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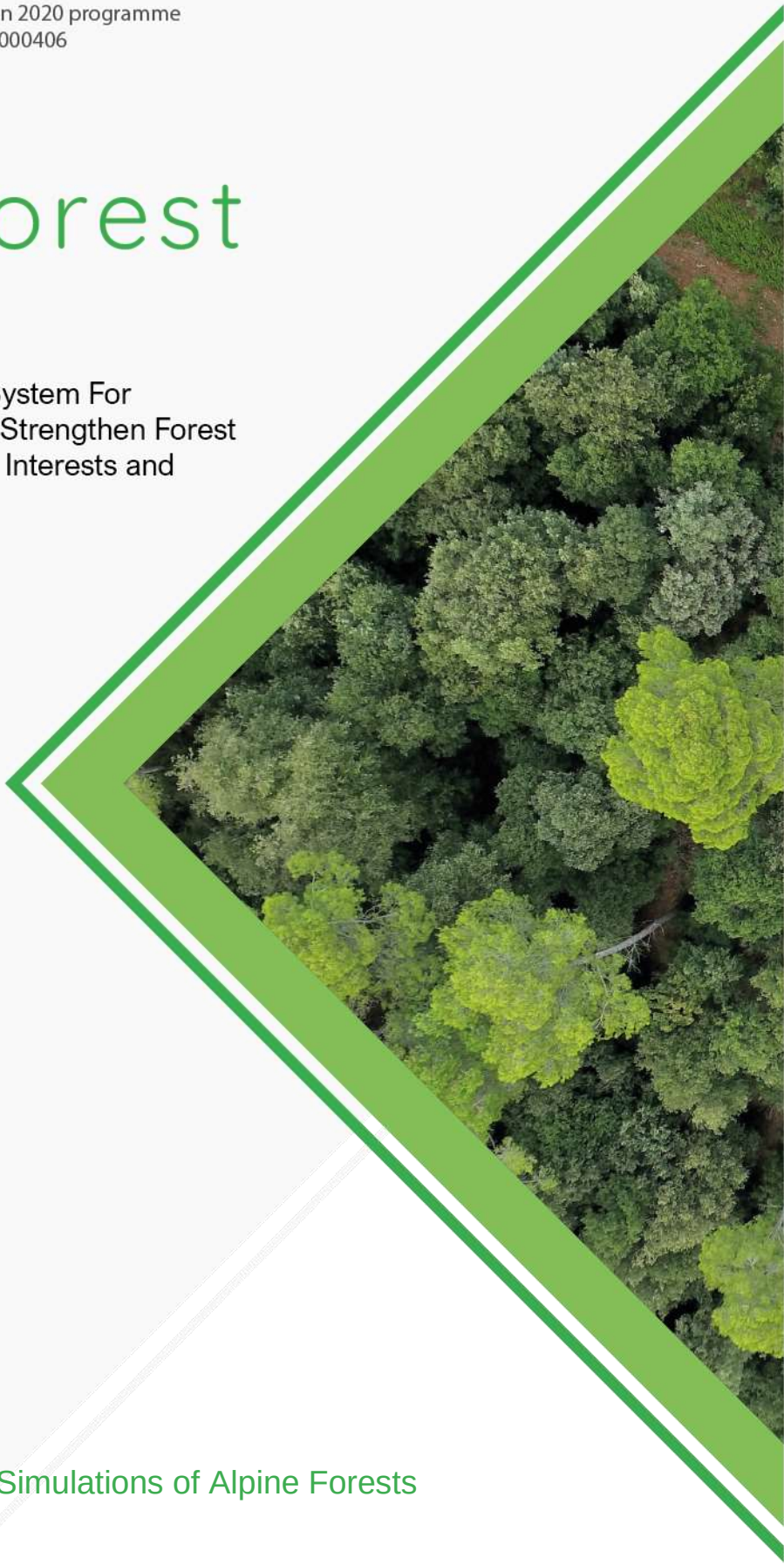
SEP-210673543

A Multi-Criteria Decision Support System For A Common Forest Management to Strengthen Forest Resilience, Harmonise Stakeholder Interests and Ensure Sustainable Wood Flows



D2.3

Scientific Dataset of Forest Growth Simulations of Alpine Forests

■ DOCUMENTATION

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A Multi-Criteria Decision Support System for a Common Forest Management to Strengthen Forest Resilience, Harmonise Stakeholder Interests and Ensure Sustainable Wood Flows

Deliverable 2.3

Title: Scientific Dataset of Forest Growth Simulations of Alpine Forests

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Dissemination Level		
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CO	Confidential, _only_for_members_of_the_consortium_(including_the_Commission_Services)	

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History

Version	Date	Modified by	Modification reason
V01.0	2023-02-09	Simon Mutterer, Timothy Thrippleton, Clemens Blattert, Leo G. Bont, Janine Schweier	Initial version
V01.1	2023-02-15	Martin Brunsmeier	Quality Revision
V01.2	2023-02-15	Simon Mutterer, Clemens Blattert, Janine Schweier	Revision, addition of relevant content
V0.1.3	2023-02-16	Sandra Krommes	Final version

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More information available at https://oneforest.eu

Executive summary

This scientific dataset of forest growth simulation of Alpine forests was developed in the frame of the EU project ONEforest and refers to the canton of Grisons, which is one out of four case study regions in the project.

Potential forest stand development simulations were conducted with the forest model ForClim. The simulations were carried out under no management and four alternative forest management strategies for a time horizon of 40 years (2020-2060).

To conduct the simulations for the overall canton, the approach of representative stand types was implemented and in total, 20 representative stand types were defined for the simulations to account for the biogeographic gradient and forest conditions in Grison. The database of the Swiss National Forest Inventory for Grisons was used for the definition of the representative stand types and initialization of the initial forest conditions for forest growth simulations.

The simulation outputs serve as basis for the next project milestone which aims to calculate biodiversity and forest ecosystem service indicators.

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1 Introduction

The aim of this deliverable is to provide a scientific dataset of forest growth simulations of Alpine forests. The simulation results of WP2, which were simulated with the forest model ForClim, were therefore aligned with the simulations of WP4 and their model Waldplaner (Hansen and Nagel, 2014). The alignment of the datasets allows to facilitate the calculation of biodiversity and ecosystem service indicators, which is part of the upcoming deliverable (D.2.2). The ForClim cohort database ('db_cohorts.sql') was therefore reshaped following the format of the Waldplaner individual tree output 'tr.csv' and the stand-level output 'st.csv'.

The deliverable refers to the alpine Case Study Region (CSR), which is represented by canton of Grisons located in the eastern part of Switzerland. With a land area of about 7105 km^2, Grisons is the largest canton of Switzerland and highly diverse in terms of its biogeographical regions, encompassing northern, central, and also southern alpine environmental conditions with an elevation ranging from 260 to 4049 meters a.s.l.

All presented datasets are based on forest growth simulations which were carried out with the dynamic forest model ForClim V4.0.1 (Huber et al., 2020). Simulations were carried out under present (historic) climatic conditions assuming a climate from 1980 to 2010 from the WorldClim2 database (Fick and Hijmans, 2017). A detailed description of the simulation approach, simulation settings and management strategies can be found in the earlier submitted **deliverable D2.4**.

The simulations of stand development were carried out under no management (NO) and four alternative forest management strategies for a time horizon of 40 years (2020-2060):

1. Business-as-usual (BAU): Focus on protection function and multifunctionality
2. Intensified management intensity (HIGH): Focus on wood production
3. Extensified management intensity (LOW): Focus on biodiversity
4. Climate-adapted forest management (ClimAdapt): similar to BAU + enhancing forests adaptive capacity to climate change by planting of climate adapted future tree species

To conduct the forest growth simulations for the overall canton of Grisons, the approach of Representative Stand Types (RST) was implemented (Bircher et al., 2015; e.g. Seidl et al., 2007). In total, 20 RST were defined for the simulations to account for the biogeographic gradient and forest conditions in Grison. The database of the Swiss National Forest Inventory (NFI) for Grisons (Brändli et al., 2020) was used for the definition of RSTs and initialization of the initial forest conditions for forest growth simulations. The detailed descriptions and definition of the key parameter for stratification of the CSR were accomplished and submitted in **deliverable D2.1**.

2 Individual tree output tables 'tr.csv'

The **individual tree output tables ('tr.csv')** describe the development of trees for all RST under the alternative management scenarios. An overview on the provided files is given in Table 1, with each file containing the information described in Table 2.

Table 1: Overview of provided datasets on individual tree level. For each simulated management scenario one separate file is provided.

Dataset	Simulation scenario
tr_Grison_Hist_NO.csv	No management, historic climate
tr_Grison_Hist_BAU.csv	BAU management, historic climate
tr_Grison_Hist_LOW.csv	LOW management, historic climate
tr_Grison_Hist_HIGH.csv	HIGH management, historic climate
tr_Grison_Hist_ClimAdapt.csv	ClimAdapt management, historic climate

Please note:

- ForClim simulates forest developments within small patches (here 500 m^2). Each simulation covers 200 patches to account for stochastic variability that occurs in stand development. **Each Stand Type (RST) in the tr,csv output table hence refers to a forest stand with a size of 10 ha.**
- Instead of individual trees, ForClim simulates the development of cohorts, i.e. groups of trees of the same age, size and species (Bugmann, 2001). To convert the ForClim output table into an individual tree table, the trees within each cohort were assigned to individual rows. As a consequence, however, there is no individual tree-ID available, only a cohort-ID. The **age of trees is not simulated**.
- **Alive and dead trees** are contained in the individual tree table. Trees therefore have the information 'status', which can be 'alive', 'dead' (i.e. died from natural mortality) or 'harvested' (i.e. removed by harvest). **The 'dead' or 'harvested' trees occur only until the year of mortality/harvest and disappear from the dataset in later time steps.**

Table 2: Abbreviations and descriptions of columns in the 'tr.csv'-datasets.

Attribute	Description	unit
StandType	abbreviated name of representative stand type (see Appendix A)	
Mng	simulated management scenario (see list above)	
year	respective output year	
patch	ID of patch	
patchsize	area of each patch (by default 500 m^2)	[m^2]
cohortno	cohort ID	
species	ForClim tree species abbreviation (see Appendix B)	
status	information whether a tree is '*alive*', '*dead*' (died by natural mortality) or '*harvested*' (removed by harvest) at this time	
dbh_cm	diameter at breast height	[cm]
height_m	height	[m]
vol_m3	individual tree volume	[m^3]
fol_area_m2	foliage area of individual tree (refers to all foliage of the tree crown)	[m^2]
LAI	leaf area index	

3 Stand level output tables 'st.csv'

The **stand output tables ('st.csv')** describe the simulation output aggregated on stand level under the alternative management scenarios. An overview on the provided files is given in Table 3, with each file containing the information described in Table 4.

Table 3: Overview of provided datasets with aggregated simulation results on stand level.

Dataset	Simulation scenario
st_Grison_Hist_NO.csv	No management, historic climate
st_Grison_Hist_BAU.csv	BAU management, historic climate
st_Grison_Hist_LOW.csv	LOW management, historic climate
st_Grison_Hist_HIGH.csv	HIGH management, historic climate
st_Grison_Hist_ClimAdapt.csv	ClimAdapt management, historic climate

Please note the same information as above:

- ForClim simulates forest developments within small patches (here 500 m^2) of land and each simulation covers 200 patches, to account for stochastic variability that occurs in stand development. Simulated forest stand had thus a size of 10 ha**.**
- Aggregated stand results of the st.csv were however scaled to value per hectare.

The **stand-level output tables ('st.csv')** contain the following information:

Table 4: Abbreviations and descriptions of attributes in in 'st.csv'-datasets.

Attribute	Description	unit
StandType	abbreviated name of representative stand type of (see Appendix A)	
Mng	simulated management scenario (see list above)	
year	respective output year	
size	simulated stand area	[ha]
lai	leaf area index (mean across stand)	
h100	mean height of 100 largest trees	[m]
bl_percentage	percentage of broadleaved trees	[%]
ba_m2_ha	basal area	[m^2/ha]
vol_m3_ha	growing stock	[m^3/ha]
ddom	diameter of the 100 largest trees	[cm]
n_ha	number of trees per hectare	[n/ha]

4 References

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Appendix A. Representative Stand Types: Abbreviations

Similar as done for the national scale by Bircher et al. (2015), inventory plots of the fourth Swiss NFI (Brändli et al., 2020) were stratified in terms of (1) ecoregion, (2) elevation zone, (3) tree species assemblage and (4) stand age.

Please note: The detailed descriptions and definition of the key parameter for stratification of the CSR have been accomplished and submitted in an earlier deliverable (D2.1).

Table 5: Abbreviations (StandType) for assigned Representative Stand Types.

StandType	Description
NAlp_B_M_Age50	Northern Alps, Spruce-Beech forest, montane (Age 50 yrs)
NAlp_B_M_Age100	Northern Alps, Spruce-Beech forest, montane (Age 100 yrs)
NAlp_FS_HM_Age50	Northern Alps, Spruce-Fir forest, high montane (50 yrs)
NAlp_FS_HM_Age100	Northern Alps, Spruce-Fir forest, high montane (100 yrs)
NAlp_S_SA_Age50	Northern Alps, Spruce forest, subalpine (50 yrs)
NAlp_S_SA_Age100	Northern Alps, Spruce forest, subalpine (100 yrs)
CAlp_SP_HM_Age50	Central Alps, Spruce-Pine forest, high montane (50 yrs)
CAlp_SP_HM_Age100	Central Alps, Spruce-Pine forest, high montane (100 yrs)
CAlp_S_S_Age50	Central Alps, Spruce forest, subalpine (50 yrs)
CAlp_S_S_Age100	Central Alps, Spruce forest, subalpine (100 yrs)
CAlp_LS_US_Age50	Central Alps, Spruce-Larch forest, upper subalpine (50 yrs)
CAlp_LS_US_Age100	Central Alps, Spruce-Larch forest, upper subalpine (100 yrs)
SAlp_LO_M_Age50	Southern Alps, Lime-Oak-Chestnut forest, montane (50 yrs)
SAlp_LO_M_Age100	Southern Alps, Lime-Oak-Chestnut forest, montane (100 yrs)
SAlp_S_S_Age50	Southern Alps, Spruce forest, subalpine (50 yrs)
SAlp_S_S_Age100	Southern Alps, Spruce forest, subalpine (100 yrs)
SAlp_L_US_Age50	Southern Alps, Larch forest, upper subalpine (50 yrs)
SAlp_L_US_Age100	Southern Alps, Larch forest, upper subalpine (100 yrs)
SAlp_FS_HM_Age50	Southern Alps, Spruce-Fir forest, high montane (50 yrs)
SAlp_FS_HM_Age100	Southern Alps: Spruce-Fir forest, high montane (100 yrs)

Appendix B. ForClim tree species abbreviations

Table 6: Tree species names and abbreviations.

Tree species	ForClim abbreviation
Abies alba	AAlb
Acer campestre	ACam
Acer pseudoplatanus	APse
Acer platanoides	APla
Alnus incana	AInc
Alnus glutinosa	AGlu
Betula pendula	BPen
Castanea sativa	CSat
Carpinus betulus	CBet
Corylus avellana	CAve
Fagus sylvatica	FSyl
Fraxinus excelsior	FExc
Larix decidua	LDec
Picea abies	PAbi
Pinus cembra	PCem
Pinus sylvestris	PSyl
Pinus montana	PMon
Populus tremula	PTre
Quercus petraea	QPet
Quercus pubescens	QPub
Quercus robur	QRob
Salix alba	SAlb
Sorbus aria	SAri
Sorbus aucuparia	SAuc
Taxus baccata	TBac
Tilia cordata	TCor
Tilia platyphyllos	TPla
Ulmus glabra	UGla

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