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Forest management addressing trade-offs and synergies between multiple ecosystem services

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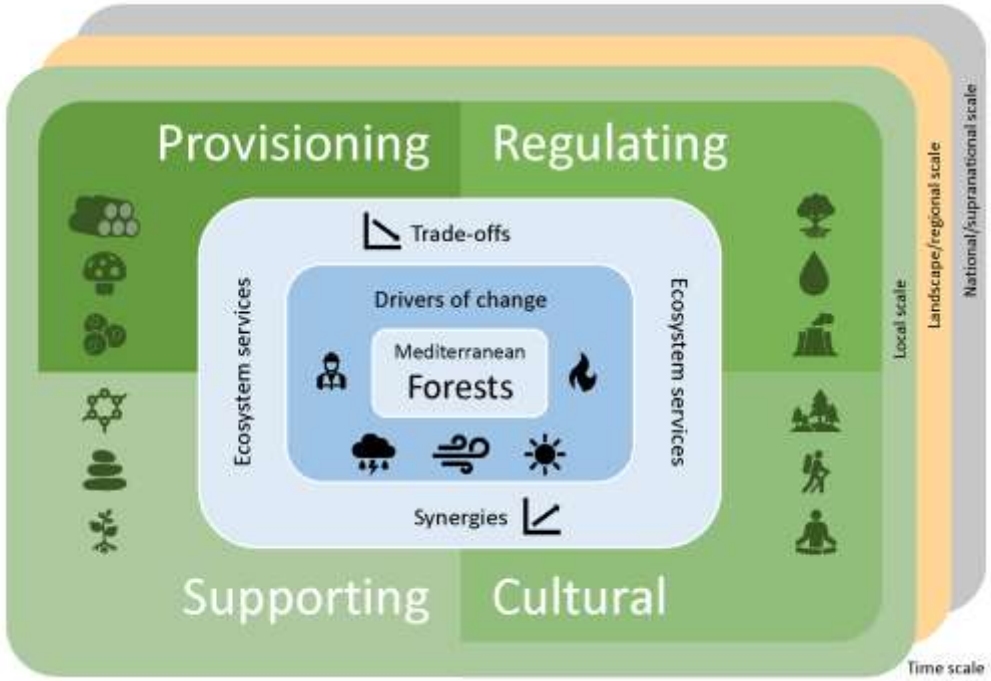
Introduction

Mediterranean forests are part of a landscape mosaic that reflects interactions between climate, geomorphological conditions, regional landforms and human influence

They provide multiple goods and benefits, which are crucial for the socio-economic development of rural areas, as well as for the well-being of the urban populations

The demand for ES is growing, but how to manage ecosystems for multiple services is still an open question



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FOREST MANAGEMENT (M WATT, SECTION EDITOR)

Managing Mediterranean Forests for Multiple Ecosystem Services: Research Progress and Knowledge Gaps

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Susanna Nocentini


Davide Travaglin


Bart Muys

We reviewed the scientific literature specifically dealing with forest management and multiple ES in Mediterranean forests

1) Outlining the progress in research in the last 10 years (2010-2020)

2) Identifying knowledge gaps and research needs

3) Discuss management approaches considering multiple ES

Scale of application

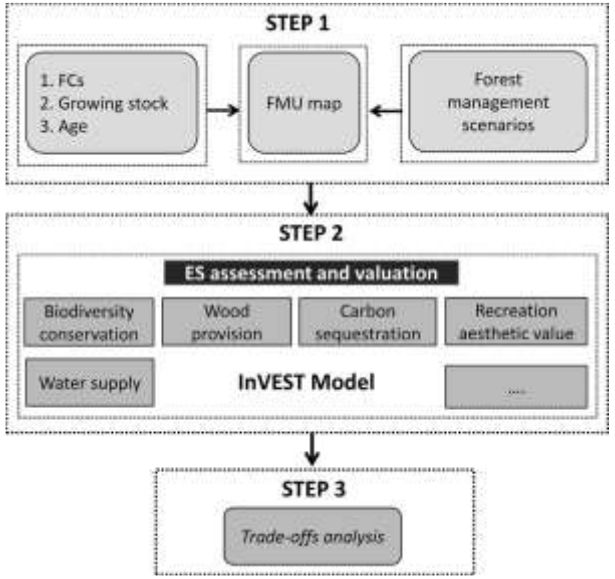
Stand / management unit level:

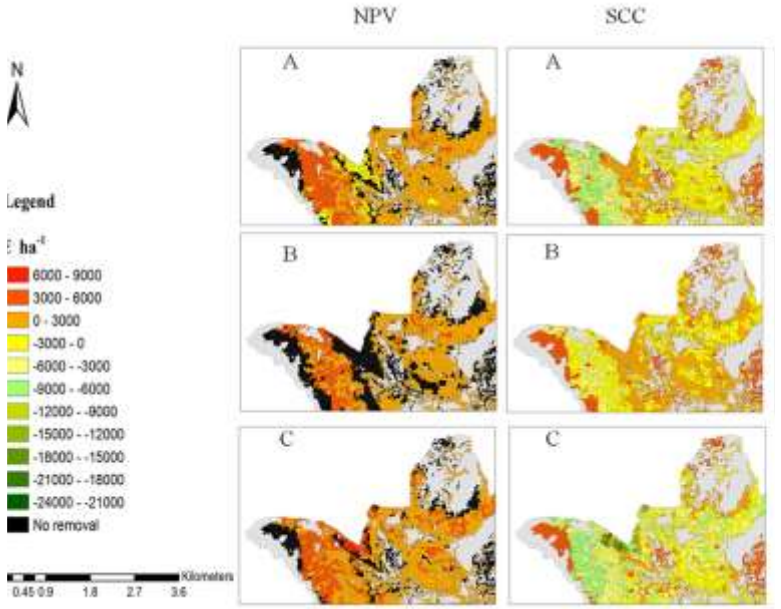
Process-oriented research based on field experiments is still at the beginning

Landscape / Regional scale:

Research based on spatially explicit data and modeling is showing substantial progress

→ growing ability in data processing and increasing availability of remote sensing data

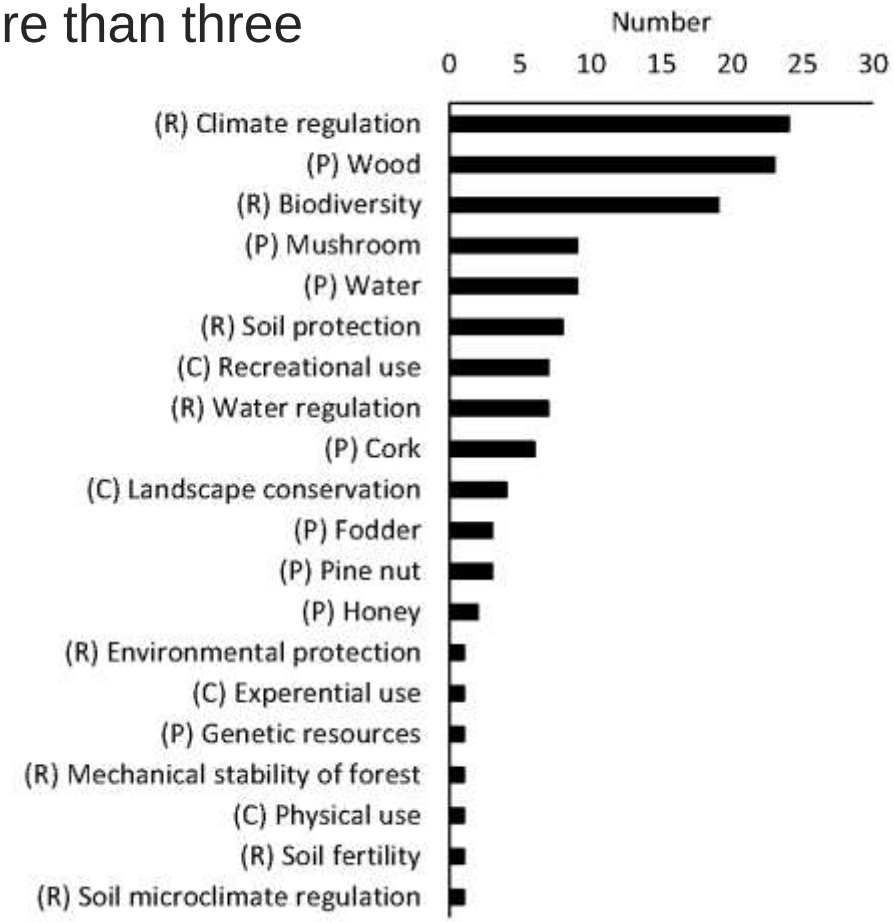




Considered ecosystem services

Most of the publications mentioned one, two, or three ES, rarely more than three

- Wood production
- Increasing attention on NWFP
- Climate regulation and biodiversity
- Increasing attention on specific aspects (e.g., lichen)
- Cultural services were less investigated



Approaches based on one or few ES

- More flexibility in accounting for drivers of change
- Only partial view of the multifunctional role of forest ecosystems

Approaches based on a wide range of ES

- Rely on heterogeneous data
- Data combination more complex and less robust

Drivers of change

The majority of the studies considered forest management as the only driver of change

The remaining studies considered no more than three drivers

- Forest management was combined with climate change and to a lesser extent with fire
- Few studies combined climate change and biodiversity with management

The impact of land abandonment on ES supply is still not fully understood




Modeling Approaches

Model name	Country	Scenario map	Scale	Time period (years)	Forest type	Ecosystem services			Drivers of change	Trade-offs and synergies
						Provisioning	Regulating	Cultural		
GOTILWA	Spain	No	MU	200	Pine, Evergreen oak	Wood production	Climate regulation Water use efficiency	Fire risk	Forest management Climate Change Soil	Trade-offs analysis
PICUS	Spain	No	L	120	Pine	Cone production Wood production	Climate regulation	n.c.	Forest management Climate change	No
SUBER	Portugal	No	L	90	Oak	Cork production	Climate regulation	n.c.	Forest management Climate Change	No
SADfLOR	Portugal	No	R	50	Oak	Cork production Wood production	Climate regulation	n.c.	Forest management	Trade-offs analysis
SORTIE-ND	Spain	No	L	99	Pine	Wood production Edible mushrooms production Water provisioning	Biodiversity Climate regulation Erosion control	n.c.	Forest management Climate change	Trade-offs and synergies analysis
LURE	France	Yes	L	200	Silver fir	Genetic resources	Biodiversity	n.c.	Forest management	No
-	Portugal	Yes	N	40	Different forest types	Water provisioning (water quality)	Erosion control	n.c.	Forest management	No
MIMOSE	Italy	Yes	R	20	Different forest types	Wood production	Climate regulation	n.c.	Forest management	Trade-offs analysis
TOOFES	Italy	Yes	MU	50-210	Silver fir	Wood production	Biodiversity Climate regulation	Recreational use	Forest management	Trade-offs analysis
										No
										Trade-offs and synergies analysis
									es	
						Wood production	Soil fertility Water regulation	Physical use Recreational use	Biodiversity variables	
EEFMD	Spain	Yes	R	90	Oak Pine	Water provisioning	Climate regulation	n.c.	Forest management Land abandonment	Trade-offs analysis
-	Tunisia	Yes	L	n.c.	Oak	Cork production Fodder production	Climate regulation Erosion control	n.c.	Forest management	No

- Spatial models provide ES maps that have many potential uses for decision-makers and planners
- Modeling complex forest dynamics is still a challenge for future research

Interactions between ES (trade-offs and synergies)

Synergy | Trade-off

ES Syn → / Trad ↓	Wood production	Cork production	Pine nuts	Edible mushrooms	Honey	Fresh water (Blue water)	Fodder	Carbon sequestration	Biodiversity	Water holding capacity	Provisioning services generic	Cultural services generic	Regulating services generic
Wood production	-			([63])* [88]+				[69]*	[69]* [71]** *** [70]				
Cork production	[77]*	-						[68]*	[25]+				
Pine nuts	[75]		-					[75]					
Edible mushrooms				-						[82]			
Honey	[81]°				-								
Fresh water (Blue water)		[68]*				-							
Fodder		[68]*					-						
Carbon sequestration	[75] [76]+++ [77]* [87]*** +++	[25]++				[83]++		-	[69]* [86]* +++ [88]+				
Biodiversity									-	[84]°			
Water holding capacity										-			
Provisioning services generic											-	[82]	
Cultural services generic											[82]	-	
Regulating services generic											[82]		-

Conclusions

Research is still mostly conceived following an ES-oriented approach

- Managing forests to create the structure and composition that best meet the desired output for humans
- Reduced ability of forest ecosystems to adapt to future unexpected changes

Consider Mediterranean forests as complex adaptive systems

- This implies an adaptable, flexible management and planning approach that sustains self-organization, adaptive capacity, and overall resilience of Mediterranean forests
- Promote functionally diverse forests and landscapes, which can act as insurance for the maintenance of key ecosystem functions (e.g., water conservation and regulation, carbon storage, resilience) against disturbances (fire, drought), and ecosystem productivity

Maintain traditional Mediterranean forest landscapes for their cultural and historical importance, but also because they can contribute to keeping more options open for adaptation to future changes

Human presence and involvement in Mediterranean forest landscapes is a safeguard against the negative consequences of rural abandonment

Research and policymakers should contribute to finding sustainable solutions for maintaining economically and environmentally viable livelihoods in these environments

Research on managing Mediterranean forests for multiple functions and benefits requires moving toward a transdisciplinary approach, where extended peer communities are involved

Webinar

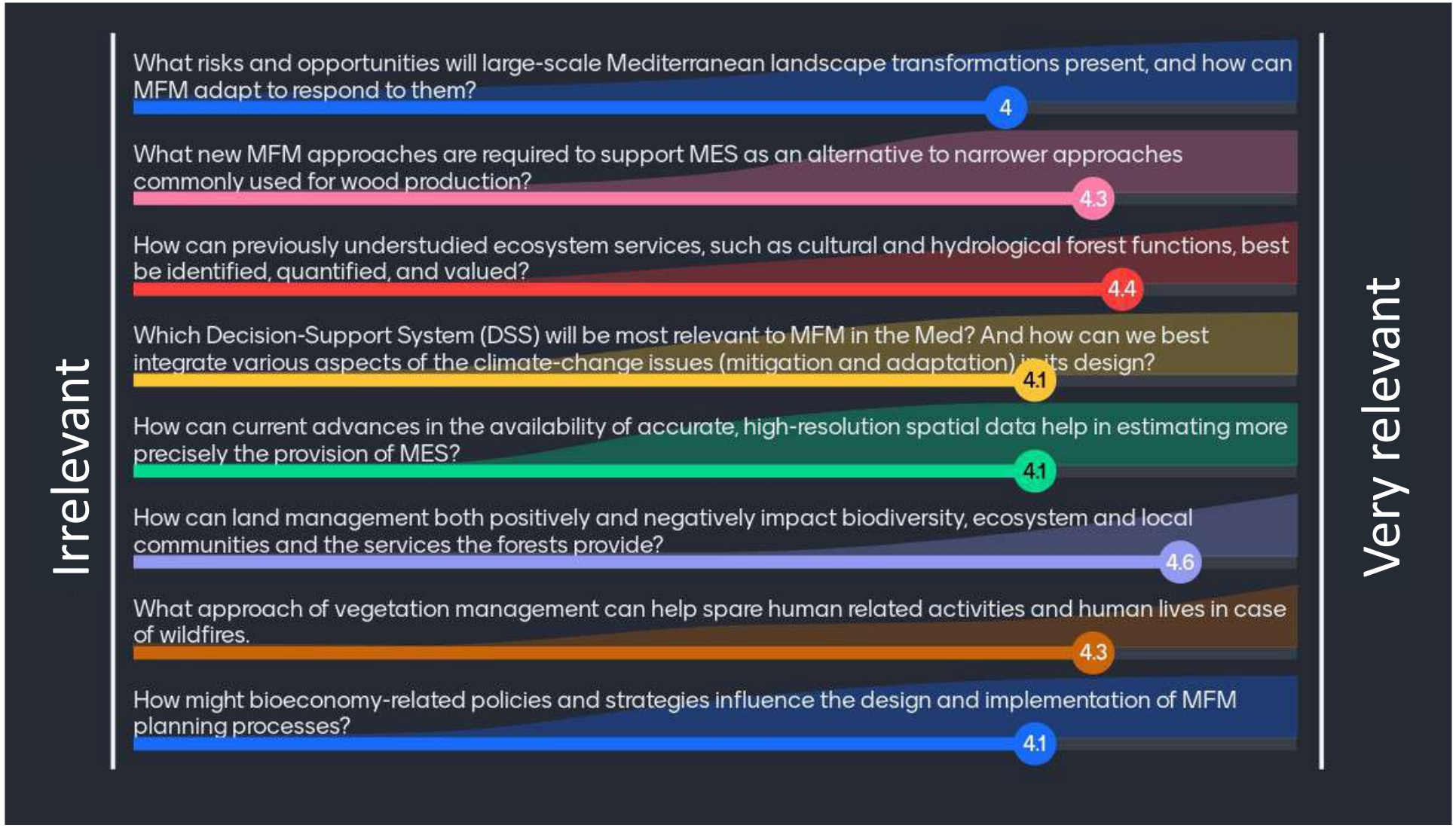
3 Nov 2022

42 participants

Key research questions identified

1	What risks and opportunities will large-scale Mediterranean landscape transformations present, and how can multifunctional forest management adapt to respond to them?
2	What new multifunctional forest management approaches are required to support multiple ecosystem services as an alternative to narrower approaches commonly used for wood production?
3	How can previously understudied ecosystem services, such as cultural and hydrological forest functions, best be identified, quantified, and valued?
4	Which DSS will be most relevant to multifunctional forest management in the Mediterranean? And how can we best integrate various aspects of the climate-change issues (mitigation and adaptation) in its design?
5	How can current advances in the availability of accurate, high-resolution spatial data help in estimating more precisely the provision of multiple ecosystem services?
6	How can land abandonment both positively and negatively impact biodiversity, ecosystems and local communities and the services that forests provide?
7	What approach of vegetation management can help spare human-related activities and human lives in case of wildfires?
8	How might bioeconomy-related policies and strategies influence the design and implementation of multifunctional forest-management planning processes?

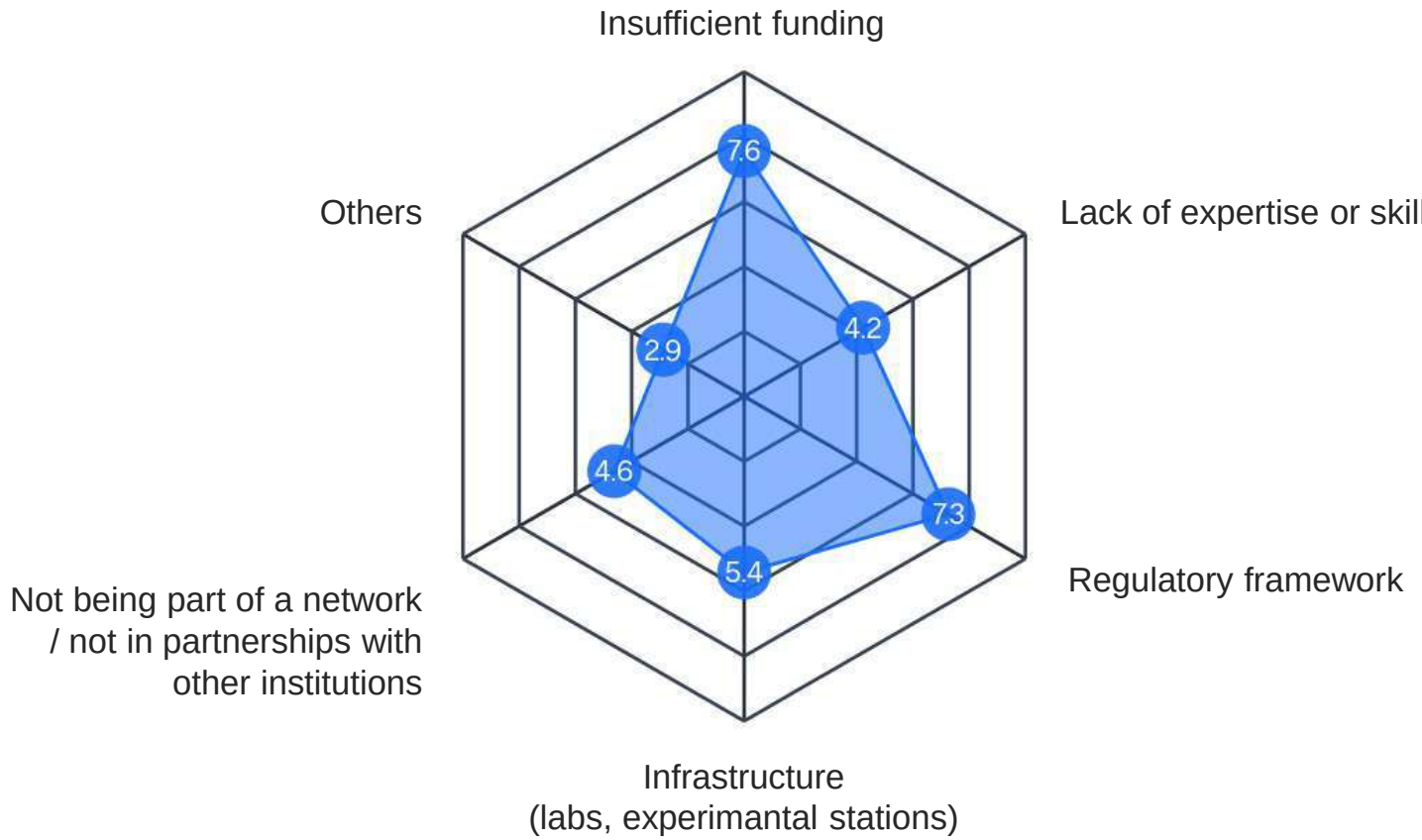
Please rate how relevant are the key research questions for your country



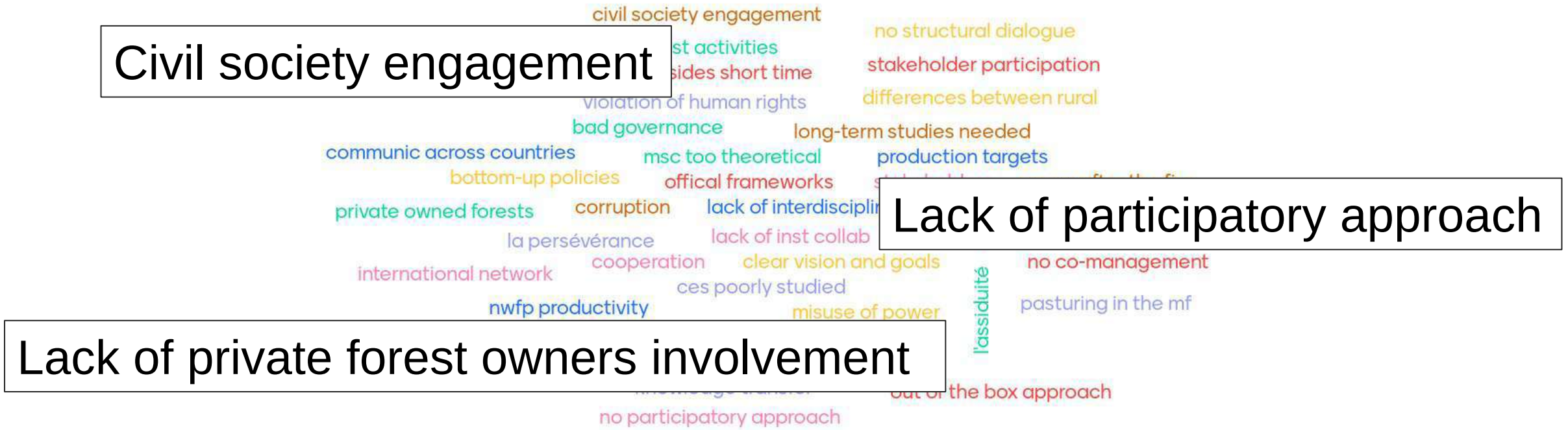
Suggested research approaches

1. Design innovative multi-objective forest management models for researchers and practitioners to help customise design and implementation of appropriate management prescriptions
2. Adopt an overall approach of vegetation / fuel load management at the landscape level beyond forest boundaries
3. Develop versatile DSS to i) address risks and uncertainties; ii) help achieve multi-faceted forest-management goals; and iii) analyse synergies and trade-offs between various ecosystem services, focusing on the water-fire-biodiversity nexus
4. Deploy DSS to develop management approaches that accommodate bioeconomic policies and strategies
5. Develop and implement management alternatives and multi-stakeholder engagement strategies (market, state, community) that will ensure sustainable production of multiple ecosystem services under climate change constraints
6. Explore to what extent do the public understand the importance of multiple ecosystem services and value them and how do these perceptions have impacts on public expectations and preferences among several forest landscape management approaches
7. Knowledge sharing and capacity building through training, coaching and skills transfer among Mediterranean institutions

The main challenges to implement the research proposed are:



What are the additional challenges to implement this work?



Civil society engagement

Lack of participatory approach

Lack of private forest owners involvement

Opportunities

- Increasing need for interactions of highly urbanised societies with nature for recreation, health and wellbeing
- The increasing integration of economic tools and approaches into nature conservation efforts

Challenges

- Managing forest ecosystems for multiple ecosystem services (functions and benefits) in the long term requires a transdisciplinary approach
- Absence of standardized Mediterranean forests inventories

Recommendations

Sustainable solutions for maintaining economically and environmentally viable livelihoods in traditional Mediterranean forest landscapes should respect cultural and historical importance, contribute to biodiversity conservation, and offer adaptive potential for future climate and other global changes (Muys et al., 2022)

Further research should pay greater attention to Southern and Eastern Mediterranean countries, where the multiple pathways of land abandonment are emerging

Mediterranean forest inventories should be expanded beyond forest production related indicators and be standardised to establish a spatial database, providing the necessary data for multifunctional forest-management planning

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Thanks for your attention

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