REPORT ON VULNERABILITY OF NATURE CONSERVATION SYSTEMS

(D.T3.2.2)

Conservation and sustainable utilization of forest tree diversity in Climate change

SUSTREE project n° CE614

The objective of the project is to improve integrated environmental management capacities for the protection and sustainable use of natural heritage and resources

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Author:
Valérie Poupon

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1. OBJECTIVE OF THE STUDY

The objective this study is to estimate the vulnerabilities of seven major tree species in conservation areas of Europe under climate change and evaluate the performance of alternative seed sources to reduce the vulnerability of the tree species.

The results of this study will be incorporated in pilot action 2 (DT3.4.2: Documentation of Pilot action in Conservation areas) and will contribute to the vulnerability assessment in which a transnational delineation models will be provided to conservation managers (O.T3.1).

2. PRIMARY DATA

2.1 AVAILABLE ONLINE

- Natura 2000 shapefile (http://ec.europa.eu/environment/nature/natura2000/).
- Natura 2000 sites description (http://ec.europa.eu/environment/nature/natura2000/).
- National parks shapefile (https://www.eea.europa.eu/data-and-maps/data/nationally-designated-areas-national-cdda-12).
- Eifel national park species description (https://www.nationalpark-eifel.de/en/nature-landscapes/list-of-species/liste/1/0/0/0/0/asc/).
- Country boundaries and names (EuroGeographics and UN-FAO, @EuroGeographics).

2.2 OUTPUT OF DELIVERABLE D.T1.2.4

Species distribution models (SDMs) in a .tif format for the seven studied species: *Abies alba, Fagus sylvatica, Larix decdua, Picea abies, Pinus sylvestris, Quercus petrea* and *Quercus robur*. These SDMs were created for both 4.5 and 8.5 scenarios as well as the following time periods: present, 2041-2060, 2061-2080 and 2081-2100.

3. DATA TRANSFORMATION

3.1 SPECIES DISTRIBUTION MODELS (.TIF FORMAT)

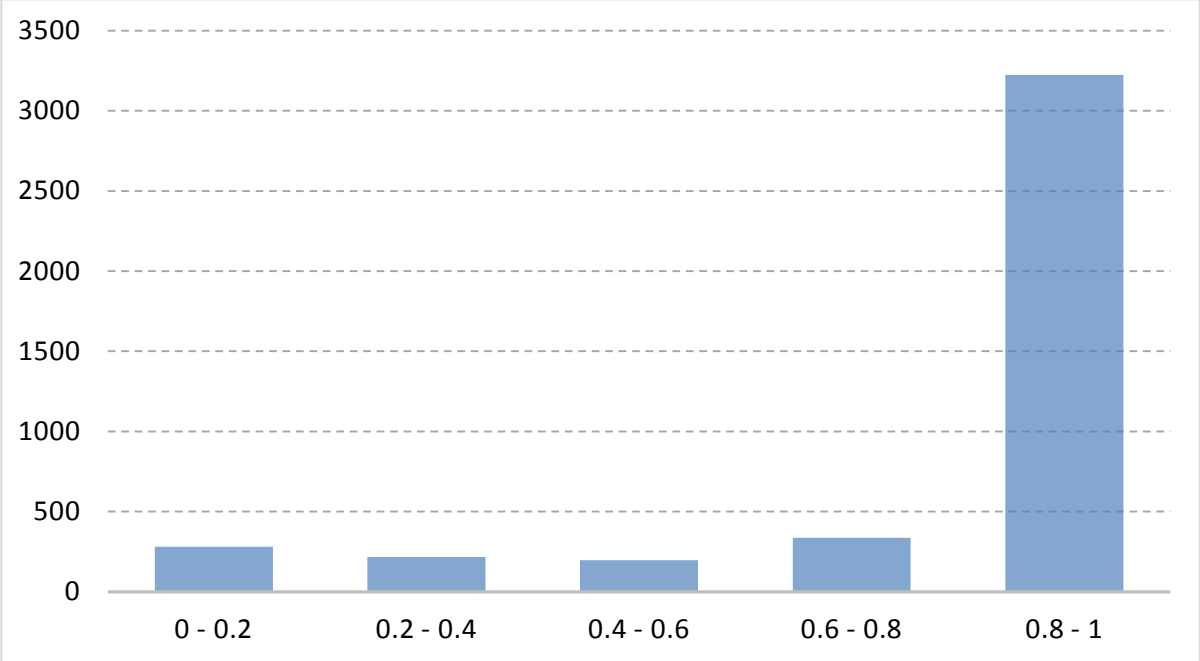
The SDMs in .tif format are representing the probabilities of presence for each species, periods and scenarios. These probabilities have values ranging from 0 to 1000 (0 to 100%). To be used more efficiently, these files were transformed in two steps using ArcGIS software. First, they were *reclassified* in 10 probabilities intervals (0-10%, 10-20% … 90-100%). Second, the raster files were transformed to polygon shape files using the function *raster to polygon* (SDMs10). After the threshold selection, the same steps were applied for the 2 probabilities interval 0-30% and 30-100% (SDMs30). The SDMs30 files were attributed values 0 for probabilities ranging between 0 and 30% (expected absence of species) and 1 for the probabilities ranging from 30 to 100% (expected presence of species). After these two steps, each SDMs were ready to use for spatial analyzes using ArcGIS software.

3.2 NATURA2000

The Natura2000 tables definitions (publically available online) were analyzed on Excel software to find sites with mention of our seven species. After this, we were able to select these Natura2000 sites on ArcGIS and create shape files of actual presence of each species in 2017 (Species Actual Presence).

4. THRESHOLD SELECTION

For this step, we *intersected* the present SDMs10 shape files of each species with the Species Actual Presence of each species. We obtained the different probabilities intervals per species per sites. For each sites was used the value of the highest probability interval since some areas were represented by several probabilities intervals. A summary of the output is represented by the graph 1 and the tables 1 & 2.



GRAPH 1: *INTERVALS OF PREDICTED PROBABILITY OF PRESENCES OF THE SEVEN SPECIES-SPECIES IN SITES WHERE THE SPECIES ACTUALLY OCCUR.*

Probabilities Intervals	Observations per probabilities intervals
0 - 0.2	281
0.2 - 0.4	217
0.4 - 0.6	197
0.6 - 0.8	337
0.8 - 1	3223
Total	4255

TABLE 1 : *PROBABILITIES INTERVALS OF THE PRESENCE PREDICTIONS OF EACH OF OUR SEVEN SPECIES AT EACH ACTUAL PRESENCE SITES.*

Species	Count of actual presence
Abies alba	152
Fagus sylvatica	224
Picea abies	1070
Larix decidua	279
Pinus sylvestris	45
Quercus petrea	25
Quercus robur	2460

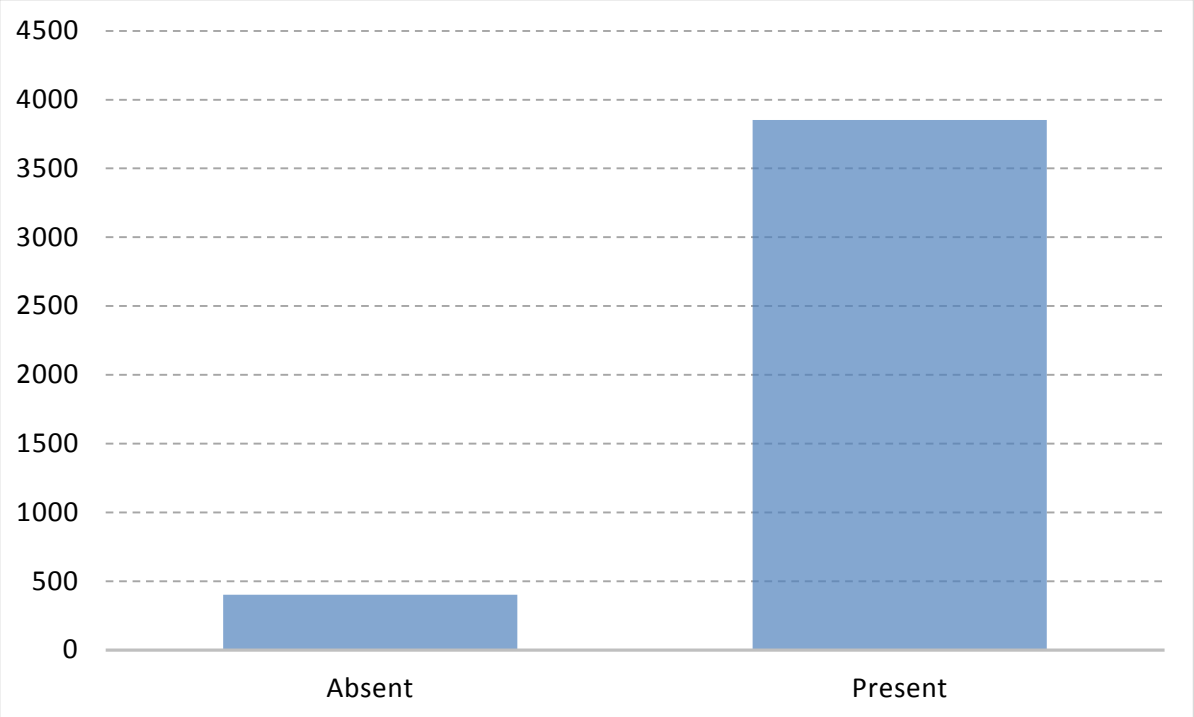
TABLE 2: COUNT OF ACTUAL PRESENCE OF OUR SEVEN STUDIED SPECIES.

To select a threshold between presence and absence, one of the best method is to maximize the sum of sensitivity and specificity (maxSSS; Liu, Berry, Dawson, & Pearson, 2005).

Unfortunately, I our case, we can only calculate the sensitivity (the proportion of true presences correctly identified by the model) and not the specificity (proportion of true absences correctly identified by the model). In this situation, one way to determine the threshold is to decide on the level of sensitivity we want to use (Liu, Newell, & White, 2015), such as sensitivity = 0.9 (Pearson, Dawson, & Liu, 2004). As you can see in the table 3 and graph 2, 90.5 percent of the actual presence had an expected probability of presence higher than 30 percent (sensitivity = 0.9). Hence, we will use 30 % as the threshold.

Status	Count	Percentage
Absence	403	9.5 %
Presence	3852	90.5 %

TABLE 3: *COUNT AND PERCENTAGE OF ACTUAL PRESENCE CLASSIFIED AS BOTH ABSENCE AND PRESENCE IN OUR SDMS WITH THE 30% THRESHOLD.*



GRAPH 2: *COUNT OF ACTUAL PRESENCE CLASSIFIED AS BOTH ABSENCE AND PRESENCE IN OUR SDMS WITH THE 30% THRESHOLD.*

5. SPECIES DISTRIBUTION MODELS

FIGURE 1: *SPECIES DISTRIBUTION MAPS FOR TWO SCENARIOS (4.5 AND 8.5) AND TWO FUTURE PERIODS (2041-2060 AND 2081-2100) FOR EACH OF THE SEVEN STUDIED SPECIES.*

On the figure 1, we can see that species such as *Quercus robur* would generally benefit from the forecasted climate change. It seems that the range of *Quercus petrea* may expand in the future, but also move up North. SDMs of *Abies alba, Picea abies* and *Larix decidua* are clearly showing that optimal ranges for these species would decrease in Central Europe and also be situated in higher latitudes and altitudes. *Fagus sylvatica* and *Pinus sylvestris* are also showing a trend up North with a relatively constant expected species range size.

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6. SITE SELECTION

Using R software, we were able to select eight sites presenting more than one species actual presence. Additionally, the Eifel national park was selected for this analysis. All the species are present in this national park. The nine sites were *merged* together using ArcGIS, the output file will be referred to as “9sites”.

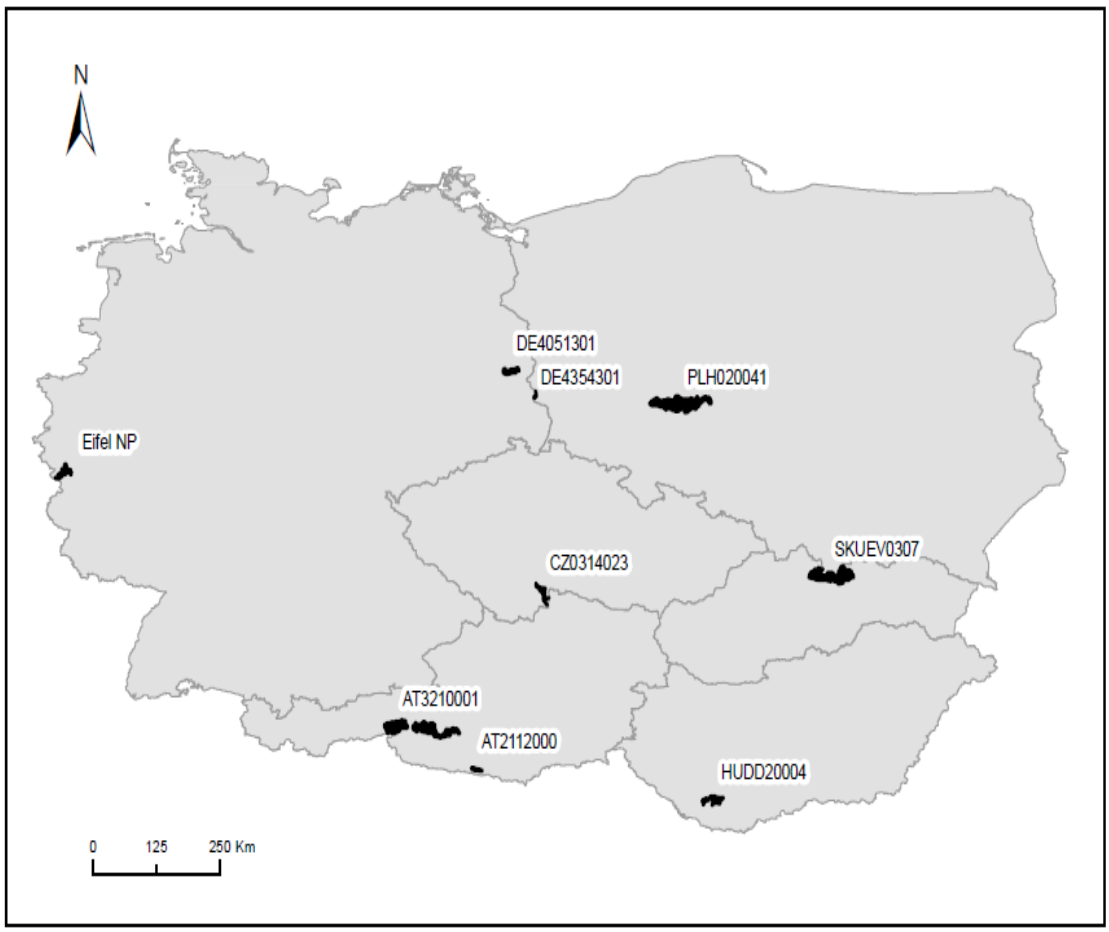

FIGURE 2: *MAP OF THE NINE CONSERVATION AREAS, WITH EIGHT NATURA2000 SITES AND ONE NATIONAL PARK (EIFEL NP).*

7. VULNERABILITY ASSESSMENT

The SDMs with the two probabilities intervals (absence/presence) were used in this deliverable. For each period and scenarios, the seven species' SDMs were *intersect* together using ArcGIS so that we were able to visualize all the species presence or absence probabilities per unit of area (Species Ranking).

With each of the Species Ranking, we *intersected* the 9sites to obtain the expected presence or absence of all the species at each sites, periods and scenarios. With this output, we can visualize if species present nowadays in each sites are probable there also in the future (table 4). When in a site we had both 0 and 1 values, we selected the value 1.

		Species						
Site	Scenario/Period	QR	QP	PS	PA	LD	FS	AA
Eifel	Present	1	1	1	1	1	1	1
	4.5 41-60	1	1	1	1	1	1	1
	8.5 41-60	1	1	1	1	1	1	1
	4.5 81-00	1	1	1	1	1	1	1
	8.5 81-00	1	1	1	0	0	1	0
AT2112000	Present	1	1	1	1	1	1	1
	4.5 41-60	1	1	1	1	1	1	1
	8.5 41-60	1	1	1	1	1	1	1
	4.5 81-00	1	1	1	1	1	1	1
	8.5 81-00	1	1	1	1	1	1	1
AT3210001	Present	1	0	1	1	1	1	1
	4.5 41-60	1	1	1	1	1	1	1
	8.5 41-60	1	1	1	1	1	1	1
	4.5 81-00	1	1	1	1	1	1	1
	8.5 81-00	1	1	1	1	1	1	1
CZ0314023	Present	1	1	1	1	1	1	1
	4.5 41-60	1	1	1	1	1	1	0
	8.5 41-60	1	1	1	1	1	1	1
	4.5 81-00	1	1	1	1	1	1	1
	8.5 81-00	1	1	1	1	0	1	0
DE4051301	Present	1	1	1	1	1	0	0
	4.5 41-60	1	1	1	1	0	0	0
	8.5 41-60	1	1	1	1	0	1	0
	4.5 81-00	1	1	1	0	0	0	0
	8.5 81-00	1	1	1	0	0	0	0
DE4354301	Present	1	1	1	1	1	1	0

	4.5 41-60	1	1	1	1	0	1	0
	8.5 41-60	1	1	1	1	0	1	0
	4.5 81-00	1	1	1	0	0	1	0
	8.5 81-00	1	1	1	0	0	1	0
HUDD20004	Present	1	1	1	0	0	1	0
	4.5 41-60	1	1	1	0	0	0	0
	8.5 41-60	1	1	1	1	1	1	0
	4.5 81-00	1	1	1	0	0	0	0
	8.5 81-00	1	1	0	0	0	0	0
PLH020041	Present	1	1	1	1	1	1	0
	4.5 41-60	1	1	1	1	0	0	0
	8.5 41-60	1	1	1	1	1	1	0
	4.5 81-00	1	1	1	0	0	1	0
	8.5 81-00	1	1	1	0	0	0	0
SKUEV0307	Present	1	1	1	1	1	1	1
	4.5 41-60	1	1	1	1	1	1	1
	8.5 41-60	1	1	1	1	1	1	1
	4.5 81-00	1	1	1	1	1	1	1
	8.5 81-00	1	1	1	1	1	1	1

TABLE 4: *PRESENCE (1) OR ABSENCE (0) OF THE SEVEN SPECIES FOR THE PRESENT TIME AS WELL AS TWO FUTURE PERIODS (2041-2060 AND 2081-2010) AND TWO SCENARIOS (4.5 AND 8.5). QR= QUERCUS ROBUR, QP= QUERCUS PETREA, PS= PINUS SYLVESTRIS, PA= PICEA ABIES, LD= LARIX DECIDUA, FS= FAGUS SYLVATICA AND AA= ABIES ALBA.*

On the table 4, we can see that low land sites such as PLH020041, HUDD20004, DE4354301 and DE4051301 are predicting a gradual decrease of the following species: *Abies alba, Fagus sylvatica, Picea abies* and *Larix decidua*. Eifel national Park and CZ0314023, situated in higher lands are showing a more moderate expected decline of the most sensitive species: *Abies alba, Larix decidua* and *Picea abies*. Finally, in the sites situated in the highest altitude, SKUEV0307, AT3210001 and AT2112000 the seven species do not seem to be at risks in the future. Some sites may even be more favorable for growth in the future than now as we can see with *Quercus petrea* in the Austrian site AT3210001.

8. BIBLIOGRAPHY

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Pearson, R. G., Dawson, T. P., & Liu, C. (2004). Modelling species distributions in Britain : a hierarchical integration of climate and land-cover data, *3*(December 2003), 285–2