A transnational cooperation for sustainable use and management of non-native trees in urban, peri-urban and forest ecosystems in the Alpine region (ALPTREES)

Katharina Lapin‡, Anja Bindewald§, Florian Kraxner¶, Aleksander Marinšek†, Nicola La Porta#, Reneema Hazarika‡, Debojyoti Chakraborty‡, Janine Oettel‡, Frederic Berger#, Patricia Detry‡, Gordana Kolesaric*, Darja Baric*, Sonia Abluton*, Giovanna Ulrici*, Isabel Georges‡, Karl Manfred Schweinzer‡, Silvio Schüler‡

‡ Austrian Research Centre for Forests (BFW), Vienna, Austria
§ Forest Research Institute Baden-Wuerttemberg (FVA), Freiburg, Germany
¶ International Institute for Applied System Analysis (IIASA), Laxenburg, Austria
† Slovenian Forestry Institute (SFI), Ljubljana, Slovenia
# Edmund Mach Foundation (FEM), Trento, Italy
| Centre For Studies and Expertise on Risks, Environment, Mobility, Urban and Country Planning (Cerema), Bron, France
« Municipality of Maribor, Maribor, Slovenia
» Development Agency Sora (RA Sora), Kranj, Slovenia
* LAMORO Development Agency (LAMORO), Asti, Italy
* Municipality of Trento (Trento), Trento, Italy

Corresponding author: Katharina Lapin (katharina.lapin@bfw.gv.at)

Received: 08 Apr 2020 | Published: 13 Apr 2020

Citation: Lapin K, Bindewald A, Kraxner F, Marinšek A, La Porta N, Hazarika R, Chakraborty D, Oettel J, Berger F, Detry P, Kolesaric G, Baric D, Abluton S, Ulrici G, Georges I, Schweinzer KM, Schüler S (2020) A transnational cooperation for sustainable use and management of non-native trees in urban, peri-urban and forest ecosystems in the Alpine region (ALPTREES). Research Ideas and Outcomes 6: e53038.
https://doi.org/10.3897/rio.6.e53038

Abstract

The expected benefits and potential risks of non-native tree species (NNT) to European geographic regions have polarized the opinions of experts and citizens. Benefits include climate change (CC) mitigation and adaptation, contributions to bioeconomy, urban and peri-urban green infrastructure and mitigation of natural hazards. However, NNT may become invasive and thus may pose risks to native biodiversity, ecosystem functioning or

© Lapin K et al. This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.
socio-economy. In critical and vulnerable ecosystems such as the Alpine Space (AS), such risks and benefits must be carefully considered before management decisions are made. Experiences in the management of NNT in urban areas, peri-urban, rural territories and forests are often region- or city-specific and rarely shared. Given the challenges in NNT management with respect to both benefits and risks, an European transnational approach is needed to qualify the role of NNT in future AS ecosystems. The objective is to provide a transnational strategy for a responsible use and sustainable management of NNT in the AS with the help of an integrated Decision Support System. The project fits within the context of national and regional site-derived policy aiming at protecting and enhancing biodiversity while maintaining a high level of resilience and ecosystem services across the AS. Implementation activities of the ALPTREES project include

1. developing a comprehensive database on NNT,
2. projecting the current and potential distribution of NNT in the AS under CC scenarios
3. determining their invasive potential and
4. analyzing the different ecosystem services provided by NNT to assess the tradeoffs between risks and benefits.

ALPTREES will formulate management recommendations for NNT under different climate and economic scenarios based on experience from sample plots combined with model projections, citizen science, and multiple stakeholder meetings. With the help of policy briefs, a handbook of lessons learned, transnational pilot actions for best management practices, and an inter-active online Decision Support System a close stakeholder interaction and benefit will be ensured. Another innovative output of the project is the Open ALPTREES Knowledge Hub, that will support the transnational and interdisciplinary knowledge transfer.

Keywords
climate change, non-native trees, alpine space, stakeholder

Translations of the Abstract

Deutsch (German)

Die erwarteten Vorteile und potentiellen Risiken von nicht-heimischen Baumarten (non-native trees, NNT) für die Regionen im europäischen Raum polarisieren die Meinungen von Experten und Bürgern. Zu den Vorteilen gehören eine mögliche Eindämmung des Klimawandels sowie eine Anpassung an diesen, Beiträge zur Bioökonomie, zur Infrastruktur im städtischen und stadtnahen Raum und zur Minderung von Naturgefahren. NNT können jedoch invasiv werden und somit Risiken für die heimische biologische Vielfalt, die Funktionsfähigkeit von Ökosystemen oder die Sozioökonomie darstellen. In
sensible and critical ecosystems such as the Alpine Space (Alpine Space, AS) must be carefully weighed before decisions on management are made. The experiences with the management of NNT in urban areas, peri-urban areas, rural areas, and forests are often local or regional in focus and an inter-regional exchange is only rarely carried out. In light of the challenges in dealing with NNT, both in terms of benefits and risks, it is necessary to have a European transnational approach to evaluate the role of NNT in future AS ecosystems. The goal is to develop an integrated system to support decision-making to have a transnational strategy for responsible handling and sustainable management of NNT in the AS. The project is in line with national and regional guidelines that aim to protect and improve biodiversity, as well as cultural resources, and at the same time maintain high resistance and ecosystem services across the AS. The activities to implement the ALPTREES project include:

1. the development of an extensive database on NNT,
2. the projection of current and potential distribution of NNT in the AS based on climate change scenarios,
3. the determination of their invasion potential, and
4. the analysis of the various ecosystem services provided by NNT, to evaluate the interactions between risks and benefits.

ALPTREES will formulate management recommendations for NNT under different climate and economic scenarios, based on the experiences from field studies in conjunction with model projections, Citizen Science and numerous stakeholder meetings. With the help of Policy Briefs, a handbook of the acquired knowledge, transnational pilot projects for best management practices and an interactive online decision support system, a close cooperation with interest groups and their benefits is ensured. A further innovative result of the project is an open ALPTREES knowledge platform, which supports transnational and interdisciplinary knowledge transfer.

Slovensko (Slovenian)

Pričakovane koristi in potencialna tveganja, ki jih prinašajo tujerodne drevesne vrste (TDV) v evropski prostor so razdelila mnenja strokovnjakov in zainteresirane javnosti. Pri tem TDV vključujejo ublažitev in prilagajanje podnebnim spremembam, prispevke k bioekonomiji, mestni in obmestni zeleni infrastrukturi ter k omiljevanju naravnih nesreč. Vendar lahko TDV postane invazivna in s tem predstavlja tveganje za domačo biotsko raznovidnost in delovanje naravnih ekosistemov. Lahko predstavlja tudi določena tveganje v družbeno gospodarski sferi. V kritičnih in ranljivih ekosistemih, kot je alpski prostor (AP), je pred sprejemanjem odločitev o upravljanju s TDV potrebno skrbno preučiti takšna tveganja in koristi. Izkušnje z upravljanjem TDV v urbanih, periurbanih in podeželskih območjih ter
gozdovih so pogosto specifične za regijo ali mesto in le redko dosežejo druga območja in deležnike. Glede na izzive pri upravljanju TDV, ki se tičejo koristi in tveganj, je potreben evropski nadnacionalni pristop k problematiki, kjer se opredeli vloga TDV v prihodnjih ekosistemih AP. Cilj projekta je zagotoviti nadnacionalno strategijo za odgovorno uporabo in trajnostno upravljanje TDV v alpskem prostoru s pomočjo integriranega sistema za podporo odločanju. Projekt se ujema z nacionalno in regionalno politiko, katere cilj je varovanje in povečanje biotske raznovrstnosti, zagotavljanje ekološke povezanosti in kulturnih virov, hkrati pa se ohranja visoka stopnja odpornosti in ekosistemskih storitev v celoti alpski regiji. Dejavnosti izvajanja projekta ALPTREES vključujejo

1. razvoj obsežne baze podatkov o TDV,
2. načrtovanje trenutne in potencialne razširjenosti TDV v AP glede na različne scenarije podnebnih sprememb,
3. določanje invazivnega potenciala TDV in
4. analiza različnih ekosistemskih storitev, ki jih zagotavljajo TDV za oceno kompromisov med tveganji in koristmi.

Projekt ALPTREES bo oblikoval priporočila za upravljanje s TDV v različnih podnebnih in gospodarskih scenarijih, ki bodo temeljili na izkušnjah iz pilotnih območij v kombinaciji z modelnimi projekcijami, ljubiteljsko znanostjo in več srečanj deležnikov ter zainteresirane javnosti. S pomočjo poročil o politikah, priročnika pridobljenih izkušenj, pilotnih akcij za najboljše upravljavske prakse ter interaktivnega spletnega sistema za podporo odločanju, bo zagotovljena tesna interakcija deležnikov. Nov inovativen rezultat projekta je Odprt ALPTREES Center Znanja (Open ALPTREES Knowledge Hub), ki bo podpiral nadnacionalni in interdisciplinarni prenos znanja.

Italiano (Italian)

I benefici attesi e i rischi potenziali delle specie di Alberi Non Nativi (Not Native Trees, NNT) per le regioni geografiche europee hanno polarizzato le opinioni di esperti e cittadini. I vantaggi dell'uso di tali specie includono l'adattamento ai cambiamenti climatici (CC), i contributi alla bioeconomia, le infrastrutture verdi urbane e periurbane e la mitigazione dei pericoli naturali da parte degli NNT, mentre i rischi comportano l'invasività di queste specie NNT e gli effetti sulla biodiversità naturale. In ecosistemi vulnerabili come Alpine Space (AS), tali rischi e benefici devono essere attentamente considerati prima di prendere decisioni sulla loro gestione. Le esperienze nella gestione di NNT nelle aree urbane, nelle aree periurbane, rurali e nelle foreste sono spesso specifiche per paese/città e quindi raramente condivise. Date le sfide nella gestione degli NNT in termini sia di benefici che di rischi, è necessario un approccio transnazionale per qualificare il ruolo degli NNT nei futuri ecosistemi di AS. Pertanto, l'obiettivo è fornire una strategia transnazionale europea per un Sistema di Supporto alle Decisioni sull'uso responsabile e la gestione sostenibile di NNT nella AS. Il progetto si inserisce nel contesto della politica nazionale e regionale derivata dal sito che mira a proteggere e migliorare la biodiversità per garantire la connettività ecologica e le risorse culturali mantenendo un alto livello di resilienza e di servizi.
ecosistemici (ES) in tutti gli AS. Le attività di implementazione del progetto ALPTREES includono:

1. lo sviluppo di un database completo su NNT tra utti i partner AS;
2. presentare la distribuzione attuale e quella prevista degli NNT in AS in diversi scenari di CC;
3. determinare il potenziale invasivo degli NNT nei diversi ambienti dello AS e
4. analizzare i diversi ES forniti da NNT per valutare i possibili compromessi tra rischi e benefici.

Nel progetto ALPTREES formuleremo raccomandazioni di gestione per la NNT in diversi scenari climatici ed economici attraverso incontri con le parti interessate, riassunti delle politiche, un manuale di lezioni apprese e azioni pilota transnazionali per le migliori pratiche di gestione. Un risultato innovativo del progetto è l'Open Knowledge ALPTREES, che supporterà il trasferimento di conoscenze transnazionali e interdisciplinari.

Français (French)

Les avantages attendus et les risques potentiels des arbres non natifs (NNT) pour les régions géographiques européennes ont polarisé les opinions des experts et des citoyens. Les avantages comprennent l'atténuation du changement climatique (CC) et son adaptation, les contributions à la bioéconomie, aux infrastructures vertes urbaines et périurbaines et à l'atténuation des risques naturels. Cependant, les NNT peuvent devenir envahissants et donc présenter des risques pour la biodiversité endémique, le fonctionnement des écosystèmes ou la socio-économie. Dans les écosystèmes critiques et vulnérables tels que l'Espace alpin (EA), ces risques et avantages doivent être soigneusement pris en compte avant que des décisions de gestion ne soient prises. Les expériences en matière de gestion des NNT dans les zones urbaines, périurbaines, rurales et forestières sont souvent spécifiques à une région ou à une ville et rarement partagées. Étant donné les défis que pose la gestion des NNT, tant en ce qui concerne les avantages que les risques, une approche transnationale européenne est nécessaire pour qualifier le rôle des NNT dans les futurs écosystèmes de l’EA. L’objectif est de fournir une stratégie transnationale pour une utilisation responsable et une gestion durable des NNT dans l’EA avec l’aide d'un système intégré d'aide à la décision. Le projet s'inscrit dans le contexte d'une politique nationale et régionale basée sur des retours d'expérience visant à protéger et à améliorer la biodiversité pour assurer la connectivité écologique et les ressources culturelles tout en maintenant un niveau élevé de résilience et de services écosystémiques dans l'ensemble de l'EA. Les activités de mise en œuvre du projet ALPTREES comprennent

1. le développement d'une base de données complète sur les NNT,
2. la projection de la distribution actuelle et potentielle des NNT dans l'EA selon des scénarios de CC,
3. la détermination de leur potentiel d'invasion et
4. l'analyse des différents services écosystémiques fournis par les NNT pour évaluer les compromis entre risques et bénéfices.
ALPTREES formulera des recommandations de gestion pour les NNT dans le cadre de différents scénarios climatiques et économiques, sur la base de l'expérience acquise sur des placettes d'échantillonnage combinées à des projections de modèles, à la science citoyenne et à des réunions avec de multiples parties prenantes. Grâce à des notes d'orientation, un manuel des enseignements tirés des retours d'expérience, des actions pilotes transnationales pour les meilleures pratiques de gestion et un système interactif d'aide à la décision en ligne, une interaction étroite entre les parties prenantes et des avantages seront garantis. Un autre résultat novateur du projet est le centre ALPTREES de ressources, outil support opérationnel pour un transfert transnational et interdisciplinaire des connaissances acquises grâce au projet ALPTREES.

Link to Project Homepage
https://www.alpine-space.eu/projects/alptrees/en/home

Introduction

Climate change poses major threats to Alpine ecosystems. The Alpine Space (AS) covers a wide gradient including Mediterranean and Atlantic influences in the South and West to continental influences in the East (Böhm et al. 2001). In the past, mountain ecosystems have been less affected by non-native tree species (NNT) due to harsher conditions, less intensive land use and reduced human activity in high elevation (Dainese et al. 2013, Petitpierre et al. 2016). Climate change is resulting in prolonged growing seasons and less severe winters (Walther et al. 2002) and thus changing growing conditions. The potential and rate of spread into higher elevations is expected to further increase in the future (Becker et al. 2005, Dainese et al. 2013, Petitpierre et al. 2016). Petitpierre et al. 2016 predicted the optimal suitability for NNT to shift from lowland to the montane or even subalpine zone.

Human influence on the spread of NNT includes anthropogenic disturbances, like direct land-use changes that create niches for NNT, human population density, increasing mobility and development in mountainous areas (Dainese et al. 2013, McDougall et al. 2010). These will further enhance the colonization, persistence and invasion by increasing propagule pressure (Chytrý et al. 2008). The results of further studies confirmed the importance of the human impact (Marini et al. 2011, Alexander et al. 2016) on the increase of NNT. Therefore, adaptation efforts are required to respond to the challenges of the invasive potential of the NNT on the Alpine environment, economy & society.

Native tree species are increasingly affected by pests, diseases, drought, and increased temperatures (Allen et al. 2010), and many of them are now considered threatened in Europe (Rivers 2019). Commercially important forest tree species such as Norway Spruce (Picea abies (L.) H. Karst.) or European Beech (Fagus sylvatica L.) have turned out to be susceptible to increasing summer drought (Albrecht and De Avila 2018). CC is therefore critical for forest management because tree species have to be carefully selected for cultivation many years before being harvested. Several NNT such as Douglas fir
(Pseudotsuga menziesii (Mirb.) Franco) are being valued for their perceived suitability to adapt European forests to CC (Vitali et al. 2017) and their cultivation will likely be intensified in the future. Douglas fir has been discussed as an alternative tree species for Norway spruce (Picea abies) especially at low elevations in Central Europe (Roques et al. 2019, Klimo and Hager 2000, Roloff and Grundmann 2006) due to their drought tolerance and superior productivity (Chakraborty et al. 2015, Chakraborty et al. 2018). Many NNT species have a long history of cultivation in Europe such as the Douglas-fir. However, there have also been concerns regarding the invasive potential of Douglas-fir in certain sites in Europe (Bindewald and Michiels 2018, Tschopp et al. 2015).

Simultaneously, some NNT which are able to cope with increasing temperatures like the black locust (Robinia pseudoacacia L.) (Nadal-Sala et al. 2019) can play an important role in cities to respond to CC. For instance, planting such NNT can improve the urban environment by reducing heat island effects and promoting better air quality (Pregitzer et al. 2018). Yet, awareness has also increased about undesirable detrimental impacts associated with the introduction of NNT and several species are considered invasive (Castro-Díez et al. 2019, Keča et al. 2019). For example, some NNT like black locust spread from cultivated sites in semi-natural environments where they pose risks to biodiversity, ecosystem functioning or socio-economy (Campagnaro et al. 2018, Vítková et al. 2017).

Nevertheless, Urban, Peri-Urban and Forest Ecosystems provide crucial goods and services such as attractions for tourism and recreation as well as climate and biodiversity conservation. NNT can support the adaptation of European forests and urban areas to CC, but simultaneously entail risks for biodiversity and ecosystem functions. Walter et al. 2005 defined changes in species composition, in succession patterns and in nutrient cycling as the most important environmental effects of NNT propagation. It is important to address the patterns and impacts of NNT dispersal in the AS in order to provide a useful set of guidelines for managers, as for example forest management has a regulatory effect on the distribution of NNT (Martin and Marks 2006, Matlack and Schaub 2013).

**Tackling territorial challenges**

Efforts have already been undertaken to responsibly manage NNT and forestry has experiences with responses of potential invasive tree species to their local management (Sitzia et al. 2015). However, neither European, national nor regional strategies for the management of NNT in the AS consider the challenges of CC yet. Moreover, the lack of a consistent methodology to assess the invasiveness of NNT in Europe hampers the comparison of risks across regions and national jurisdictions (Bindewald et al. 2019). This has led to an incoherent patchwork of local strategies for NNT in the AS. Under a prudent estimation, currently, ca. 4% of the European forest area (8.5mio ha) is covered with over 150 different NNT species (Brus et al. 2019). Furthermore, a yet not well-known number of NNT are cultivated as ornamentals in (peri-) urban areas. In order to formulate science-based policies for biodiversity conservation while balancing the trade-offs between forest health and ecosystem services, it is important to not only quantify the range of benefits but...
also the risks linked to biodiversity. The common territorial aim is therefore to identify current and future benefits as well as detrimental impacts of NNT in the AS (Fig. 1).

Map of the Alpine Space region (AS) showing the target territory for the application of the strategy of NNT to be developed in the ALPTREES project. The presence of non-native species in local ecosystems is becoming more common and more challenging to manage, yet NNT management methods and related regulations are often country-specific and not shared regionally/transnational, especially in the Alpine space region.

**Target groups**

Stakeholders and residents of the Alpine Space and their future generations will benefit from the sustainable action for CC adaptation, mitigation, and a system change for ensuring ecosystem services. Regional, national and local policymakers, landowners, public authorities, urban planners, regional agencies, and NGOs will benefit from a comprehensive strategy providing valid input for their governance strategies. Conservation managers, forest businesses and alpine communities will be provided with a handbook helping them to optimize their management of NNT in a sustainable and cost-efficient manner. The objectives and nature of activities of ALPTREES follow strategic policy developments in the policy cycle involving analytical assessments aiming at elaborating a transnational strategy for NNT in the AS (Table 1).
### Project objectives and outputs

The overall objective of ALPTREES is to improve knowledge-based decision-making on the responsible use and management of NNT in the AS by developing a transnational strategy. This strategy will evaluate the tradeoffs between promoting CC adaptation through planting adapted NNT while preserving and enhancing biodiversity, ecosystem services and cultural resources of natural forests. Based on scientific analysis, also with the help of a Citizen Science approach, ALPTREES’ strategy of sharing knowledge on challenges and best practices as well as the establishment of a transnational network to learn from each other and take advantage of synergies will significantly contribute to the

| Target groups | Please further specify the target groups |
|---------------|----------------------------------------|
| local public authority | Municipalities in the AS |
| regional public authority | Regional public authorities will benefit from comprehensive strategy that provides valid input for their governance strategies. |
| national public authority | National authorities are representative of national ministries and benefits from comprehensive strategy that provides valid input for their governance strategies. |
| sectoral agency | Regional agency dealing with forestry, ecology and sustainable development, can gain from comprehensive strategy for valid governance strategies. |
| infrastructure and (public) service provider | Provision of CC and NNT risk management tools for environmental service provider and urban service provider (e.g. tree safety and tree health in cities) |
| interest groups including NGOs | Various NGOs (nature conservation, education, forest protection, rural development) will be invited to participate on pilot actions. |
| higher education and research | Forest/ environment/ agriculture. Universities/research centres will be able to use developed database |
| education/training centre and school | Forest/environment educational institutions and local schools; horticulture schools and Local VETs (Vocational Education and Training) institutions for forestry, wood, horticulture and natural environment |
| enterprise, excluding SME | Forest & wood, horticulture & gardening, and Shorth Rotation Forestry (SRF; wood for energy) enterprises |
| SME | Forest & wood, horticulture & gardening, and Shorth Rotation Forestry (SRF; wood for energy) enterprises |
| business support organisation | Consultancy forest/nature conservation/rural planning agencies; |
| International organisation under national law | Contribution to international policies; Observer include international organisation |
| International organisation under inter-national law | Transnational cooperation strategies will provide technical guidance to International organisation under inter-national law; certification bodies e.g. PEFC and FSC |
| General public | Citizens of AS, aim is to increase the awareness and knowledge of NNT |
protection, conservation and connectivity of Alpine Space ecosystems. The specific objectives are:

1. Increasing knowledge on the current and prospective status of NNT in the AS: transnational inventories of policies, NNT distributions, threats, management measures and ecosystem services.
2. Development and implementation of a unified homogeneous and science-based solution strategy for NNT in the AS.
3. Increasing public awareness and capacity building on the responsible use of NNT through dialogues between science, administration, and citizens.

**Contribution to regional strategies and policies**

NNT are being discussed as an alternative to adapt European forests to climate change, in the likelihood of a drastic reduction in the distribution range of native tree species in climate change (Dyderski et al. 2017). The growing importance of NNT for European CC adaptation measures is increasingly reflected in policy frameworks. At the same time, invasive NNT can seriously affect nature conservation goals, economic activities, livelihoods, food security, and human health and well-being, and thus bear the risk of undermining progress towards sustainable development as also impeding achieving the United Nations, (2015-2030) Sustainable Development Goals (SDGs). Utilizing the true potential of NNT in the Alpine space while safeguarding the native ecosystems from potential threats of the NNT is thus crucial. A wide range of policy instruments and framework exists which can guide science-based management of NNT in the Alpine space (Table 2).

| Policy framework | Potential role |
|------------------|----------------|
| Convention on Biological Diversity | provision of guidance for safeguarding native biodiversity |
| Dir.92/43/EEC | preserving, protecting and improving the quality of the environment through a risk assessment of NNT and supporting the coherent European ecological network by integrating NATURA2000 sites in pilot actions |
| EU IAS Reg.1143/2014 | early detection of potential risks from NNT; providing information on measures, costs and management options |
| European Strategy for the AS: EUSALP Action Groups (AG) Obj. 3: Action 6,7,8 | to strengthen cooperation between AS partner countries to address common challenges in a more effective way |
| EU Strategy on adaptation to CC & Green Infrastructure | ensuring that the AS's green infrastructure is made more resilient against natural and man-made disasters |

In addition, ALPTREES will help to strengthen the sustainable use of natural resources under CC (Action Group 6 of EUSALP) by addressing potential conflicts between
stakeholders such as forestry, nature conservation and environmental protection. Outputs for site-specific evaluation of NNT risk/benefit, trade-offs will support the Action Group 8 of EUSALP to improve risk management; the results will provide solutions for protecting against natural and man-made disasters and improving CC management. The project will also target the ecological connectivity of urban, peri-urban and rural areas Action Group 7 of EUSALP.

**Project structure**

The Alptrees consortium consists of 12 project partners (PP) from seven countries in the AS. Additionally, a network of 32 observers outside the PPs is invited to actively advising on the project development. The project activities are structured in thematic work packages (WP), which includes management (WPM) and a communication work package (WPC). Technical WPT1 aims to analyze the spatial extent for potential or existing invasive NNT in the AS. This information is essential for risk/benefit and trade-off analysis and therefore for underpinning decision-making including prioritization of sensitive areas of high conservation value. Under WPT2 Risk maps will be developed based on CC projection models, with special emphasis on the forest area, urban forests, the peri-urban interface, and urban trees. These products are essential to support tools for CC adapted decision making in the public and private space. WPT3 will focus on the transfer of knowledge generated in the project to end-users at different levels. Preliminary project results will be shared first with observers, stakeholders and experts from the AS in 2 Transnational Stakeholder Seminars and various separate stakeholder workshops in each AS country during which the Open ALPTREES Knowledge Hub will be furnished with contents. The objective of WPT4 is to provide a transnational strategy for knowledge-based decision-making on responsible use and management of NNT in the AS. Stakeholder commitment will be widely encouraged to integrate diverse knowledge and perspectives into the management of invasive species and to deal with potential conflicts of interest.

**Communication strategy**

Communication improves the understanding of the responsible use of NNT for CC adaptation of European forests and urban areas. Yet, a communication strategy requires cross-sectoral and transnational cooperation to secure the biodiversity, ecosystem services and cultural resources of native forests against the invasion risks that could be represented by NNT. The knowledge gained in the ALPTREES project through transnational cooperation of experts in the ALPTREES PP consortium will be shared through formal and non-formal education tools. In a series of public events both at the national and international levels, like movies/documentaries, scientific conferences, public talking, school activities, forest and horticulture professionals, the PPs will educate stakeholders to engage with science and administration for sustainable development of the biodiversity in the AS. All the communication activities will follow the bottom-up approach “listen – observe – inspire”. The activities will target local policymakers, stakeholders from the forestry industry and urban/rural planning, along with the general public (Table 1).
Acknowledgment

This proposal was selected to be funded by the Alpine Space Programme on 01.10.2019, which is financed through the European Regional Development Fund (ERDF) as well as through national public and private co-funding of the Partner States (Total eligible costs: 2.348.664; EURERDF grant:1.996.364 EUR). The authors thank the respondents who participated in this work.

Funding program

Funded by the Interreg Alpine Space Programme, financed through the European Regional Development Fund (ERDF) as well as through national public and private co-funding of the Partner States. (Total eligible costs:2.348.664; EURERDF grant:1.996.364 EUR).

Grant title

A Transnational Cooperation for Sustainable Use and Management of Non-Native Trees in Urban, Peri-Urban and Forest Ecosystems in the Alpine Region.

Hosting institution

Austrian Research Centre for Forests (BFW), Vienna, Austria

Ethics and security

The idea in this proposal is the property of the ALPTREES project and it partners. Further circulation of this proposal is welcome with reference to the ALPTREES project.

Author contributions

Lead project partner, BFW, Vienna developed the idea of the proposal and the other project partners from Austria, Germany, France, Slovenia and Italy contributed by editing and providing inputs.

Conflicts of interest

The authors and contributors declare no conflict of interest.
References

- Albrecht A, De Avila A (2018) Alternative Baumarten im Klimawandel: Artensteckbrief - eine Stoffsammlung. Forstliche Versuchs- und Forschungsanstalt Baden-Württemberg (FVA).
- Alexander J, Lembrechts J, Cavieres L, Daehler C, Haider S, Kueffer C, Liu G, McDougall K, Milbau A, Pauchard A, Rew L, Seipel T (2016) Plant invasions into mountains and alpine ecosystems: current status and future challenges. Alpine Botany 126 (2): 89-103. https://doi.org/10.1007/s00035-016-0172-8
- Allen C, Macalady A, Chenchouni H, Bachelet D, McDowell N, Vennetier M, Kitzberger T, Rigling A, Breshears D, Hogg EH, Gonzalez P, Fensham R, Zhang Z, Castro J, Demidova N, Lim J, Allard G, Running S, Semerci A, Cobb N (2010) A global overview of drought and heat-induced tree mortality reveals emerging climate change risks for forests. Forest Ecology and Management 259 (4): 660-684. https://doi.org/10.1016/j.foreco.2009.09.001
- Becker T, Dietz H, Billetter R, Buschmann H, Edwards P (2005) Altitudinal distribution of alien plant species in the Swiss Alps. Perspectives in Plant Ecology, Evolution and Systematics 7: 173-183. https://doi.org/10.1016/j.ppees.2005.09.006
- Bindewald A, Michiels H (2018) Invasivität der Douglasie in Südwestdeutschland: Waldinventurdaten erlauben eine Einschätzung. Schweizerische Zeitschrift für Forstwesen 169 (2): 86-92. https://doi.org/10.3188/szf.2018.0086
- Bindewald A, Michiels H, Bauhus J (2019) Risk is in the eye of the assessor: comparing risk assessments of four non-native tree species in Germany. Forestry: An International Journal of Forest Research https://doi.org/10.1093/forestry/cpz052
- Böhm R, Auer I, Brunetti M, Maugeri M, Nanni T, Schöner W (2001) Regional temperature variability in the European Alps: 1760-1998 from homogenized instrumental time series. International Journal of Climatology 21 (14): 1779-1801. https://doi.org/10.1002/joc.689
- Brus R, Pützelsberger E, Lapin K, Brundu G, Orazio C, Straigyte L, Hasenauer H (2019) Extent, distribution and origin of non-native forest tree species in Europe. Scandinavian Journal of Forest Research 34 (7): 533-544. https://doi.org/10.1080/02827581.2019.1676464
- Campagnaro T, Brundu G, Sitzia T (2018) Five major invasive alien tree species in European Union forest habitat types of the Alpine and Continental biogeographical regions. Journal for Nature Conservation 43: 227-238. https://doi.org/10.1016/j.jnc.2017.07.007
- Castro-Díez P, Vaz AS, Silva JS, van Loo M, Alonso Á, Aponte C, Bayón Á, Bellingham PJ, Chiuffo MC, DiManno N, Julian K, Kandert S, La Porta N, Marchante H, Maule HG, Mayfield MM, Metcalfe D, Monteverdi MC, Núñez MA, Ostertag R, Parker IM, Peltzer DA, Potgieter LJ, Raymundo M, Rayome D, Reisman-Berman O, Richardson DM, Roos RE, Saldaña A, Shackleton RT, Torres A, Trudgen M, Urban J, Vicente JR, Vilà M, Ylioja T, Zenni RD, Godoy O (2019) Global effects of non-native tree species on multiple ecosystem services. Biological reviews of the Cambridge Philosophical Society 94 (4): 1477-1501. https://doi.org/10.1111/bvr.12511
- Chakraborty D, Wang T, Andre K, Konnert M, Lexer M, Matulla C, Schueler S (2015) Selecting populations for non-analogous climate conditions using universal response
functions: The case of Douglas-fir in Central Europe. PLOS ONE 10 (8). https://doi.org/10.1371/journal.pone.0136357

- Chakraborty D, Schueler S, Lexer M, Wang T (2018) Genetic trials improve the transfer of Douglas-fir distribution models across continents. Ecography 42 (1): 88-101. https://doi.org/10.1111/ecog.03888

- Chytrý M, Jarošík V, Pyšek P, Hájek O, Knollová I, Tichý L, Danihelka J (2008) Separating habitat invasibility by alien plants from the actual level of invasion. Ecology 89 (6): 1541-1553. https://doi.org/10.1890/07-0682.1

- Dainese M, Kühn I, Bragazza L (2013) Alien plant species distribution in the European Alps: influence of species’ climatic requirements. Biological Invasions 16 (4): 815-831. https://doi.org/10.1007/s10530-013-0540-x

- Dyderski M, Paź S, Frelich L, Jagodziński A (2017) How much does climate change threaten European forest tree species distributions? Global Change Biology 24 (3): 1150-1163. https://doi.org/10.1111/gcb.13925

- Keča L, Mrčeta M, Božič G, Perić S, Tsvetkov I, Andreassen K, Stijovic A, Mandzukovski D, Zlokapa B, Nicolescu VN (2019) Non-native tree species: strategies for sustainable management in Europe. International Forestry Review 21 (3): 295-314. https://doi.org/10.1505/146554819827293222

- Klimo E, Hager H (2000) Spruce monocultures in Central Europe - problems and prospects. EFI Proceedings (33).

- Marini L, Klimek S, Battisti A (2011) Mitigating the impacts of the decline of traditional farming on mountain landscapes and biodiversity: a case study in the European Alps. Environmental Science & Policy 14 (3): 258-267. https://doi.org/10.1016/j.envsci.2010.12.003

- Martin PH, Marks PL (2006) Intact forests provide only weak resistance to a shade-tolerant invasive Norway maple (Acer platanoides L.). Journal of Ecology 94 (6): 1070-1079. https://doi.org/10.1111/j.1365-2745.2006.01159.x

- Matlack G, Schaub J (2013) Long-term persistence and spatial assortment of nonnative plant species in second-growth forests. Ecography 34 (4): 649-658. https://doi.org/10.1111/j.1600-0587.2010.06654.x

- McDougall K, Alexander J, Haider S, Pauchard A, Walsh N, Kueffer C (2010) Alien flora of mountains: global comparisons for the development of local preventive measures against plant invasions. Diversity and Distributions 17 (1): 103-111. https://doi.org/10.1111/j.1472-4642.2010.00713.x

- Nadal-Sala D, Hartig F, Gracia C, Sabaté S (2019) Global warming likely to enhance black locust (Robinia pseudoacacia L.) growth in a Mediterranean riparian forest. Forest Ecology and Management 449 https://doi.org/10.1016/j.foreco.2019.117448

- Petitpierre B, Broennimann O, Kueffer C, Daehler C, Guisan A (2016) Selecting predictors to maximize the transferability of species distribution models: lessons from cross-continental plant invasions. Global Ecology and Biogeography 26 (3): 275-287. https://doi.org/10.1111/geb.12530

- Pregitzer C, Charlop-Powers S, Bibbo S, Forgione H, Gunther B, Hallett R, Bradford M (2018) A city-scale assessment reveals that native forest types and overstory species dominate New York City forests. Ecological Applications 29 (1). https://doi.org/10.1002/eap.1819

- Rivers M (2019) European Red List of Trees. IUCN: Cambridge, UK and Brussels, Belgium. https://doi.org/10.2305/iucn.ch.2019.erl.1.en
- Roloff A, Grundmann BM (2006) Waldbaumarten und ihre Verwendung im Klimawandel. Archiv für Forstwesen und Landschaftsökologie (42) 97-109.
- Roques A, Rozenberg MAA, Capretti P, Sauvard D, La Porta N, Santini A (2019) Pests and diseases in the native and European range of Douglas fir. Douglas fir - an option for Europe. What science can tell us series: Douglas fir - an option for Europe. COST Action FP1403 NINETXT.
- Sitzia T, Campagnaro T, Kowarik I, Trentanovi G (2015) Using forest management to control invasive alien species: helping implement the new European regulation on invasive alien species. Biological Invasions 18 (1): 1-7. https://doi.org/10.1007/s10530-015-0999-8
- Tschopp T, Holderegger R, Bollmann K (2015) Auswirkungen der Douglasie auf die Waldbiodiversität. Schweizerische Zeitschrift für Forstwesen 166 (1): 9-15. https://doi.org/10.3188/szf.2015.0009
- Vitali V, Büntgen U, Bauhus J (2017) Silver fir and Douglas fir are more tolerant to extreme droughts than Norway spruce in south-western Germany. Global Change Biology 23 (12): 5108-5119. https://doi.org/10.1111/gcb.13774
- Vítková M, Müllerová J, Sádlo J, Pergl J, Pyšek P (2017) Black locust (Robinia pseudoacacia) beloved and despised: A story of an invasive tree in Central Europe. Forest Ecology and Management 384: 287-302. https://doi.org/10.1016/j.foreco.2016.10.057
- Walter J, Essl F, Englisch T, Kiehn M (2005) Neophytes in Austria: Habitat preferences and ecological effects. Biological Invasions (5)13-25.
- Walther G, Post E, Convey P, Menzel A, Parmesan C, Beebee TC, Fromentin J, Hoegh-Guldberg O, Bairlein F (2002) Ecological responses to recent climate change. Nature 416 (6879): 389-395. https://doi.org/10.1038/416389a