



BUNDES  
FORSCHUNGS  
ZENTRUM  
FÜR WALD

# Assisted migration in practice: seed sources, provenance selection and cross border collaboration

Marcela van Loo  
Austrian Research Centre for Forests (BFW)

# The REIN-Forest Project: Assisted Migration from Theory to Practice

Marcela van Loo, Heino Konrad, Lambert Weissenbacher, Erik Szamosvári, László Nagy, Anita Bálint  
Strategic partners

01.10. 2020 – 31.12.2022



# Forests in Austria and Hungary

## AUSTRIA

- Country area: 83,879 km<sup>2</sup>
- Forest cover: 47% (in 2020)
- Main species: Spruce (*Picea abies*)
- Oak species: 2.4%
- Beech: 10%

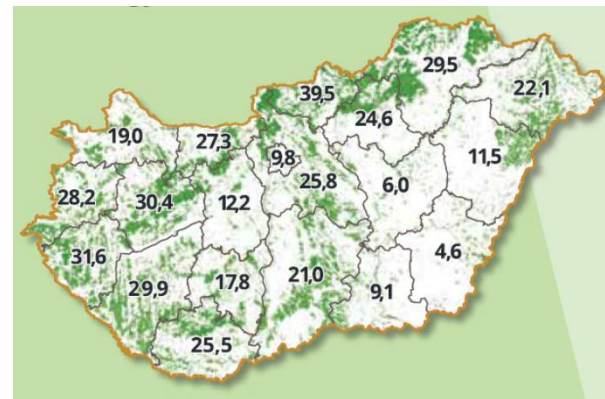
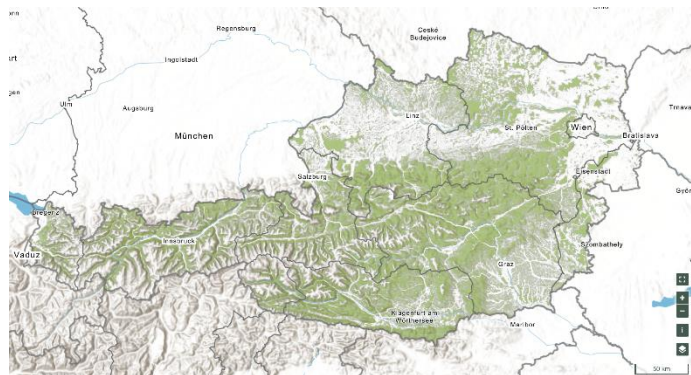


## HUNGARY

- Country area: 93,030 km<sup>2</sup>
- Forest cover: 22,5% (in 2020)
- Main species: Black Locust (*Robinia pseudoacacia*)
- Oak species: 32.5 %
- Beech: 24%



*Quercus petraea*, *Q. robur*, *Q. cerris*, *Q. pubescens*, *Q. rubra*  
*Fagus sylvatica*



## **Biodiversity conservation & climate adaptation using assisted migration**

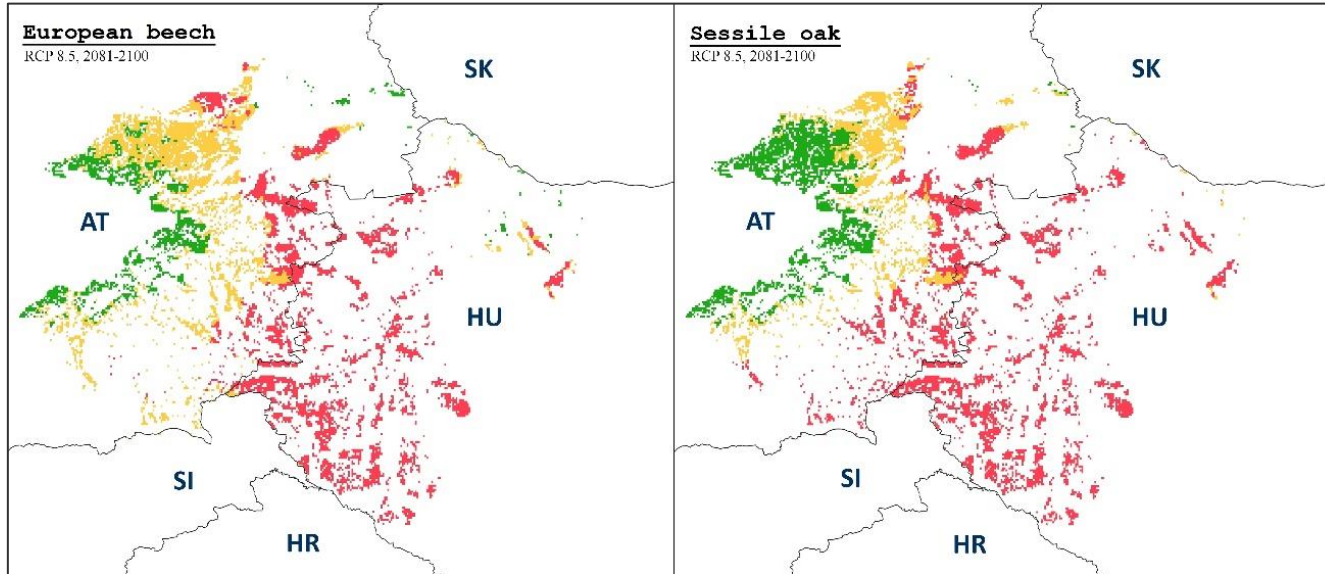
1. Model-based assessment of current status and future of beech & oak forests
2. Cross-border strategy for forest reproductive material (FRM) transfer
3. Establishment of SIX demonstration sites (AT/HU) with local and climate-adapted planting material
4. Long-term monitoring, management & evaluation plan
5. Communication & outreach: stakeholder engagement, public, education materials for schools

# Modelling: Future distribution and Vulnerability

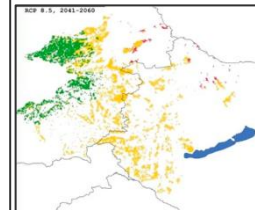
*Fagus sylvatica*



Non-vulnerable regions (<15%)  
Moderately vulnerable regions (<15-50%)  
Highly vulnerable regions (>50%)



*Quercus petraea*



RCP 8.5: 2041-2060

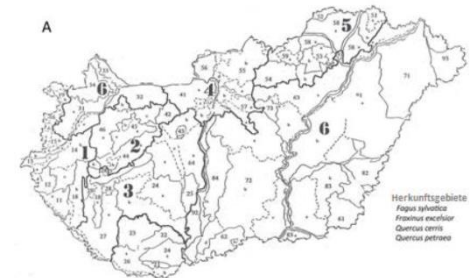
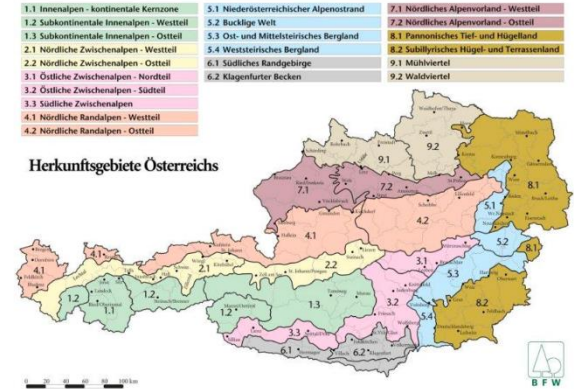
Vulnerability status in the border region under the **RCP 8.5 climate scenario** (4–4.8°C) for **2081–2100**

- Both species are dominant native forest tree species in the border region
- Model analyses indicate that the distribution of both species in the border region will most likely decline due to climate change

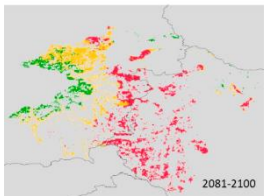
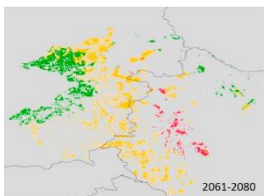
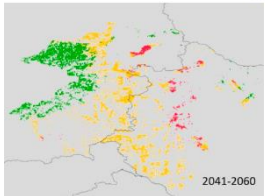
# Strategy for forest reproductive material (FRM) transfer and use

- Summarize legal frameworks for forest material transfer in both countries
- Outline future prospects for beech and oak forests.
- Provide transfer recommendations.

- **not threatened areas:** use local provenances, mixing with pre-adapted sources is recommended.
- **moderately threatened a.** : prefer pre-adapted material and develop mixed stands to enhance stability.
- **highly threatened zones:** assisted migration is crucial

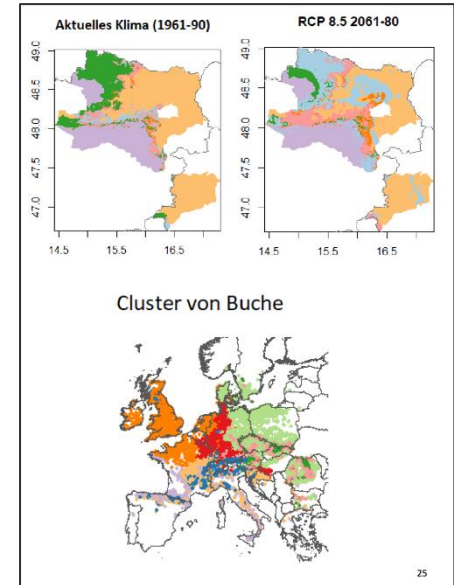
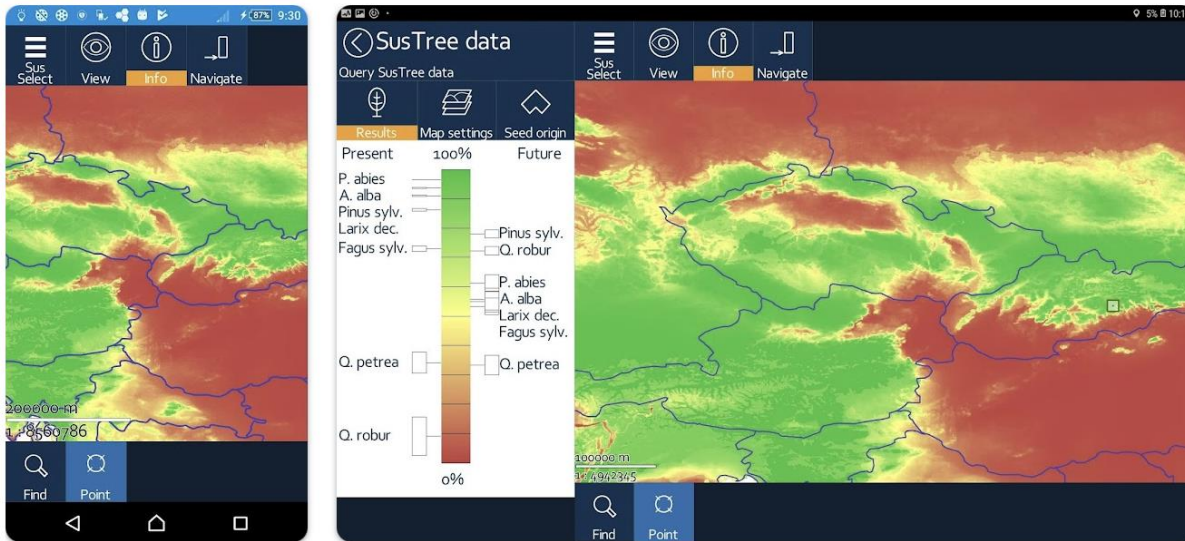


Szamosvári et al. (2023)



# Demonstration sites: tools used

1. Forest Vulnerability and Seed Transfer Tool (SusSelect App from the **SUSTREE** project),
2. Seed Transfer Tool ([www.seed4forest.org](http://www.seed4forest.org))
3. Tree species Tree species traffic light ([www.klimafitterwald.at/baumarten/](http://www.klimafitterwald.at/baumarten/))



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[Seed selection tool](#) | [How to](#) | [Project Info](#) | [Links & Downloads](#)

Start Location Species Seeds

Tree Species

Compare Suitabilities

Select a tree species based on its suitability for a climate change scenario of interest.

Tree Species	Climate Change Scenario	
	RCP 4.5	RCP 8.5
Abies alba	400 <span style="color: red;">⊗</span>	300 <span style="color: red;">⊗</span>
Fagus sylvatica	600 <span style="color: orange;">⊗</span>	400 <span style="color: red;">⊗</span>
Larix decidua	400 <span style="color: red;">⊗</span>	200 <span style="color: red;">⊗</span>
Picea abies	500 <span style="color: red;">⊗</span>	400 <span style="color: red;">⊗</span>
Pinus sylvestris	500 <span style="color: red;">⊗</span>	400 <span style="color: red;">⊗</span>
Quercus petraea	600 <span style="color: orange;">⊗</span>	500 <span style="color: orange;">⊗</span>
Quercus robur	600 <span style="color: orange;">⊗</span>	900 <span style="color: green;">⊗</span>
Alnus glutinosa	1000 <span style="color: green;">⊗</span>	800 <span style="color: green;">⊗</span>
Fraxinus angustifolia	900 <span style="color: green;">⊗</span>	800 <span style="color: green;">⊗</span>
Fraxinus excelsior	1000 <span style="color: green;">⊗</span>	1000 <span style="color: green;">⊗</span>
Populus nigra	900 <span style="color: green;">⊗</span>	900 <span style="color: green;">⊗</span>

Click get seed list to see suitable seed stands.

```

ID, Species, Seedstandtype, National_Register_Info, Seed_Cluster, Lat, Lon, Distance_to_Location, Altitude
19895, Fagus sylvatica, FOREMATIS, ES-71-02, 8, 45, 31, 14, 27, 276, 9, 150
19894, Fagus sylvatica, FOREMATIS, IT, FS-11/A/VEN/V10598, 8, 45, 51, 11, 19, 428, 1, 350
19829, Fagus sylvatica, FOREMATIS, IT, FS-11/A/VEN/VR130, 8, 45, 46, 10, 52, 475, 6, 150
19828, Fagus sylvatica, FOREMATIS, IT, FS-11/A/VEN/VR127, 8, 45, 41, 10, 52, 478, 4, 100
19849, Fagus sylvatica, FOREMATIS, IT, FS-11/A6/LON/BS015, 8, 45, 49, 10, 44, 479, 3, 150
19858, Fagus sylvatica, FOREMATIS, IT, FS-11/A6/LON/BS003, 8, 45, 4, 10, 34, 491, 1, 100
19045, Fagus sylvatica, FOREMATIS, IT, FS-11/A6/LON/S0007, 8, 46, 14, 9, 35, 526, 8, 200
19852, Fagus sylvatica, FOREMATIS, IT, FS-11/A6/LON/BG016, 8, 45, 46, 9, 32, 558, 1, 100
19848, Fagus sylvatica, FOREMATIS, IT, FS-11/A6/LON/C0004, 8, 45, 57, 9, 02, 574, 0, 200
19037, Fagus sylvatica, FOREMATIS, IT, FS-11/D/PUG/FG10, 8, 41, 52, 16, 81, 650, 1, 750
19836, Fagus sylvatica, FOREMATIS, IT, FS-11/D/PUG/FG17, 8, 41, 76, 15, 89, 635, 9, 900
19838, Fagus sylvatica, FOREMATIS, IT, FS-11/D/PUG/FG2, 8, 41, 33, 15, 14, 688, 4, 900
19842, Fagus sylvatica, FOREMATIS, IT, FS-11/A/PIE/OM055, 8, 44, 27, 8, 09, 708, 1, 950
19738, Fagus sylvatica, FOREMATIS, ES-71-02 / FS-71/02/33/089, 8, 43, 06, 5, 14, 913, 5, 0
19729, Fagus sylvatica, FOREMATIS, ES-71-02 / FS-71/02/33/017, 8, 43, 1, 6, 09, 914, 3, 100
19835, Fagus sylvatica, FOREMATIS, IT, FS-11/F/SIC/P024, 8, 37, 58, 14, 49, 1106, 9, 300
19830, Fagus sylvatica, FOREMATIS, IT, FS-11/F/SIC/ME096, 8, 37, 55, 14, 39, 1113, 1, 350
19834, Fagus sylvatica, FOREMATIS, IT, FS-11/F/SIC/P026, 8, 37, 55, 14, 04, 1116, 8, 450
19832, Fagus sylvatica, FOREMATIS, IT, FS-11/F/SIC/CT038, 8, 37, 5, 14, 58, 1117, 0, 300
19831, Fagus sylvatica, FOREMATIS, IT, FS-11/F/SIC/CT071, 8, 37, 45, 15, 03, 1119, 3, 0
19833, Fagus sylvatica, FOREMATIS, IT, FS-11/F/SIC/P031, 8, 37, 51, 14, 04, 1121, 2, 450
19665, Fagus sylvatica, FOREMATIS, ES-71-06 / RS-71/06/01/002, 8, 43, 2, 55, 1162, 4, 400
19726, Fagus sylvatica, FOREMATIS, ES-71-07 / FS-71/07/40/003, 8, 43, 06, 2, 39, 1170, 4, 450
19727, Fagus sylvatica, FOREMATIS, ES-71-07 / FS-71/07/40/001, 8, 43, 02, 2, 41, 1171, 2, 650
19688, Fagus sylvatica, FOREMATIS, ES-71-17 / FS-71/17/26/043, 8, 42, 24, 3, 03, 1172, 8, 0
19687, Fagus sylvatica, FOREMATIS, ES-71-17 / FS-71/17/26/045, 8, 42, 24, 3, 03, 1174, 2, 0
19718, Fagus sylvatica, FOREMATIS, ES-71-17 / FS-71/17/09/001, 8, 42, 13, 3, 08, 1177, 1, 0
19693, Fagus sylvatica, FOREMATIS, ES-71-17 / FS-71/17/26/033, 8, 42, 15, 3, 01, 1181, 2, 50
19781, Fagus sylvatica, FOREMATIS, ES-71-17 / FS-71/17/26/013, 8, 42, 08, 3, 04, 1183, 6, 50
19691, Fagus sylvatica, FOREMATIS, ES-71-17 / FS-71/17/26/037, 8, 42, 21, 2, 58, 1206, 8, 200
19689, Fagus sylvatica, FOREMATIS, ES-71-17 / FS-71/17/26/041, 8, 42, 21, 2, 58, 1208, 1, 500
19692, Fagus sylvatica, FOREMATIS, ES-71-17 / FS-71/17/26/035, 8, 42, 23, 2, 54, 1208, 3, 300
19690, Fagus sylvatica, FOREMATIS, ES-71-17 / FS-71/17/26/039, 8, 42, 17, 2, 57, 1209, 9, 700
19698, Fagus sylvatica, FOREMATIS, ES-71-17 / FS-71/17/26/023, 8, 42, 21, 2, 53, 1210, 2, 400
19695, Fagus sylvatica, FOREMATIS, ES-71-17 / FS-71/17/26/029, 8, 42, 08, 2, 59, 1214, 2, 400
19701, Fagus sylvatica, FOREMATIS, ES-71-17 / FS-71/17/26/017, 8, 42, 09, 2, 56, 1214, 2, 500
19694, Fagus sylvatica, FOREMATIS, ES-71-17 / FS-71/17/26/031, 8, 42, 13, 3, 04, 1214, 5, 950
19785, Fagus sylvatica, FOREMATIS, ES-71-17 / FS-71/17/26/009, 8, 42, 16, 2, 51, 1214, 7, 550
19697, Fagus sylvatica, FOREMATIS, ES-71-17 / FS-71/17/26/025, 8, 42, 07, 2, 57, 1216, 2, 450
19696, Fagus sylvatica, FOREMATIS, ES-71-17 / FS-71/17/26/027, 8, 42, 06, 2, 55, 1218, 2, 400
19782, Fagus sylvatica, FOREMATIS, ES-71-17 / FS-71/17/26/015, 8, 42, 19, 2, 41, 1219, 7, 550
19794, Fagus sylvatica, FOREMATIS, ES-71-17 / FS-71/17/26/011, 8, 42, 12, 2, 47, 1219, 9, 500
19674, Fagus sylvatica, FOREMATIS, ES-71-17 / FS-71/17/26/071, 8, 42, 23, 2, 37, 1220, 8, 900
                    
```



# Demonstration sites

## Six demonstration sites:

3 in Austria: Reichenau an der Rax, Sparbach, Mannersdorf am Leithagebirge

3 in Hungary: Sopron, Ivanc, BajansenyeLocal

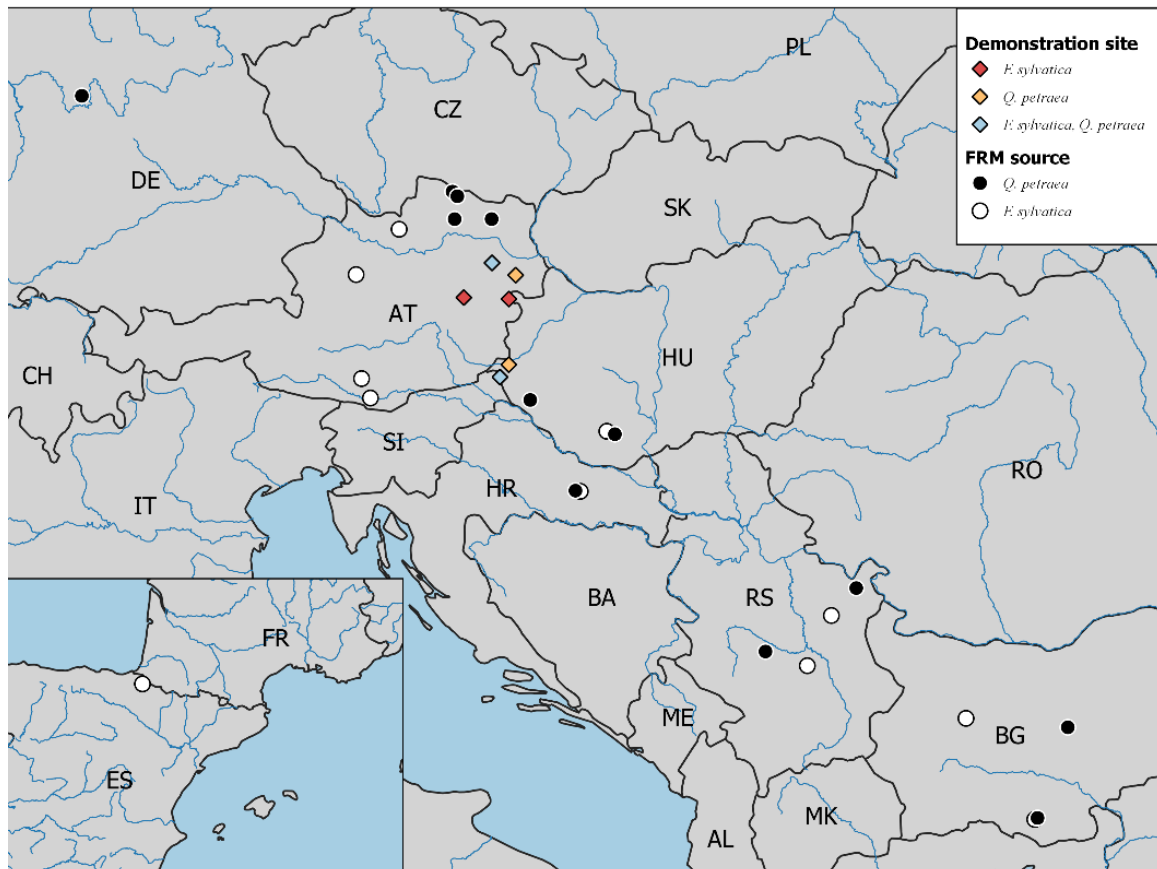
**Design:** 1. “local” and “adapted” oak  
2. “local” and “adapted” beech  
3. “local” beech and “adapted” oak

## FRM:

European beech: Austria, Croatia, Serbia, Bulgaria, Spain

Sessile oak: Austria, Germany, Croatia, Serbia, Bulgaria, Hungary

Planted: > 14420 seedlings, 25 provenances from 7 countries

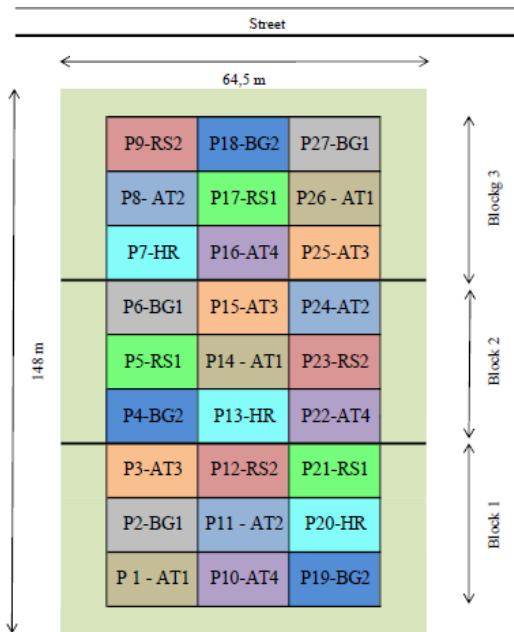


# Demonstration sites



Experimental site with beech: 21/11/2022

# An example: demonstration site with European beech



Coordinates: 47°41'38.39"N, 15°44'52.29"E

Tree species: European beech (*Fagus sylvatica*)

Year of planting 2022 - Autumn

ID	Provenance	Tree / Plot	Tree SUM	Plot number	Master Certificate Nr	Comments
AT1	R.Bu 9(9.1)	208	624	1, 14, 26	A/406023-01/2020	BFZ
AT2	R.Bu 4(3.2)	208	624	11, 24, 8	A/21001-03/2020	Murauer
AT3	R.Bu 6(4.1)	208	624	3, 15, 25	A/409041-03/2020	Murauer
AT4	R.Bu 6(6.2)	208	624	10, 22, 16	A/20505-05/2020	Murauer
RS1	Serbia	208	624	21, 5, 17	RS-2-2-fy-34-378	
RS2	Serbia	208	624	12, 23, 9	RS-2-2-fy-33-633	
BG1	Bulgaria	208	624	2, 6, 27	C02FSY13502512	
BG2	Bulgaria	208	624	19, 4, 18	C01FSY01510512	
HR	Croatia	208	624	20, 13, 7	HR-FSY-SS-223/167	
ES	Spain	150	150	28	RS-71/09/003	
BG3	Bulgaria	150	150	29	C01FSY12502612	
	Hornbeam		748			
	SUM		6664			

Provenances	9	+ 2 (ES, BG3)
Plots	27	+ 2 (ES, BG3)
Row spacing	1 x 1,5 m	1 x 1,5 m
Plots size	16 x 19,5 m	15 x 15 m
Tree / Plot	208	150

Plot structure:

16	17	48	49	80	81	112	113	144	145	176	177	208
15	18	47	50	79	82	111	114	143	146	175	178	207
14	19	46	51	78	83	110	115	142	147	174	179	206
13	20	45	52	77	84	109	116	141	148	173	180	205
12	21	44	53	76	85	108	117	140	149	172	181	204
11	22	43	54	75	86	107	118	139	150	171	182	203
10	23	42	55	74	87	106	119	138	151	170	183	202
9	24	41	56	73	88	105	120	137	152	169	184	201
8	25	40	57	72	89	104	121	136	153	168	185	200
7	26	39	58	71	90	103	122	135	154	167	186	199
6	27	38	59	70	91	102	123	134	155	166	187	198
5	28	37	60	69	92	101	124	133	156	165	188	197
4	29	36	61	68	93	100	125	132	157	164	189	196
3	30	35	62	67	94	99	126	131	158	163	190	195
2	31	34	63	66	95	98	127	130	159	162	191	194
1	32	33	64	65	96	97	128	129	160	161	192	193

16 Seedlings

13 Seedlings

Reichenau an der Rax



size: 1.3 ha  
 altitude: 1120-1170 m a.s.l.  
 Local: AT  
 Adapted: BG, RS, HR  
 around 6.700 seedlings



# The monitoring plan for the first 15-year period (2022-2037)

Assessment	1st year	2nd or 3rd year	5th year	10th year	15th year	At a later date
Survival/failure of the seedlings	X	X	X	X	X	(X)
Juvenile growth, growth rate, increment	(X)	X	X	X	X	(X)
Phenology	(X)	(X)	(X)	(X)	(X)	(X)
Vitality	X	X	X	X	X	(X)
Qualitative traits	-	X	X	X	X	(X)
Genetic monitoring	(X)	(X)	(X)	(X)	(X)	(X)

X mandatory a.  
 (X) voluntary a.  
 - no assesment

- experimental plot agreement**

e.g. design, responsibilities of both parties, planned measurements

150/23



**Bundesforschungs- und Ausbildungszentrum für Wald, Naturgefahren und Landschaft**  
Austrian Research and Training Centre for Forests, Natural Hazards and Landscape | <http://bfw.ac.at>

**Versuchsflächenvereinbarung**

zwischen dem

**Bundesforschungs- und Ausbildungszentrum für Wald, Naturgefahren und Landschaft, kurz BFW,**  
 Seckendorff-Gudent-Weg 8  
 A-1131 Wien

hier handelnd:

Fachinstitut Waldwachstum, Waldbau & Genetik  
 Abteilung Herkunftsforschung und Züchtung  
 Seckendorff-Gudent-Weg 8  
 A-1131 Wien

# Communication



- 4 lecture series for the general public
- 2 program series/excursion for schools
- 4 workshop series for specialist audiences
- Final conference



Bundesforschungsanstalt für Wald - BFW  
23 November 2022

Der Wald ist im Umbruch - der **#Klimawandel** ändert unsere Artenzusammensetzung und deshalb müssen wir uns auch auf Änderungen beim verfügbaren Vermehrungsgut einstellen. Beim länderübergreifenden Interreg Projekt REIN-Forest (01.10.2020-31.12.2022) zwischen #Österreich und #Ungarn legen wir gerade **#Wiederaufforstung** 6 Demonstrationsstandorten. Dort wird lokales und angepasstes Buchen- und Eichenartenmaterial gepflanzt und eine langfristige **#Monitoringstrategie** erstellt, um d... See more



# Publications & summer school



Research Ideas and Outcomes 9: e109816  
doi: [10.3897/rio.9.e109816](https://doi.org/10.3897/rio.9.e109816)



## Project Report

### Bilateral cooperation - Fostering the ability of native European beech and sessile oak forests in the border region against the impacts of climate change

Erik Szamosvári<sup>‡</sup>, László Nagy<sup>§</sup>, Heino Konrad<sup>‡</sup>, Norbert Móricz<sup>§</sup>, Lambert Weissenbacher<sup>‡</sup>,  
Anita Bálint<sup>‡</sup>, Anikó Neuvirthné Bilics<sup>‡</sup>, Marcela van Loo<sup>‡</sup>

<sup>‡</sup> Austrian Research Centre for Forests (BFW), Vienna, Austria  
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<sup>|</sup> Vas County Government Office (VVOH), Szombathely, Hungary

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<https://doi.org/10.3897/rio.9.e109816>

## Szamosvári et al. (2023)

### Hungary and Austria: Best Practice for Habitat and Species Connectivity: European Beech and Sessile Oak

29

Marcela van Loo, Erik Szamosvári, Anita Bálint, Anikó Neuvirthné Bilics, Heino Konrad, and László Nagy



van Loo et al. (2025)

### Assisted Migration as a Climate Change Adaptation Strategy

14

Erik Szamosvári, Debojyoti Chakraborty, Silvio Schieler, and Marcela van Loo



Szamosvári et al. (2025)

In: Ecological Connectivity of Forest Ecosystems. Springer, Cham.

[https://doi.org/10.1007/978-3-031-82206-3\\_29](https://doi.org/10.1007/978-3-031-82206-3_29)

[nature](#) > [nature climate change](#) > [articles](#) > [article](#)

Article | [Open access](#) | Published: 25 July 2024

## Assisted tree migration can preserve the European forest carbon sink under climate change

[Debojyoti Chakraborty](#), [Albert Ciceu](#), [Dalibor Ballian](#), [Marta Benito Garzón](#), [Andreas Bolte](#), [Gregor Bozic](#), [Rafael Buchacher](#), [Jaroslav Čepič](#), [Eva Cremer](#), [Alexis Ducousso](#), [Julian Gaviria](#), [Jan Peter George](#), [André Hardtke](#), [Mladen Ivankovic](#), [Marcin Klisz](#), [Jan Kowalczyk](#), [Antoine Kremer](#), [Milan Lstibůrek](#), [Roman Longauer](#), [Georgeta Mihai](#), [László Nagy](#), [Krasimira Petkova](#), [Emil Popov](#), [Randolf Schirmer](#), ... [Silvio Schueler](#) [+ Show authors](#)

[Nature Climate Change](#) **14**, 845–852 (2024) | [Cite this article](#)

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## SUMMER SCHOOL: Adapting forests to climate change: Operationalizing Assisted Migration

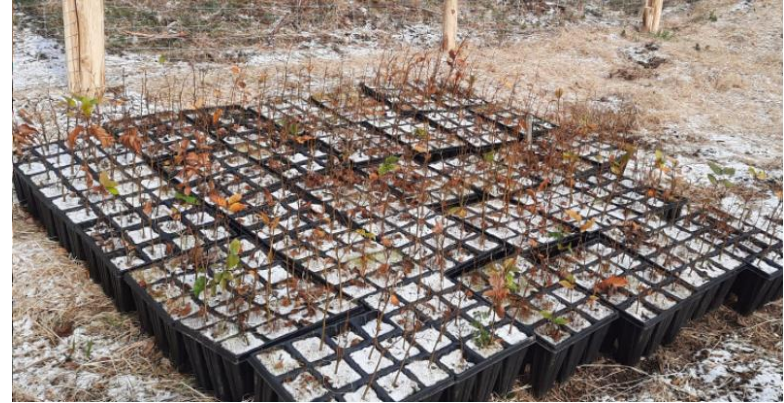
[Debojyoti Chakraborty](#)  
Austrian Research Centre for... · 2K followers  
Published Feb 24, 2026

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**Summer school: 20-24/07 2026  
(in Vienna)**

# Lessons learned and recommendations

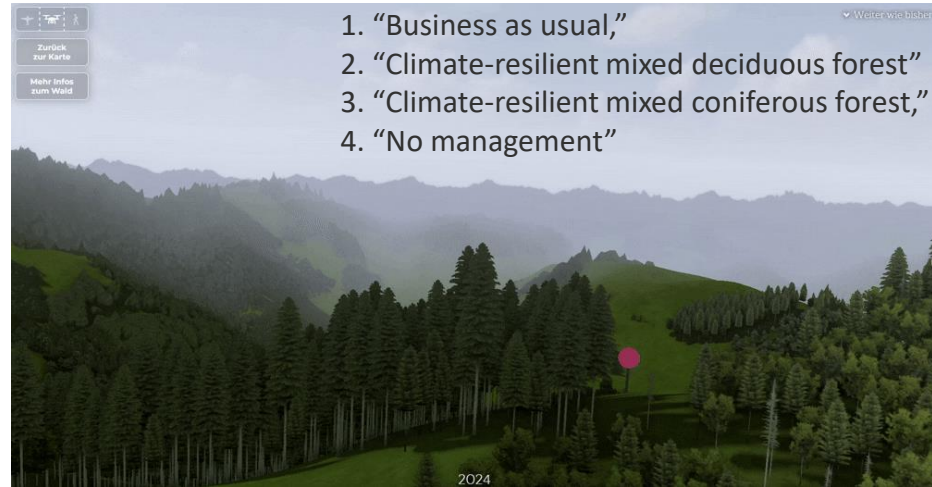
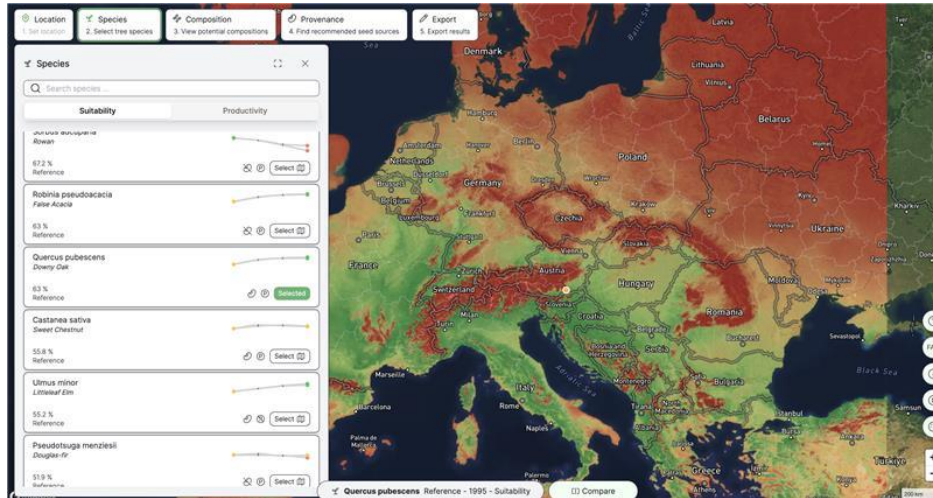
1. Seed and sapling procurement challenges, including quality and availability (e.g., recalcitrant seeds)
2. Sapling production
3. Project duration and preparation
4. Trial design and duration: research questions, density and spacing, species mixture



# New tools

<https://app.seed4forest.org/> : A decision support system used to identify suitable and productive forest compositions and provenances best for future climate conditions.

<https://www.forforestinnovation.com/>: Simulation of future forest in 3D until 2100, uses climate, site and forest type classification, different forest management scenarios and compare the impacts on profitability, climate resilience & biodiversity



# BFW

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Kodym Andrea

Trujillo-Moya Carlos

Heino Konrad

Feichter Jonathan

Buchert Eszter

Debojyoti Chakraborty

Moholea Vasile

Mayr Bernhard

Mahr Roland

Roland Molnár

Ijjas Fanni

Zainer Wernfried

Weinzettl Wolfgang

Zolles Anita

Klich Marian

Kovacs Gyula



Thank you

Hainisch Erich

Lyakin Victoria

Schellmann Michael

Perny Bernhard

Valenta Viktoria

Aigner Anton

Schnabel Gerald

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