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TRANSNATIONAL STRATEGY

ON THE SUSTAINABLE MANAGEMENT & RESPONSIBLE USE OF NON-NATIVE TREES IN THE ALPINE SPACE

PREPARED BY

Katharina Lapin, Anja Bindewald, Guiseppe Brundu, Martin Braun, Aleksander Marinšek, Debojyoti Chakraborty, Janine Oettel, Heino Konrad, Nicola La Porta, Ajša Alagić, Frédéric Berger, Patricia Detry, Peter Brang, Dimitry Schepaschenko, Florian Kraxner, Reneema Hazarika, Thomas Wohlgemuth

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Authors of the text:
Katharina Lapin[1*], Anja Bindewald[2], Guiseppe Brundu[3], Martin Braun[1], Aleksander Marinšek[4], Debojyoti Chakraborty[1], Janine Oettel[1], Heino Konrad[1], Nicola La Porta[5], Ajša Alagić[4], Frédéric Berger[6], Patricia Detry[7], Peter Brang[8], Dimitry Schepaschenko[9], Florian Kraxner[9], Reneema Hazarika[1], Thomas Wohlgemuth[8]

[1] Austrian Federal Research Centre for Forests, Natural Hazards and Landscape, Seckendorff-Gudent-Weg 8, 1131 Vienna, Austria
[2] Forest Research Institute Baden-Württemberg, Wonnhaldestraße 4, 79100 Freiburg im Breisgau, Germany
[3] Department of Agricultural Sciences, University of Sassari, Italy
[4] Slovenian Forestry Institute, Večna pot 2, 1000 Ljubljana
[5] Research and Innovation Centre, Fondazione Edmund Mach, San Michele a/A (Trento), Italy
[6] INRAE, Research Unit LESSEM, 2 rue de la papeteire, 38402 Saint Martin d'Hères, France
[7] Centre For Studies and Expertise on Risks, Environment, Mobility, Urban and Country Planning (Cerema), Bron, France
[8] Swiss Federal Institute of Forest, Snow and Landscape Research WSL, Zürcherstrasse 101, 8903 Birmensdorf
[9] International Institute for Applied Systems Analysis (IIASA), Schlossplatz 1, 2361 Laxenburg, Austria

*corresponding author: katharina.lapin@bfw.gv.at

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Katharina Lapin

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Summary

Tree species whose regional occurrence is the result of human activity through intentional or unintentional introduction are commonly denoted as non-native trees. Non-native trees have long been a part of the Alpine Space, providing numerous benefits, but also posing a potential threat to native biodiversity and related ecosystem services. Compared to the urban space where non-native trees comprise most tree species, the number of non-native trees in forests and plantations is relatively low in the Alpine Space.

Given the already visible and predicted future impacts of climate change on forests and the urban space, non-native tree species will likely increase in importance because they might be better adapted to future climatic conditions. To anticipate potential risks and strengthen the benefits of non-native tree use in the Alpine Space, a transnational strategy for the sustainable and responsible use and management of non-native trees is needed.

The goals of the strategy are to ensure sustainable and responsible management practices that include non-native trees, to reduce the risks connected with the invasive potential of some non-native tree species, to help forests and urban areas to adapt to climate change, and to improve coordination and cooperation regarding best practices between different regions of the Alpine Space. We propose a transnational strategy on the sustainable management and responsible use of non-native trees in the Alpine Space which is anticipating strong collaboration among a diverse set of stakeholders, robust governance and an adequate long-term and fair funding scheme.

1. Background

The Alpine Space spans across an extensive region (390.000 km²) of several European countries (Austria, Germany, Italy, Slovenia, Liechtenstein, France and Switzerland), covering a mosaic of landscapes (Grêt-Regamey et al. 2008, Tattoni et al. 2017) (Fig. 1). Likewise, some of the most important European metropolitan areas with over 70 million inhabitants are located in this region. Almost two thirds of the plants on the European continent are present in four biogeographic regions (Continental, Alpine, Mediterranean and Pannonian Region) crossing the Alpine Space (Sundseth 2009). The Alpine Space is one of the most responsive Hot-Spots for climate change and is among the richest areas in Europe in terms of biodiversity in many sensitive ecosystems (EEA 2020). It will likely face more severe consequences of both climate change and the biodiversity crisis than other parts of Europe, as climate warming is advancing at faster rates than the average warming of the northern hemisphere (Rebetez and Reinhard 2008, IPBES 2020). On the one hand, trees in urban, peri-urban and forest ecosystems are widely discussed and promoted as nature-based solutions for climate change mitigation in the Alpine Space. On the other hand, trees increasingly face challenging growth conditions under climate change: inter alia droughts, high temperatures, floods, storms, wildfires, seasonal shifts in precipitation, and other extreme weather conditions limiting the growth and vitality of native tree species and entire forests in the Alpine Space (Brang et al. 2013). Already visible and future impacts of climate change therefore represent a major challenge for urban planners as well as forest and conservation managers who aim to sustain a wide range of ecosystem services, such as wood production, biodiversity protection, or local heat control. Against this background, management approaches to promote resilience are urgently needed to adapt ecosystems so that they are able to cope with disturbances and to become resilient to climate change.

The use of non-native trees (hereafter: NNT), i.e. tree species, breeds or hybrids in the Alpine Space whose presence is the result of human activity through intentional (e.g. assisted migration) or accidental introduction (Isaac-Renton et al. 2014), are considered one important climate change mitigation strategy (Brang et al. 2016, Krumm and Vítková 2016, Rigling et al. 2016). In addition to climate change mitigation, NNT can enhance ecological and cultural ecosystem services, for example, they may provide habitats for native species, reduce soil erosion and contribute to other protective functions of forests, or they are grown as ornamentals in arboreta, parks and urban green spaces (Schilthuizen et al. 2016, Vaz et al. 2018, Bouget et al. 2021, Castro-Díez et al. 2021, Wohlgemuth et al. 2021).

In the last decades the number of NNT in planted forests has increased worldwide (Brus et al. 2019, Brundu et al. 2020). However, the number of NNT in forests or forest plantations of the Alpine Space remains relatively low. Although 526 NNT were identified in total in the Alpine Space in the year 2021, the majority (67%) are currently cultivated exclusively in urban forests and green city areas, where they are important components of the green infrastructure. Most of the reported NNT in the Alpine Space (90%) have their

natural distribution range outside of Europe, especially in Asia and in North America (Müller-Meißner and Bindewald 2021).

While using NNT has potential benefits, their large-scale cultivation can nevertheless entail risks for biodiversity and ecosystem functioning (Wohlgemuth et al. 2021). For example, NNT may threaten native species and habitats when spreading from cultivated to (semi-)natural sites, or they may hybridize with native tree species or cause outbreaks of (new) pests and pathogens (Bolte et al. 2009), especially when they have congeneric native species in the Alpine Space (Brunet et al. 2013). As a result, controversial views on the continued use of some NNT in the Alpine Space exist, highlighting the need for a careful and consistent assessment of risks and benefits involving various stakeholders.

The major drivers for the use of NNT in planted forests are the economic, social and ecological benefits associated with their often better growth performance and pest/disease resistance compared to native tree species, increasingly when considering the potential impacts of climate change (Hanewinkel and Knook 2016, Thurm et al. 2018, Pötzelsberger et al. 2020b). Yet, some NNT are regarded as or are legally classified as invasive, meaning they pose potential or real risks to native biodiversity, ecosystem functioning or socio-economy, including human health (Haysom and Murphy 2004, Richardson and Rejmánek 2011, Pötzelsberger et al. 2020a). Mitigating the risks of invasive trees has therefore become a major global challenge for the protection of biodiversity and ecosystem services.

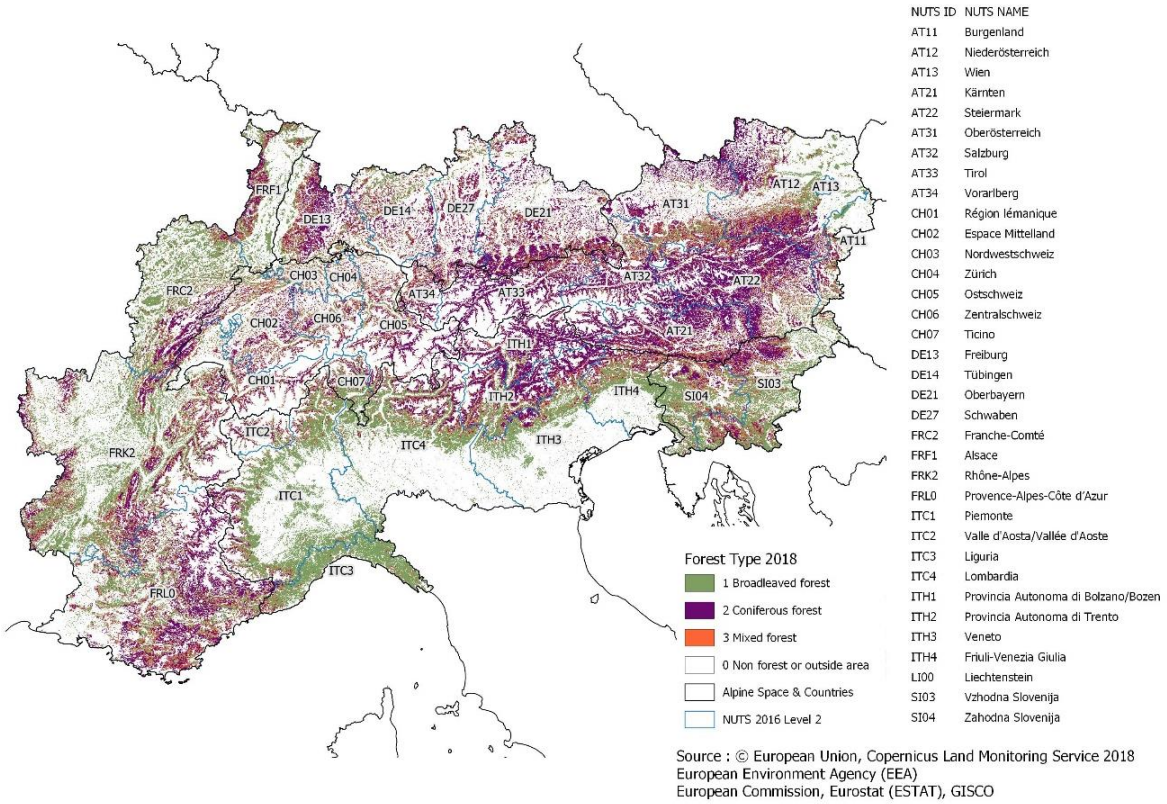

Figure 1 | Map of the forest cover by forest type (broadleaved, coniferous, and mixed forest) in the Alpine Space by NUT3 level.

2.Objectives

The overall objective of the presented transnational strategy is to improve knowledge-based decision-making and communication on the responsible use and management of NNT in the Alpine Space. The responsible use of NNT implies that the potential risks on biodiversity and related ecosystem services as well as cultural resources of forests and urban areas are minimized, and the potential benefits, including climate adaptation and mitigation, are maximized. The strategy aims to help national, regional, and local policymakers, forest owners, public authorities, urban planners, regional agencies and NGOs to unify their governance strategies and to enable all citizens to participate actively in the development and implementation of transnational policies on NNT. The strategy will improve coordination and thus a roadmap can be established for the implementation of specific, achievable, and targeted actions facilitated by broad collaboration and an agreed implementation plan. This strategy is underpinned by three key principles:

1. *Knowledge is freely sought and shared:* Access to the latest scientific results and technical experiences on the ecology, site-specific invasive potential, impact on human health, usage value, and management of NNT is seen as the basis for decision making.

2. *Legislation, ownership, and individual rights are respected*: Any action should be based on the knowledge of the legislative frameworks underlying the regulation of the introduction, use and management of NNT. Public as well as private ownership of forests or green infrastructure is linked to duties and rights in the framework of the implemented legislation. Decisions within this legal framework need to be respected. Implementation of the strategic goals shall be supported by an open dialogue and mutual respect for individual decision-making.

3. *Communication and decisions are evidence-based*: Any regulative decision related to the use or management of NNT should be evidence-based and follow the analysis of quantitative data to ensure reliability and transparency. Clear communication should therefore be practiced when sharing scientific studies and results of risk assessments with policymakers and other stakeholders involved, such as practitioners and the public.

3.The Methodological Framework

First, stakeholders from the sectors of forest management and wood processing, nature conservation and urban, peri-urban and rural planning were involved in the development of the strategy and policy implementation plan, through the participation in a transnational conference as well as through stakeholder workshops in their respective local languages at multiple stages of the project. Existing conflicts concerning NNT species were identified in collaboration with NGOs, international organisations and public authorities from the conservation and forestry sectors during these activities.

Second, data on the occurrence, management, use, and ecosystem services of NNT were gathered to provide an overview of the status-quo in forests and urban areas. This step included the collection of species-specific information on the ecology, growth, and potential risks of existing NNT in the Alpine Space as well as an overview of the current policy approaches.

Third, a consortium of scientists working in the Alpine Space conducted an expert-based assessment of the collated information and developed the first draft of the Strategy. Fourth, a public consultation was conducted from the 1st of September 2021 to the 15th of October 2021 via the EU online survey management system for public consultations (EU Survey). National, regional, and local policymakers and owners, public authorities, urban planners, regional agencies and NGOs as well as citizens of the Alpine Space were invited to participate in the public consultation of the strategy document. We implemented the responses (n=40) in development of the strategy.

Fifth, the consortium of scientists responded to the comments gathered systematically in the public consultation and provided the final version of the Strategy document.

4. GOALS AND RECOMMENDATIONS

1. Achieving sustainability
2. Reduce the risk of escape and other threats
3. Improve resilience of forest and urban trees to climate change
4. Improve cooperation, capacity building, and expertise sharing
5. Increased communication, citizens' awareness and involvement

GOAL 1 ACHIEVING SUSTAINABILITY

On the one hand, NNT can support sustainable development of the Alpine Space, in particular when regarded through the framework of "The UN Sustainable Development Goals (SDGs)" targets 13, 15, and 17. Many NNT are valued for their provision of ecosystem services in urban areas and for increasing the option for climate change adaptation and carbon sequestration in areas of the Alpine Space´s forest where native trees, on certain sites and in certain regions, are already at risk. Conversely, invasive NNT can severely detract from nature conservation goals, economic activities, livelihoods, food security, and human health and well-being, and thus bear the risk of undermining progress towards achieving 10 of the 17 SDGs.

This goal implies that sustainable management of NNT follow several steps, including identification of suitable NNT and the risks associated with them, the regionally produced supply of reproductive plant material for the forest and the horticultural sector, as well as their long-term maintenance. Therefore, increased and in particular site-specific research is urgently needed to investigate characteristic responses of NNT to climate change, including risks and benefits in different regions across the Alpine Space.

Recommendations

○ Promote or prefer native tree species whenever possible.
○ Evaluate potential benefits and risks of each NNT in the Alpine Space in respect to ecosystem services (e.g. protective forests) and disservices provided or jeopardized by that species.
○ Promote and facilitate discussions and information sharing between public authorities, regional agencies, NGOs, timber industry and forest owners.
○ Support collection, breeding, propagation and local production of forest and horticultural plant material for diverse NNT and native species.
○ Evaluate NNT in urban environments that pose no risk to human health, whose spread can be controlled with minimal effort, and whose inclusion diversifies the portfolio for tree species selection.
○ Evaluate the use of those NNT in forests that currently pose no risk (of becoming invasive) in the area of interest, or where any risks can be easily mitigated or eliminated by management measures.

GOAL 2 REDUCE THE RISK OF ESCAPE AND OTHER THREATS

Invasive NNT threaten the protection, conservation and ecological connectivity of Alpine Space ecosystems as well as the sustainability of their services. The risk of a NNT becoming invasive can be defined as the likelihood and magnitude of negative impacts associated with its introduction, establishment, and spread. More specifically, the risk reflects the possibility that NNT will outcompete native species, hybridize with native congeneric species, change ecosystem functions, introduce or facilitate the establishment of new pathogens and pests, and cause allergies or other negative impacts to humans or human activities. Whether a NNT escapes from the planting site and becomes invasive depends not solely on tree species specific characteristics and ecological behaviour, but also on local site conditions and silvicultural management practices, as well as plantation size and density. Therefore, the potential invasiveness of a given NNT can significantly vary between regions and ecosystems of the Alpine Space and change over time.

Anticipation of the risks posed by NNT is an important goal of the strategy. This can be achieved by creating, sharing and updating knowledge on the risks and management options of NNT with the various stakeholders from the Alpine Space, while also considering knowledge and expertise from external territories. In order to be able to assess the risks associated with the use of NNT, regional data is needed on their extent and distribution, regeneration dynamics, dispersal distances, potential impacts in different ecosystem types, experiences with removal and eradication efforts, as well as the information on the cost-efficiency of risk management and habitat restoration measures (Bindewald et al. n.d.). Regardless of the positive or negative influences of NNT, the preparation of any measures must be based on knowledge about their site-specific appearance and behaviour. Explicit monitoring of NNT in forest inventories and their addition to a respective database, as well as harmonization and dissemination of information obtained through regional and international projects, will be very helpful for achieving this goal.

Recommendations

○ Use of Site-Specific Risk Assessment which can be defined as a structured assessment of risks posed by NNT species, distinguishing between location, habitat or ecosystem type.
○ Do not introduce and promote new tree species in the Alpine Space until a pre-entry risk assessment has been performed.
○ Clearly communicate the results of the Site-Specific Risk Assessment with policymakers, practitioners, and public users.
○ Promote tree diversity in planting sites, including the genetic breeding of native tree species, and those NNT of which the knowledge and/or experience of have shown that all risks can be controlled, and effective mitigation measures are in place.
○ Explore new methods to improve the rapid and species-specific response for identifying and potentially eradicating high-risk NNT.
○ Develop general and species-specific management plans to ensure a coordinated multilateral approach across sectors and the general public.
○ Improve data availability on NNT occurrence and their growth characteristics, through continuous monitoring, for example by explicit inclusion in national or regional forest inventories.

GOAL 3 IMPROVE RESILIENCE OF FOREST & URBAN TREES TO CLIMATE CHANGE

The goal is to improve the possibility of climate change adaptation by increasing tree species richness - both at the inter- and intra-specific diversity level. Where reasonable, climate adaptation and mitigation strategies may include NNT with low risk of invasiveness in regional species portfolios to increase the resilience in both, urban and forest areas. Particularly when selecting NNT for urban areas, better knowledge is required for choosing optimal provenances or genotypes adapted to anticipated climate conditions.

However, to strengthen the resilience of green infrastructure to climate change, three approaches are important, which may be applied simultaneously: The first approach involves utilizing new provenances and genotypes of the same native species (assisted gene flow) and tree density reductions; the second approach employs the translocation at a regional level of additional native tree species and species mixtures better adapted to climate change (Chakraborty et al. 2019). If the first and second approaches do not seem sufficient to support the resilience to climate change, NNT may be planted to sustain important ecosystem services such as protection from avalanches, rockfall and erosion, timber production, long-term preservation of habitats, and carbon storage (Castro-Díez et al. 2019). Depending on the site-specific assessment of the expected positive and negative impacts of NNT, all three approaches may be applied in parallel or sequentially.

Recommendations

○ NNT that currently pose no risk of becoming invasive, or for which this risk can be kept low, can be integrated in mixed species stands with strict management of their reproduction to prevent further invasions caused by increasing propagule pressure.
○ Consider multiple criteria for the selection of suitable NNT for planting in urban areas, wherein the selection should be limited to those species that are climate-adapted, drought tolerant, non-invasive, and aesthetically attractive, and do not pose a threat to human health.
○ Re-evaluate recommendations for site-specific suitability of NNT, integrating assessed changes of their risks and benefits according to the latest research on the predicted range of future climatic conditions.
○ Facilitate the testing and transfer of tree species native in regions of south-eastern Europe to central and northern parts of Europe.

GOAL 4 IMPROVE COOPERATION, CAPACITY BUILDING, AND EXPERTISE SHARING

Research and training activities in the Alpine Space have been inconsistent to date, especially in the area of NNT. This places the Alpine Space at a disadvantage in terms of dealing with climate change and being in a position to influence policy at EU level. The goal is to fill the gap in the lack of coordinated management of NNT across different regions, countries, stakeholders and the inadequate engagement and communication amongst stakeholders of the forest and horticultural sector. The development of sustainable funding mechanisms for cross-sectoral cooperation and partnerships will lead to increased research and innovation, accessible to all stakeholders in the Alpine Space.

Recommendations

○ Ensure close cross-sector cooperation and exchange of expertise in the field of forestry, horticulture and ornamentals.
○ Enable cross-border trade and utilization of forest reproductive materials, with full accordance to OECD regulations.
○ Develop and maintain networks to provide and exchange information on the distribution, management and use cases of NNT to ensure the free and user-friendly access to comprehensive information on them.
○ Invest in transnational research activities investigating population genetics to identify suitable tree species and their long-term management requirements, and assess the adaptation potential of native and NNT in the Alpine Space.
○ Coordinate the establishment of training initiatives to ensure that stakeholders are equipped with the appropriate skills and knowledge to conduct a risk assessment.

GOAL 5 INCREASED COMMUNICATION, CITIZENS' AWARENESS & INVOLVEMENT

Citizens' awareness and involvement are important for the management and sustainable use of NNT. The goal is to give all citizens equal access to the latest information on NNT by overcoming languages, digital divide, and age barriers. The transnational strategy emphasises that generalisations should be avoided when informing the public, and site-specific knowledge derived from risk assessments including the expected benefits of using non-native tree species and management options will be provided.

Recommendations

○ When communicating with the public, always refer to species- and site-specific information to avoid generalisations and support the differentiation between invasive and non-invasive tree species and tree species whose risks are not yet known.
○ Translate guidance and training material as well as policy documents and all relevant project results to local languages.
○ Support appropriate education initiatives at all levels, in Schools, Universities and stakeholders' organizations.

5.Strategy implementation

The implementation of this transnational strategy will require strong stakeholder partnerships, robust governance and an equitable funding model that is applicable to all stakeholders. A Strategy Implementation Plan has been prepared to address these issues and includes a set of actions in a time frame of 10 years. It provides further details about the actions necessary to achieve the goals set out in this document. Coordination, leadership, and adequate funding models will be required to implement and monitor the goals and recommendations of the strategy.

Table 1 | Strategy Implementation Plan.

Stages	Action	Target Group	Indicators / targets
Stage 1 *[0 to 3 years]*	Establishment of a transnational knowledge hub for non-native tree species	General public, higher education and research, public authority	An exchange platform for knowledge on NNT
	Coordination of partnerships that build capacity and capability	Sector agency, public authority, interest groups including NGOs, business support organisation	Number of network meetings and stakeholder events
	Develop a register for site-specific risk assessments and the distribution of non-native tree species in the Alpine Space	Public authority, interest groups including NGOs	Number of site-specific risk assessment developed
	Establishment of transnational leadership including major stakeholders of the forest and horticulture sector in the Alpine Space	Public authority	Board of consortium members from at least four Alpine Space countries
Stage 2 *[3 to 8 years]*	Update and review knowledge about pests and pathogens on NNT in the Alpine Space	Higher education and research, public authority (EPPO, NPPOs)	Number of full lists of P&P for NNT in the Alpine Space
	Update site-specific risk assessments	General public, higher education and research, public authority	Number of site-specific risk assessment updated
	Develop & maintain networks for education & training	Education/training centre and school, higher education and research	Number of networks established
	Systematic and regular collection of data on NNT	Sector agency, public authority, interest groups including NGOs, business support organisation, higher education and research	Availability of data for the NNT of the Alpine Space
	Improvement of the knowledge on risks and use of NNT	Enterprise, SME, infrastructure and (public) service provider	Improvement of knowledge measured through dedicated questionnaires
Stage 3 *[8 to 10 years]*	Assessment of the outcomes of the strategy implementation	Public authority, higher education and research	Assessment report
	Adjustment of the strategy on NNT	Public authority, higher education and research, interest groups including NGOs	public consultation on the adjustment of the strategy; adjustment plan

6.Conclusion

A wide range of stakeholders influence, either implicitly or explicitly, the tree species composition and the management and conservation of forest and urban green space (Tattoni et al. 2017, Suanno et al. 2021). NNT have long been a part of the Alpine Space and many of them are valued for their numerous benefits. However, some carry the risk of being or becoming invasive, threatening native biodiversity and associated ecosystem services, and could cause human health issues (Tattoni et al. 2017, Suanno et al. 2021). This strategy ensures that relevant stakeholders are aware of the benefits and risks of NNT as well as of their responsibilities for communication and management. In this way, the strategy can assist various stakeholders in balancing the benefits and disadvantages of using NNT.

To conclude, in order to keep the risks as low as possible, while strengthening the potential benefits of NNT in the Alpine Space at the same time, the transnational strategy for a decision support system on their sustainable and responsible use and cross-sectoral management is urgently needed (Felton et al. 2013). The strategy reflects in transnational and European policies and allows an evaluation of site-specific trade-offs between promoting NNT which could potentially be better adapted to a future climate whilst protecting biodiversity, ecosystem services and cultural resources from possible negative impacts of NNT in the Alpine Space.

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CONTACT

Katharina Lapin
katharina.lapin@bfw.gv.at
Federal Research and Training Centre for Forests,
Natural Hazards and Landscape (BFW)
Seckendorff-Gudent-Weg 8, A-1131
Vienna, Austria