Bridging Science and Society: Socio-Ecological Approaches to Ecosystem Restoration in European and Mediterranean Regions

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Premise
The following extended abstract describes part of the research work developed within the Horizon Europe project RESTORE4Cs, aimed at investigating the social acceptability of coastal wetland restoration to enhance climate resilience. The contribution proposed to ERSA 2026 will complete this experience with preliminary results from MONALISA, another ongoing Horizon Europe project focused on nature-based strategies to combat soil degradation and desertification adopting socio-ecological approaches.

This contribution analyses the factors influencing the social acceptability of initiatives of land-use management and nature restoration in coastal wetlands, with particular reference to the implications for climate change mitigation and adaptation. Coastal wetlands can act as strategic carbon sinks while supporting biodiversity and the provision of other key ecosystem services. However, their ecological integrity must be preserved. Wetland restoration therefore represents not only a nature protection measure, but also a key strategy to safeguard ecological processes and to gain a deeper understanding of the interactions between land-use patterns, biophysical processes, socio-economic dynamics, and stakeholder perceptions. Given their potentially high impact on landscapes and local livelihoods, restoration interventions may encounter strong resistance from local communities. Despite the growing recognition of the crucial role of stakeholder involvement in the success of restoration initiatives, socio-economic and cultural dimensions remain insufficiently integrated into restoration planning. To address this gap, the paper presents the conceptualisation of an original framework for assessing the social acceptability of restoration options, and a preliminary application to the six European coastal wetlands identified within the Horizon Europe project RESTORE4Cs. In doing so, the paper contributes to a more holistic approach to environmental land management, promoting social acceptability assessment and restoration practices that are both socially inclusive and ecologically effective.

Keywords: *coastal wetlands, nature restoration, social acceptability, participatory processes, socio-ecological systems*

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1. Introduction

Climate change poses severe threats to natural ecosystems, including habitat destruction and fragmentation, biodiversity loss, alterations in species distributions and phenology, land degradation, changes in hydrological regimes, and eutrophication (IPCC, 2021). These threats are particularly evident in coastal wetlands, whose complex ecological equilibrium largely depends on water availability and quality, which is highly sensitive to climate variability and change. Consistent with the wide scale and complexity of the dynamics influencing these natural landscapes, a coordinated mobilisation effort is needed across multiple actors and territories (Moshofsky et al., 2019; IPBES, 2024). Accordingly, an increasing body of literature emphasises the urgency of participatory, integrated, and transdisciplinary strategies to enhance climate resilience in wetlands (Busse et al., 2019; Sella et al., 2024).

In line with the socio-ecological perspective proposed by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES, 2024), coastal wetlands can be conceived as adaptive ecological and cultural systems in which local actors, institutions, economic activities, fauna, flora, and habitats continuously interact over time (Gobster et al., 2007). Within this framework, land-use and land-management decisions play a crucial role in ensuring ecosystem conservation, but also in enabling coastal wetlands functionality as both carbon sinks and green infrastructures hosting a wide diversity of animal and plant species. Through this dual role, wetlands provide a wide range of ecosystem services and reinforce the climate resilience of the territories in which they are embedded (Gamborg et al., 2019; Garcia et al., 2020).

Within this background, the paper draws on the experience of the Horizon Europe project RESTORE4Cs (Restoration of wetlands for Carbon pathways, Climate Change mitigation and adaptation, ecosystem services, and biodiversity co-benefits - https://www.restore4cs.eu/), which conceptualises wetland management and restoration as a negotiation arena open to the participation of diverse stakeholder groups for the prioritisation and co-design of actions. Moving from six case pilots across Europe, RESTORE4Cs generates evidence-based knowledge to support EU policies for the restoration of coastal wetlands by analysing restoration impacts, developing decision-support tools, and fostering a community of practice. Central to this approach is the concept of social acceptability, which has gained increasing relevance over the last decade both in environmental land management—particularly in relation to large-scale restoration initiatives embedded in complex socio-ecological systems (Sella et al., 2024)—and in policy discourse (see, for instance, the recent EU Nature Restoration Law, Regulation EU 2024/1991).

Since restoration initiatives in coastal wetlands often entail significant changes in land use, landscapes, and local livelihoods, community perceptions and preferences—which jointly shape the social acceptability and feasibility of proposed restoration interventions (Sella et al., 2024)—may vary widely, ranging from strong commitment to open opposition (Gobster et al., 2007; Hill & Daniel, 2007). As a result, even technically sound and ecologically justified interventions may encounter resistance if local socio-economic and cultural dimensions are not sufficiently considered. At the same time, social acceptability should not be approached merely as a condition for consensus, but rather as a key analytical lens for understanding how restoration policies are interpreted, negotiated, and contested across different territories and communities (Sella et al., 2025). Consistently, the paper explores how local stakeholders position themselves with respect to restoration strategies, developing a critical discussion on the determinants of social acceptability and deriving preliminary indications to support decision-making in land-use planning and ecosystem restoration.

2. A mixed-method approach to assess the social acceptability of nature restoration

Besides being biodiversity hotspots, coastal wetlands perform crucial regulatory functions for climate, including carbon sequestration and storage, greenhouse gas regulation, microclimate moderation, hydrological regulation, and storm protection. However, coastal wetlands are fragile ecological habitats increasingly requiring restoration interventions to be ecologically healthy and to provide their services

effectively. This implies the need to control and contrast multiple sources of alteration (Gobster et al., 2007), both natural (such as droughts, extreme events, and invasive species) and anthropogenic (such as urbanisation, pollution, overtourism, and resource exploitation), which operate at different temporal and spatial scales. Moreover, restoration can be effectively addressed only through a strong assumption of responsibility and commitment by local communities, together with the implementation of participatory planning processes integrating ecological, socio-economic, and cultural dimensions (Reed et al., 2017; IUCN, 2020; MERN, 2018).

Unfortunately, coastal wetlands such as salt marshes, seagrass meadows, swamps, and bogs are neither among the most popular natural landscapes nor among the most widely appreciated, despite the diversity of services and co-benefits they provide. Accordingly, current scientific research and policy debates on wetland restoration—such as those associated with the European Nature Restoration Law—strongly emphasise the need for broader and more inclusive participation of local communities in coastal wetland decision-making and in the assessment of social acceptability.

From an operational perspective, assessing the social acceptability of land-use management decisions requires an integrated transdisciplinary approach capable of linking land-use patterns, biophysical processes, socio-economic dynamics, and stakeholder perceptions (Sella et al., 2023). Coastal wetlands are particularly suitable contexts for this type of analysis, as they concentrate, within environmentally sensitive areas, diverse and competing interests, including nature conservation and climate regulation, as well as agriculture, fisheries, breeding, harvesting, cultural consumption, and tourism. In this sense, social acceptability provides a conceptual and operational bridge between objectives of ecological protection and territorial development, supporting a context-sensitive approach to the feasibility and long-term sustainability of restoration actions.

Consistent with this framework, this section describes the methodology developed within the RESTORE4Cs project to assess the social acceptability of wetland restoration. The project, which concluded at the end of 2025, aimed to provide tools and methodologies to combine the analysis of the pressures and impacts affecting coastal wetland ecosystems with the assessment of the biophysical and socio-economic co-benefits of their restoration, applying a socio-ecological perspective. To this end, six coastal wetland areas in six European countries were identified as case pilots (CPs), including well-preserved, degraded, and restored plots in their area (Figure 1).

Overall, RESTORE4Cs also aimed to strengthen socio-economic evaluations in restoration contexts by providing a manageable approach to assessing the acceptability of restoration interventions by local communities. For this purpose, it developed an innovative combination of Multi-Criteria Analysis (MCA) and Social Acceptability Assessment (SAA) approaches, building on the socio-economic, environmental and socio-cultural analysis of the territorial contexts in which wetlands are embedded. More specifically, the dimensions of social acceptability used to analyse the six RESTORE4Cs wetlands were derived from the flower-shaped representation of the eight factors (or "petals") influencing the acceptability of nature-related policy decisions developed by the Ministère de l'Énergie et des Ressources naturelles (MERN, 2018). For details, see Sella et al. (2025).

Figure 1 - Coastal wetland case pilots (CPs) of RESTORE4Cs project. Source: https://www.restore4cs.eu/

Consistent with a citizen science approach, the framework proposed here integrates knowledge provided by scientific experts with stakeholders' perceptions and know-how (see Figure 2). Importantly, it also addresses, in a practical way, a challenge common to many participatory research projects, namely the need to reduce stakeholder fatigue. In many projects, groups of stakeholders are repeatedly asked to contribute through time-consuming interactions, such as participating in workshops or taking part in roundtables, living labs, and focus groups, to share opinions and preferences, transmit know-how, and co-design solutions. The approach proposed here streamlines these inputs, while maintaining analytical robustness:

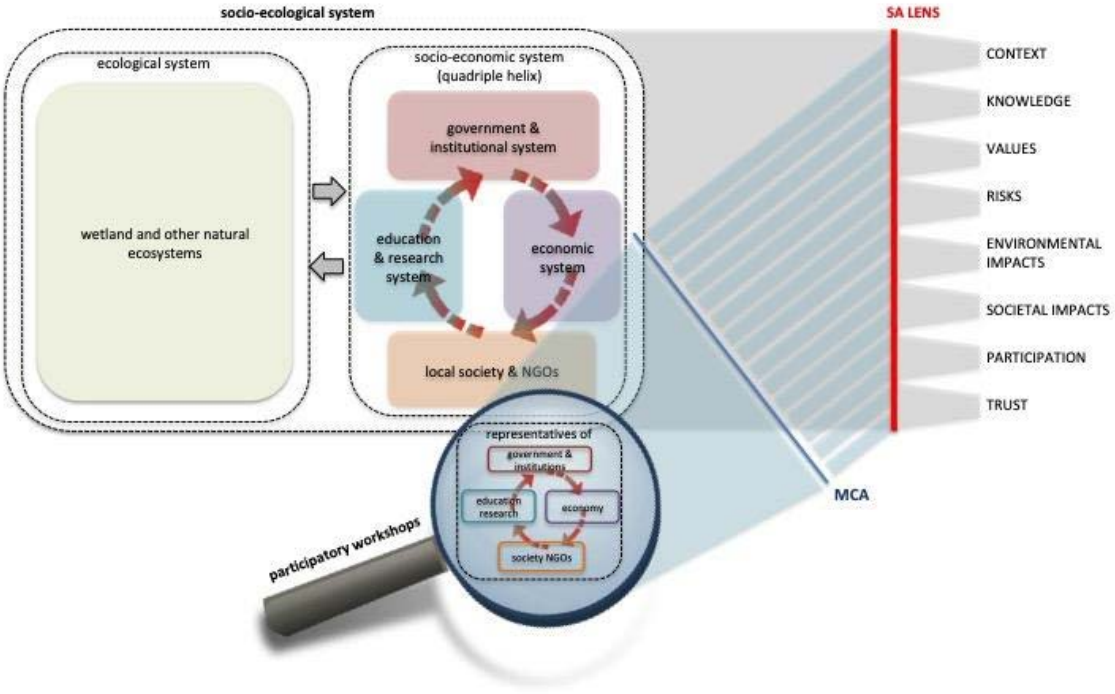
a) First, a three-level multi-criteria matrix containing the themes (level 1), categories (level 2), and criteria (level 3) relevant to wetland management was developed, based on the literature and on inputs provided by case pilot experts (Table 1). More specifically, an initial list of 50 criteria was identified through a socio-ecological reading of the literature, aimed at capturing in an integrated manner the cultural, ecological, and socio-economic dimensions.
b) Second, an MCA–SAA correspondence matrix was developed, assigning to each criterion the corresponding social acceptability petals, based on the literature and on experts' opinion.
c) Third, at the case pilot level, a short list of relevant criteria was extracted, and on-site MCA workshops were organised with local stakeholders to collect their preferences and prioritise criteria. In this phase, local stakeholders were asked to think about restoration in their specific site and to rank, on a scale from 1 to 9, first themes, then categories, and finally criteria. Via the MCA–SAA correspondence matrix, the criteria rankings were then translated into the prioritisation of social acceptability petals and visualised through Sankey diagrams.

Figure 2 offers a visual representation of the analytical framework based on a socio-ecological reading of wetlands and on the combined use of the MCA and SAA approaches.

Table 1 - The MCA selection matrix. Source: our elaboration

Level 1	Level 2	Level 3	Camargue 18	Curonian Lagoon 17	Danube Delta 16	Dutch Delta 18	Ria de Aveiro 32	Valencian Wetlands 22	Frequency of selection	TOTAL
Socio-economics	Socio-economic activities	Agriculture	x		x	x	x	x	5	47
		Livestock	x						1	
		Fishing	x	x	x	x	x		5	
		Hunting	x						1	
		Salt extraction					x		1	
		Water provisioning					x	x	2	
		Harbour activities	x						1	
		Industrial activities						x	1	
		Renewable energy production					x		1	
		Tourism / Recreational activities	x	x	x	x	x	x	6	
		Nature conservation	x						1	
	Employment	Jobs created or lost during restoration					x		1	
		Jobs created or lost following			x		x	x	3	
	Costs of the restoration project	Investment costs			x	x	x	x	4	
		Maintenance costs		x	x	x	x		4	
		Indirect costs on socio-economic					x		1	
	Costs of risk management	Flood control	x	x		x	x	x	5	
		Erosion / Runoff					x		1	
		Coastal protection/marine submersion				x	x	x	3	
Environment	Habitats	Spread and quality of habitats	x						1	41
		Aquatic habitats created/preserved or		x	x	x	x		4	
		Land habitats created/preserved or lost					x	x	2	
	Biodiversity	Species richness	x	x		x	x	x	5	
		Invasive alien species introduced		x	x		x		3	
		Pollinator species introduced					x		1	
	Climate	Global climate regulation	x	x	x	x	x	x	6	
		Sea level rise				x			1	
		Local climate regulation		x			x		2	
	Soil	Soil quality improvement					x		1	
		Salination	x						1	
	Water cycle	Water quality improvement	x	x	x	x	x		5	
		Water flow improvement / Hydrological	x	x	x	x		x	5	
		Groundwater recharge						x	1	
	Risk management	Air quality improvement					x	x	2	
		Noise pollution regulation							0	
		Fire prevention						x	1	
Socio-cultural	Cultural landscape and land uses	Land use - Cultural heritage	x						1	35
		Accessibility to public blue green areas			x	x		x	3	
		Cultural heritage		x		x	x	x	4	
	Values and beliefs	Aesthetic			x	x			2	
		Spiritual					x		1	
		Place attachment		x		x	x	x	4	
	Perceived risks and uncertainties	Disturbance during restoration					x		1	
		Disturbance following restoration			x				1	
	Health and well-being	Physical health influence	x	x			x		3	
		Mental health influence		x				x	2	
	Local awareness and knowledge	Scientific research	x	x	x			x	4	
		Education & recreative interest			x		x	x	3	
	Institutions and governance	Participation in decision making	x	x		x	x	x	5	
		Trust in institutions					x		1	

Figure 2 - The MCA-SAA analytical framework. Source: Sella et al., 2025, p. 27



As the elaboration of stakeholders' rankings is still under validation, the following section focuses exclusively on the representation of the most relevant social acceptability dimensions that emerge from the analysis of the selection matrix (Table 1).

3. Preliminary results from RESTORE4Cs coastal wetlands

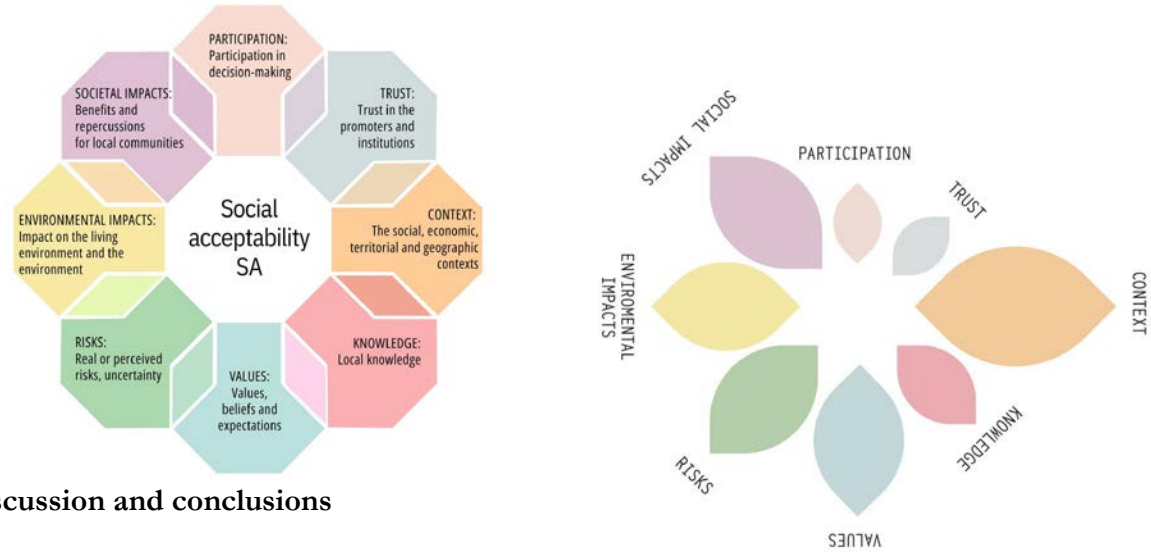
As clearly explained in MERN (2018), the social acceptability of a restoration intervention in coastal and other natural landscapes reflects the combined influence of contextual conditions, perceived risks and benefits, cultural values, trust in institutions, participation processes, and knowledge circulation. Social acceptability therefore emerges as a multidimensional construct that cannot be reduced to a single indicator of support or opposition.

The methodological approach adopted in this study builds on this understanding by integrating Multi-Criteria Analysis with a Social Acceptability Assessment framework and by jointly analysing expert-based evaluations and local stakeholder preferences. This combined approach is particularly suited to wetland restoration decisions, where trade-offs between ecological effectiveness, socio-economic impacts, and local knowledge and values play a key role and must be explicitly addressed, together with the unique contextual features that characterise each wetland region. Although they represent coastal wetland habitats, the six RESTORE4Cs case pilots present very different situations in terms of spatial extent, habitat types, pressures, management practices, and socio-ecological systems of reference.

The preliminary results of the MCA-SAA in Ria de Aveiro (Portugal), Marjal dels Moros (Spain), the South-West Dutch Delta (The Netherlands), the Danube Delta (Romania), the Curonian Lagoon (Lithuania), and Camargue (France) confirm this heterogeneity, providing a rich basis for comparative analysis. By translating the selection frequency of MCA criteria expressed by CP experts into a measure of the relative importance of the corresponding social acceptability petals (via the MCA-SAA correspondence matrix), the findings show how petals' relevance varies across contexts. For instance, in the Valencian wetlands (Marjal dels Moros site), the petal *Societal Impacts* emerges as the most important, followed by the *Context* petal. In Ria de Aveiro and in the Dutch Delta, the *Context* petal also accounts for a substantial share of the total preferences (over 20%), highlighting above all the importance of local socio-economic conditions in wetland decisions. Conversely, in Camargue, the petal most strongly emphasised in stakeholders' opinions is *Values*.

These differences in the MCA-SAA results underline the need for context-specific restoration strategies. At the same time, when considered collectively, they reveal a broadly aligned perception of the most valued dimensions. This reflects the fact that, in the MCA selection matrix, the criteria categorised under the Environment theme (Level 1) are selected more consistently across CPs than the socio-cultural ones. This pattern emerges clearly in the right panel of Figure 3, where the MERN symmetrical flower-shaped representation of the dimensions of social acceptability (left panel) is translated into a weighted diagram, where the size of each petal reflects the share of total preferences derived from experts' evaluations.

Figure 3 - The social acceptability flower of coastal wetland restoration. Left panel: the MERN model (source: adapted from MERN, 2025); right panel: the flower of RESTORE4Cs case pilots (source: Rota et al., 2025)



4. Discussion and conclusions

Overall, the findings confirm that integrating the assessment of social acceptability into environmental

management and restoration decision-making can enhance the analytical depth of the entire process while providing results of clear operational relevance. By combining Multi-Criteria Analysis and Social Acceptability Assessment techniques, and by explicitly accounting for socio-economic and socio-cultural dimensions alongside ecological criteria, the proposed framework supports more inclusive and context-sensitive decision-making. In line with the recent EU Nature Restoration Regulation, this approach also contributes to strengthening the legitimacy, feasibility, and long-term effectiveness of coastal wetland restoration, while offering a robust interpretative tool for analysing socio-ecological management across diverse territorial contexts.

While each wetland is characterised by specific ecological and socio-economic conditions, the comparative analysis highlights both recurring and context-dependent drivers of social acceptability. Across sites, environmental benefits and impacts on local economic activities tend to play a prominent role, whereas dimensions such as trust, participation, and local knowledge display greater variability and context sensitivity. This confirms that social acceptability is shaped by place-specific configurations rather than by universal patterns, reinforcing the need for territorially grounded restoration strategies.

By combining MCA and SAA, the approach provides both generalised and context-specific representations of stakeholders' priorities and demonstrates the importance of rebalancing socio-cultural factors alongside ecological and economic considerations in shaping the feasibility of restoration projects. The MCA–SAA approach also shows strong potential for bridging expert-driven assessments and local stakeholder perceptions into an integrated participatory framework. Its intuitive and replicable methodology provides clear outputs while reducing stakeholder fatigue. The comparative design allows for the identification of both common restoration priorities across sites and highly localised factors influencing social acceptability.

Certainly, some key challenges remain. First, the analysis of stakeholder data is ongoing and the method still requires validation, particularly with regard to the correspondence between MCA criteria and SAA petals. Second, issues of representativeness arise: even when stakeholder-based results are fully integrated with experts' assessments, the analysis relies on six pilot sites across Europe, raising questions about consistency and scalability. Third, the translation of MCA preferences into SAA rankings, together with the absence of covariates, may limit the depth of the analysis.

Despite these limitations, the approach fosters a transdisciplinary perspective aligned with the citizen science paradigm, enabling cooperation and mutual learning among scientists and stakeholders and promoting the co-production of knowledge between experts and non-experts. It also opens pathways for comparative analysis across European sites, informing both local strategies and broader policy frameworks.

References

Andrews, C., & Russo, A. (2022). Exploring the driving factors that influence the design, function, and use of urban wetlands in the United Kingdom. *Wetlands*, 42(7), 93. https://doi.org/10.1007/s13157-022-01610-1

Bosetti, V. (2021). Climate resilience and integrative frameworks.

Busse, M., Heitepriem, N., & Siebert, R. (2019). The acceptability of land pools for the sustainable revalorisation of wetland meadows in the Spreewald Region, Germany. *Sustainability*, 11(15), 4056. https://doi.org/10.3390/su11154056

Couix, N., & Gonzalo-Turpin, H. (2015). Towards a land management approach to ecological restoration to encourage stakeholder participation. *Land Use Policy*, 46, 155-162. https://doi.org/10.1016/j.landusepol.2015.01.025

Gamborg, C., Morsing, J., & Raulund-Rasmussen, K. (2019). Adjustive ecological restoration through stakeholder involvement: A case of riparian landscape restoration on privately owned land with public access. *Restoration Ecology*, 27(5), 1073-1083. https://doi.org/10.1111/rec.12955

Garcia, X., Benages-Albert, M., Buchecker, M., & Vall-Casas, P. (2020). River rehabilitation: Preference factors and public participation implications. *Journal of Environmental Planning and Management*, 63(9), 1528-1549. https://doi.org/10.1080/09640568.2019.1680353

Gobster, P. H., Nassauer, J. I., Daniel, T. C., & Fry, G. (2007). The shared landscape: What does aesthetics have to do with ecology? *Landscape Ecology*, 22(7), 959-972. https://doi.org/10.1007/s10980-007-9110-x

Hill, D., & Daniel, T. C. (2007). Foundations for an ecological aesthetic: Can information alter landscape preferences? *Society & Natural Resources*, 21(1), 34-49. https://doi.org/10.1080/08941920701655700

IPBES (2024). Thematic Assessment Report on the Underlying Causes of Biodiversity Loss and the Determinants

of Transformative Change and Options for Achieving the 2050 Vision for Biodiversity of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. O'Brien, K., Garibaldi, L., and Agrawal, A. (eds.). IPBES Secretariat, Bonn. DOI: https://doi.org/10.5281/zenodo.11382215

IPCC (2021). *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge.

MERN (2025). *Factors influencing social acceptability*. MERN, Québec. https://cdn-contenu.quebec.ca/cdn-contenu/adm/min/energie-ressources-naturelles/publications-adm/acceptabilite-sociale/AS-Aide-memoire_facteurs-Influence-en.pdf

Morton, L. W., Regen, E., Engle, D. M., Miller, J. R., & Harr, R. N. (2010). Perceptions of landowners concerning conservation, grazing, fire, and eastern redcedar management in tallgrass prairie. Ra*ngeland Ecology & Management*, 63(6), 645-654. https://doi.org/10.2111/REM-D-09-00041.1

Moshofsky, M., Gilani, R., & Kozak, R. A. (2019). Adapting forest ecosystems to climate change by identifying the range of acceptable human interventions in western Canada. *Canadian Journal of Forest Research*, 49.

Rota F.S., Sella, L., & Vivaldo, G. (2025). *Social acceptability: The key ingredient for enhanced coastal wetland restoration*. Policy brief. RESTORE4Cs project. https://www.restore4cs.eu/wp-content/uploads/2025/12/EN_Policy-Brief-7-v5-Final.pdf

Sella, L., Rota, F.S., Pollo, N. (2024). *How to measure the social acceptability of alternative environmental management solutions in wetlands and other ecosystems*, CNR-IRCrES Working Paper, 1/2024, IRCrES Torino. https://dx.doi.org/10.23760/2421-7158.2024.001

Sella, L., Rota, F.S., Pollo, N., & Giuca, R.C. (2025). Understanding social acceptability in coastal wetland restoration. A socio-ecological perspective of the Danube Delta Biosphere Reserve. *Central European Journal of Geography and Sustainable Development*, 7(2), 23-43. https://doi.org/10.51865/CEJGSD.2025.7.2.3

Shindler, B. A. (2000). Landscape-level management: It's all about context. *Journal of Forestry*, 98(12), 10-14.

Shindler, B. A., Brunson, M., & Stankey, G. H. (2002). *Social acceptability of forest conditions and management practices: A problem analysis*. General Technical Report PNW, 537. USDA Forest Service.

Stankey, G. H., & Shindler, B. (2006). Formation of social acceptability judgments and their implications for management of rare and little-known species. *Conservation Biology*, 20(1), 28-37. https://doi.org/10.1111/j.1523-1739.2005.00298.x