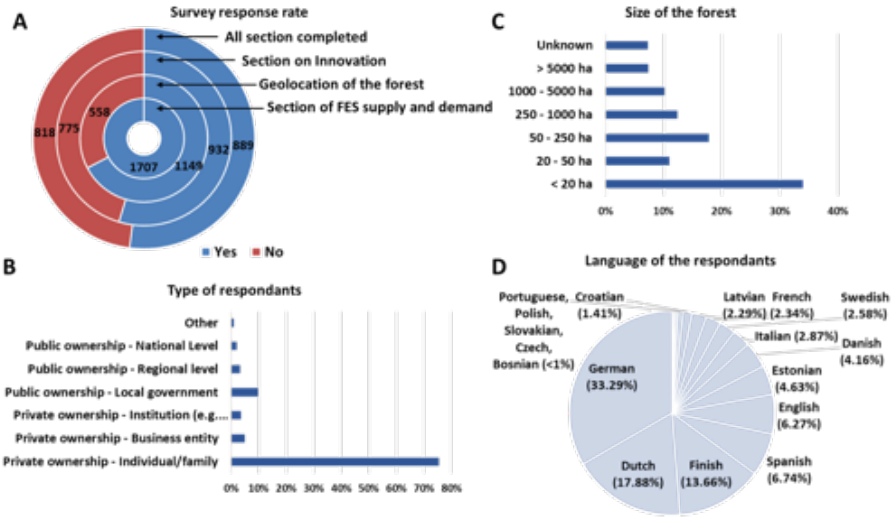
Format: on Maptionnaire platform (on-line); translated to 19 languages

Questionnaire pre-testing: within SINCERE and INNOFOREST consortiums, May-August 2019

Data collection: 19/09/2019 - 10/12/2019

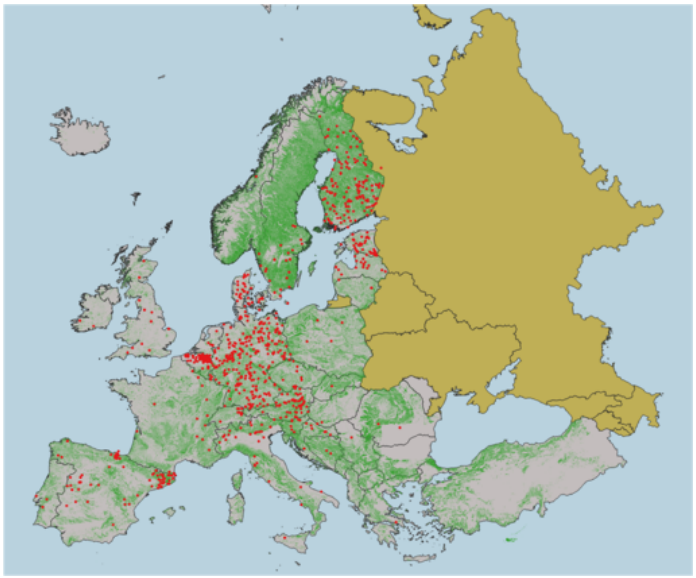
TYPOLOGY OF RESPONSES

- **Total of 2597 responses**
- **Reduced to 1707**



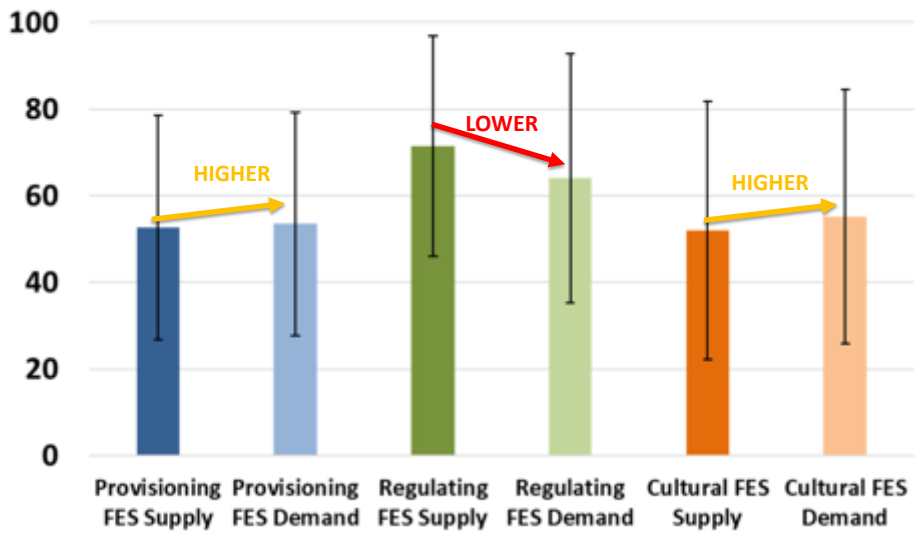
Characteristics of the respondents. A: Survey response rate - Number of respondents of each part of the three parts of the survey. B: Type of forests owned or managed by the respondents. C: Size of the forest. D: Language of choice in which the survey was completed.

POINT-LOCATIONS OF FORESTS



Mapped responses to the survey. Background: forest is Europe (Source: CORINE: Codes 311, 312 and 313)

MEAN SUPPLY AND DEMAND FOR EACH FES CATEGORY



CROSS-CORRELATION OF FES SUPPLY

SUPPLY	Biomass (material)	Biomass (Energy)	Game	Wild forest products	Watershed protection	Air quality regulation	C. Change mitigation	Habitat provision	Cultural values	Educational values	Outdoor recreation
	Supply										
Biomass (material)	1	-	-	-	-	-	-	-	-	-	-
Biomass (Energy)	0.45	1	-	-	-	-	-	-	-	-	-
Game	0.45	0.32	1	-	-	-	-	-	-	-	-
Wild forest products	0.23	0.20	0.37	1	-	-	-	-	-	-	-
Watershed protection	0.35	0.25	0.35	0.33	1	-	-	-	-	-	-
Air quality regulation	0.24	0.23	0.23	0.22	0.54	1	-	-	-	-	-
Climate change mitigation	0.31	0.25	0.29	0.19	0.45	0.73	1	-	-	-	-
Habitat for plants and animals	0.18	0.20	0.29	0.12	0.43	0.54	0.62	1	-	-	-
Cultural, emotional and spiritual values	0.22	0.21	0.22	0.36	0.36	0.37	0.37	0.39	1	-	-
Educational values	0.22	0.27	0.22	0.22	0.38	0.31	0.27	0.31	0.39	1	-
Healthcare, sports and outdoor recreation	0.25	0.24	0.25	0.30	0.41	0.37	0.33	0.37	0.43	0.61	1

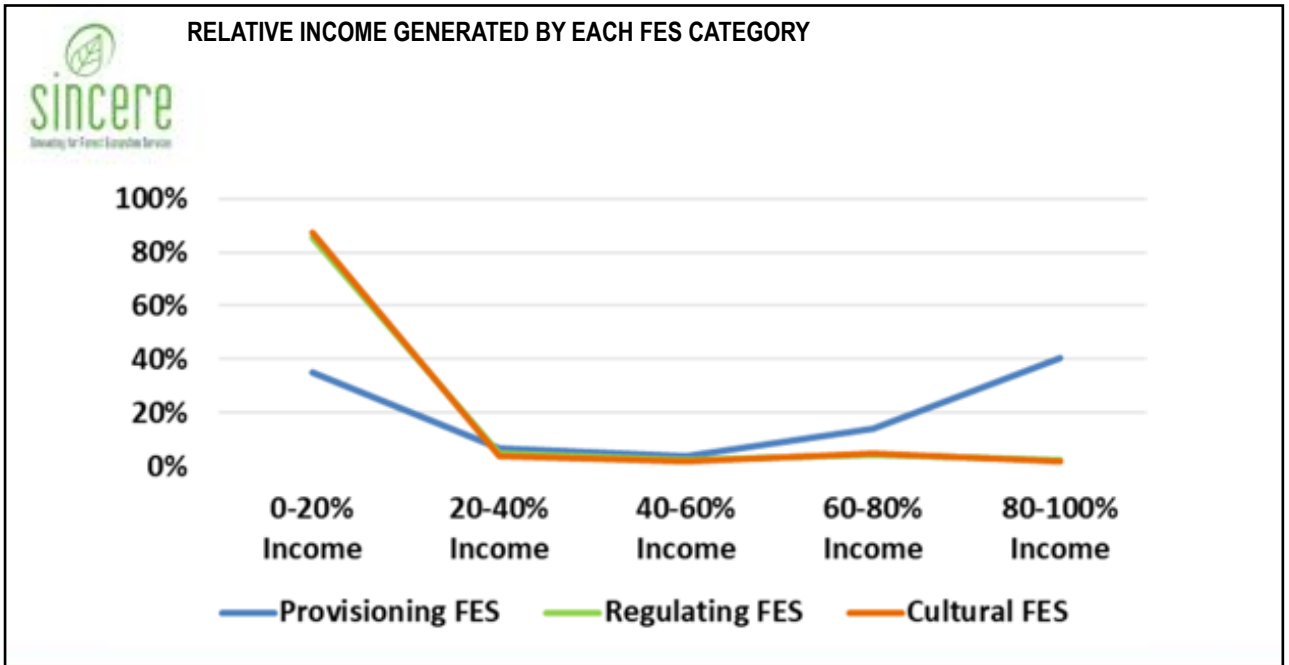
CROSS-CORRELATION OF FES SUPPLY AND DEMAND

SUPPLY	Biomass (material)	Biomass (Energy)	Game	Wild forest products	Watershed protection	Air quality regulation	C. Change mitigation	Habitat provision	Cultural values	Educational values	Outdoor recreation
	DEMAND										
Biomass (material)	0.65	0.36	0.28	0.21	0.28	0.07	0.11	0.15	0.19	0.16	0.16
Biomass (Energy)	-	0.61	0.26	0.20	0.22	0.09	0.09	0.12	0.17	0.17	0.19
Game	-	-	0.55	0.27	0.23	0.03	0.06	0.12	0.13	0.16	0.15
Wild forest products	-	-	-	0.60	0.20	0.10	0.09	0.08	0.22	0.11	0.12
Watershed protection	-	-	-	-	0.53	0.16	0.13	0.15	0.24	0.26	0.31
Air quality regulation	-	-	-	-	-	0.42	0.24	0.20	0.27	0.22	0.31
Climate change mitigation	-	-	-	-	-	-	0.30	0.25	0.21	0.17	0.26
Habitat for plants and animals	-	-	-	-	-	-	-	0.30	0.20	0.23	0.31
Cultural, emotional and spiritual values	-	-	-	-	-	-	-	-	0.62	0.31	0.27
Educational values	-	-	-	-	-	-	-	-	-	0.61	0.40
Healthcare, sports and outdoor recreation	-	-	-	-	-	-	-	-	-	-	0.62

CROSS-CORRELATION OF FES DEMAND

DEMAND	Biomass (material)	Biomass (Energy)	Game	Wild forest products	Watershed protection	Air quality regulation	C. Change mitigation	Habitat provision	Cultural values	Educational values	Outdoor recreation
Biomass (material)	1	-	-	-	-	-	-	-	-	-	-
Biomass (Energy)	0.62	1	-	-	-	-	-	-	-	-	-
Game	0.39	0.42	1	-	-	-	-	-	-	-	-
Wild forest products	0.29	0.34	0.39	1	-	-	-	-	-	-	-
Watershed protection	0.36	0.36	0.32	0.42	1	-	-	-	-	-	-
Air quality regulation	0.24	0.26	0.19	0.30	0.59	1	-	-	-	-	-
Climate change mitigation	0.28	0.27	0.20	0.26	0.52	0.75	1	-	-	-	-
Habitat for plants and animals	0.27	0.28	0.22	0.25	0.46	0.59	0.64	1	-	-	-
Cultural, emotional and spiritual values	0.23	0.28	0.25	0.40	0.41	0.48	0.42	0.49	1	-	-
Educational values	0.24	0.29	0.20	0.30	0.45	0.42	0.35	0.44	0.55	1	-
Healthcare, sports and outdoor recreation	0.27	0.31	0.22	0.37	0.41	0.44	0.38	0.42	0.51	0.64	1

RELATIVE INCOME GENERATED BY EACH FES CATEGORY



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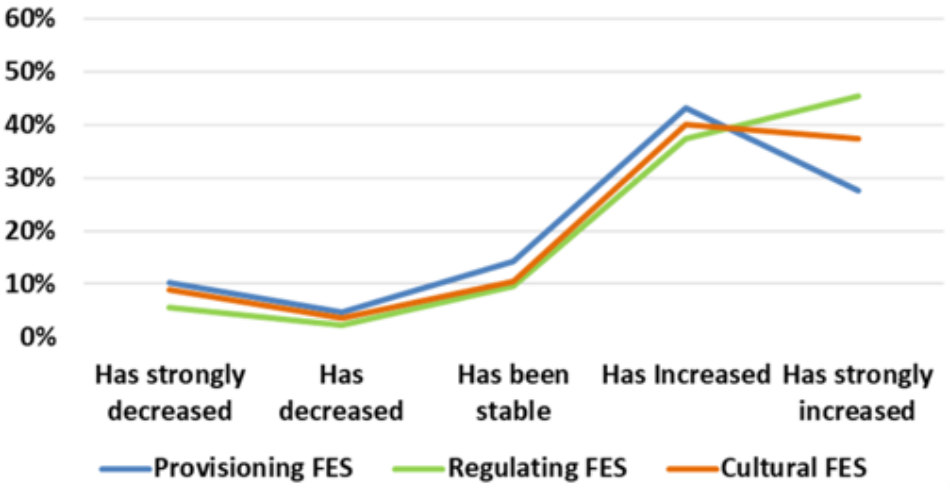
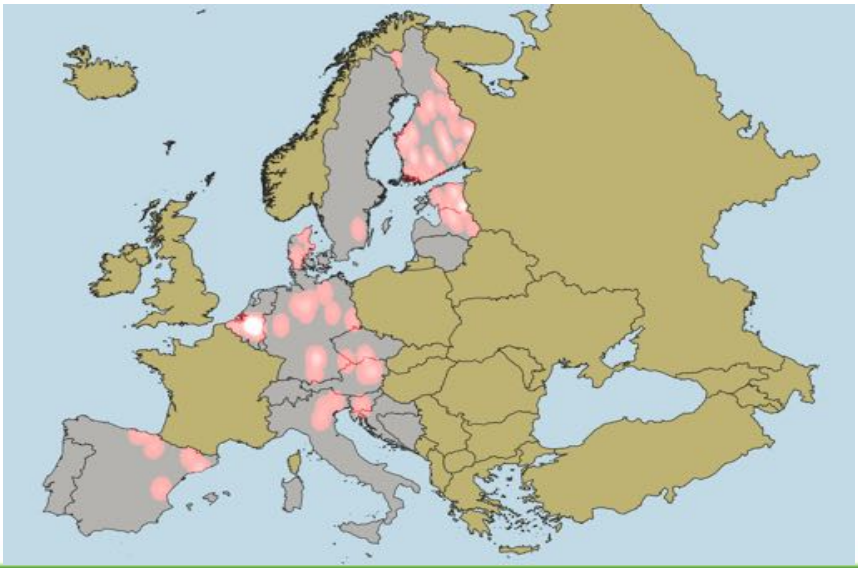
EVOLUTION OF SOCIETAL DEMAND FOR FES AS PERCEIVED BY EUROPEAN FOREST OWNERS AND MANAGERS



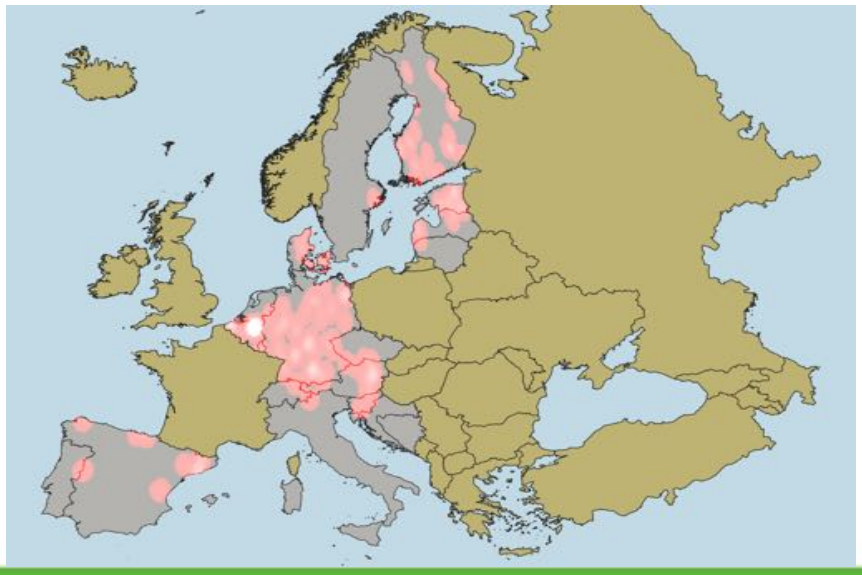
FOCUS AREAS FOR HABITAT FOR BIODIVERSITY IN EUROPEAN FORESTS

(SUPPLY < 60%; DEMAND > 40%)

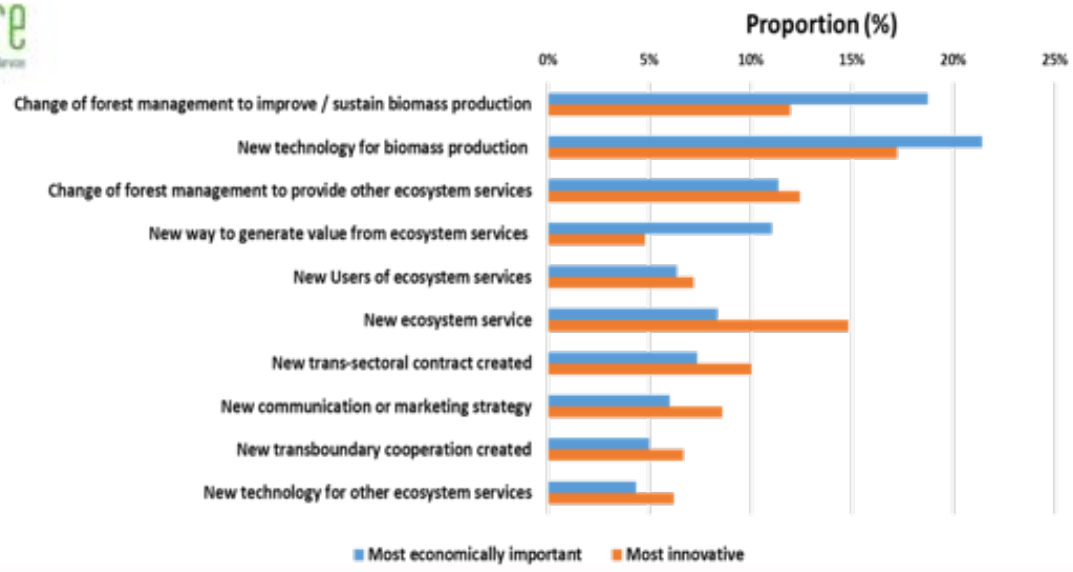


FOCUS AREAS FOR HEALTHCARE AND OUTDOOR ACTIVITIES IN EUROPEAN FORESTS

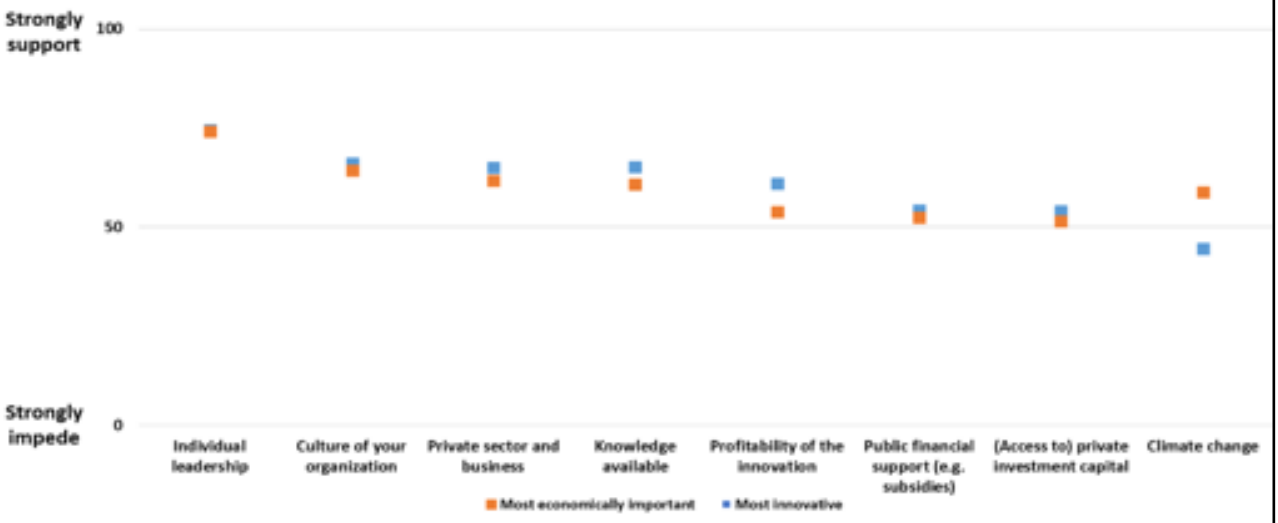
(SUPPLY < 60%; DEMAND > 40%)



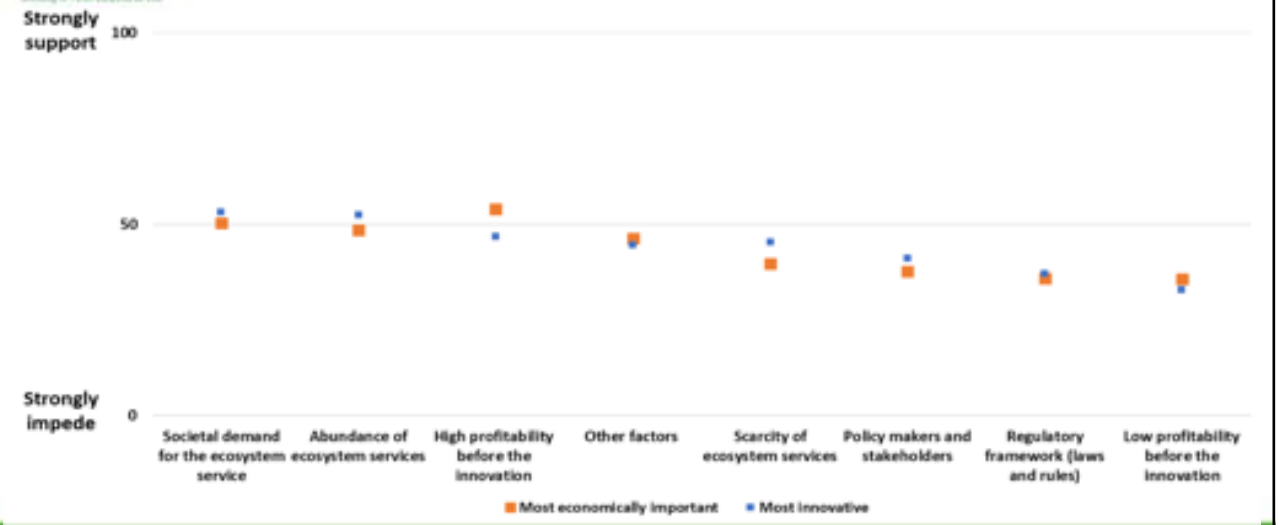
SHARE OF MOST ECONOMICALLY IMPORTANT AND MOST INNOVATIVE INNOVATIONS BY TYPE



ENABLING AND HINDERING FACTORS ON DEVELOPMENT OF MOST ECONOMIC AND RELEVANT INNOVATIONS IN EUROPEAN FORESTS



ENABLING AND HINDERING FACTORS ON DEVELOPMENT OF MOST ECONOMIC AND RELEVANT INNOVATIONS IN EUROPEAN FORESTS (CONTINUATION)



OTHER IM RELATED RESULTS

- No difference between sub-sample that has and has not IMs by country ($\chi 2$ (df=16, N=1706) = 20.882, p = 0.183)
- Significantly higher share of IMs is found for
  'Public ownership by the State at national level',
  'Public ownership by the State at sub-national (regional) level',
  'Private ownership by private business entity',
  'Private ownership by private institution (e.g. church, foundation, etc.)',
  'Managing the forest (but not owning it)'
  'Responsible for certain segments of forest management (e.g. reforestation or sale of wood) but not owning it'
- Significantly lower share of IMs found for
  'Private ownership by individual and family'
  'Owning and managing the forest'
- Forests with IMS have significantly higher supply and demand of FES (except for air quality regulation)
- Biggest difference in: supply of education-related FES (13.2), demand of education-related FES (10.6), supply of cultural, emotional and spiritual values (10.3), supply of healthcare, sports and outdoor recreation (10.1) and supply of biomass and wood for material use (9.9)

PRELIMINARY CONCLUSIONS

- Supply and demand of FES are perceived as rather high and synergistic. However, forest owners only benefit from provisioning services. Regulating and cultural FES seems to be on the rise, but there is a clear need of innovative mechanisms implementation.
- Supply and demand vary greatly depending on the local context. It seems therefore necessary to refine the spatial target prior any intervention to boost supply of any FES.
- Supply of FES seems to be enhanced by innovation. However, this innovation is perceived to be constrained by policy makers, stakeholders and regulatory frameworks

NEXT STEPS

- Make more inferential analysis
- Improve discussion and conclusions
- Extrapolate results for all European forests (Burkhard and Maes, 2017)

Section	Division	Class	Indicators
Provisioning	Materials	Biomass	stand level / tree species level: stocking volume (m^3 / ha); growth (m^3 / ha x a); yield (m^3 / ha x a) tree species composition protected area soil productivity precipitation long term mean temperature water shortage (Difference between precipitation and potential evapotranspiration) Accessibility (Travel time to cities > 50,000 inhabitants) Slope Soil bearing capacity (Share of soil types with no bearing capacity) Share of forest that is privately owned Population density (number of people per square kilometre)
Regulation & Maintenance	Maintenance of physical, chemical and biological conditions	Global climate regulation	GHG emissions / ha x a; above and belowground sequestered carbon; humus forms
Cultural	Spiritual, symbolic	Symbolic	abundance of rare species; number of above-average aged / thick single trees / breeding burrow trees, dead-wood stock (m^3 / ha)

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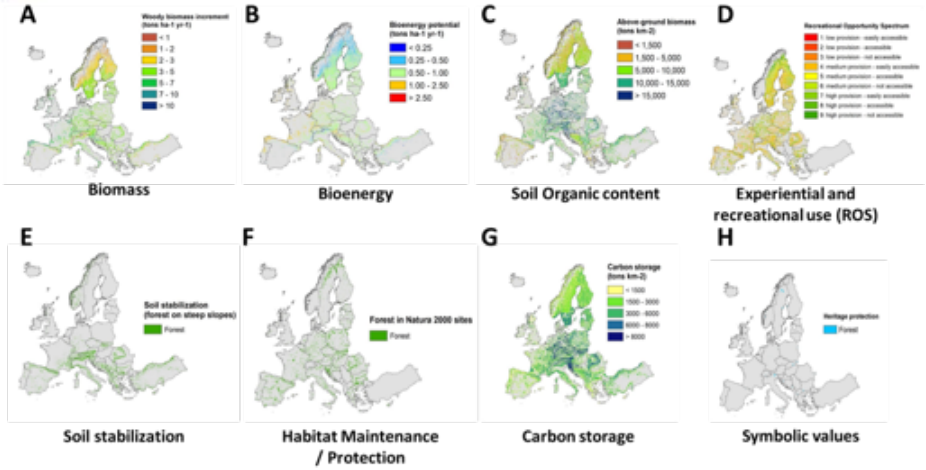
THANK YOU!

PAN-EUROPEAN MAPS OF FES SUPPLY (SEE PRIMMER ET AL., 2018 FOR MORE DETAILS)

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