

Forest ecosystem vulnerabilities to climate change in the Carpathians from the perspective of polish experts

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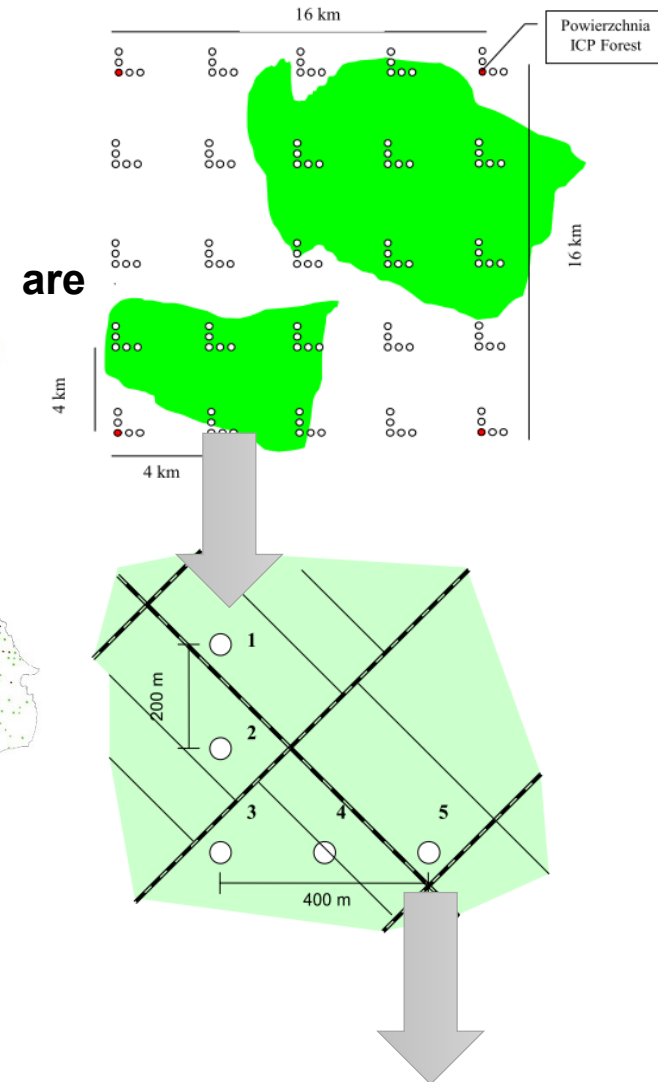
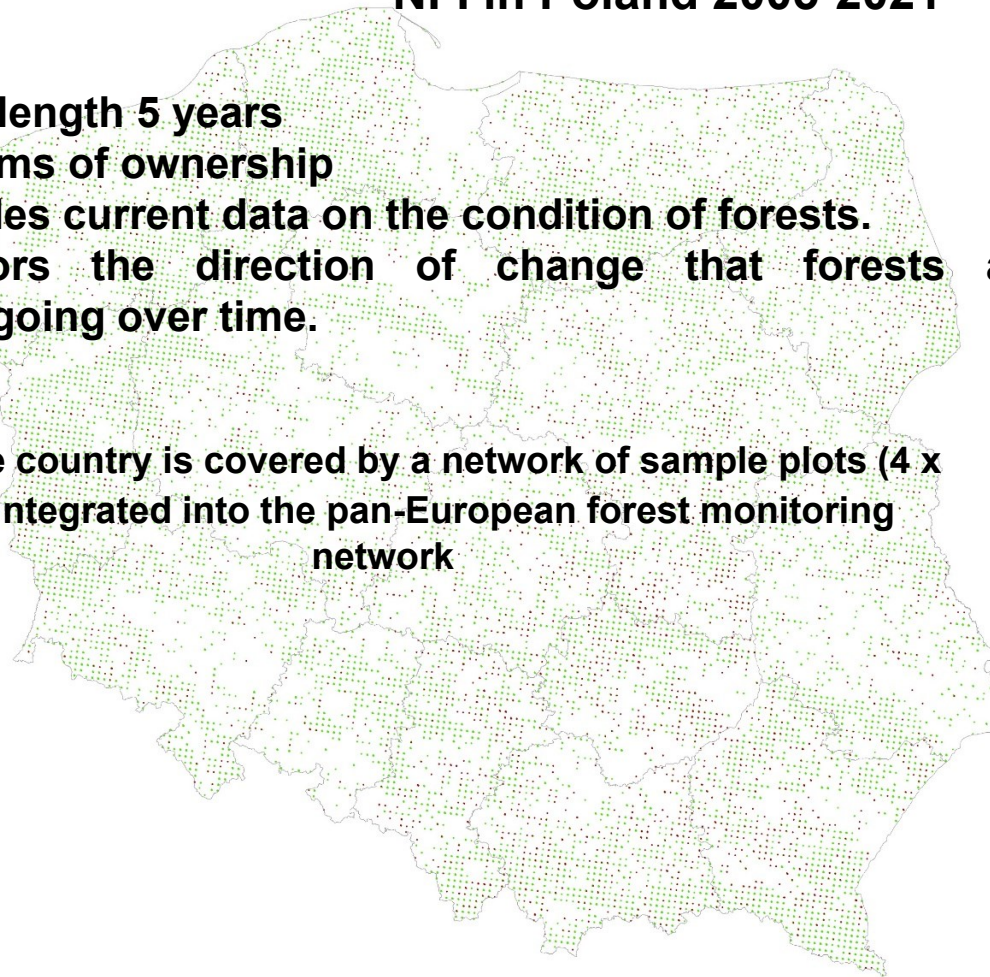
Information about Polish forests National Forest Inventory



NFI in Poland 2005-2021

- **Cycle length 5 years**
- **All forms of ownership**
- **Provides current data on the condition of forests.**
- **Monitors the direction of change that forests are undergoing over time.**

The whole country is covered by a network of sample plots (4 x 4 km), integrated into the pan-European forest monitoring network

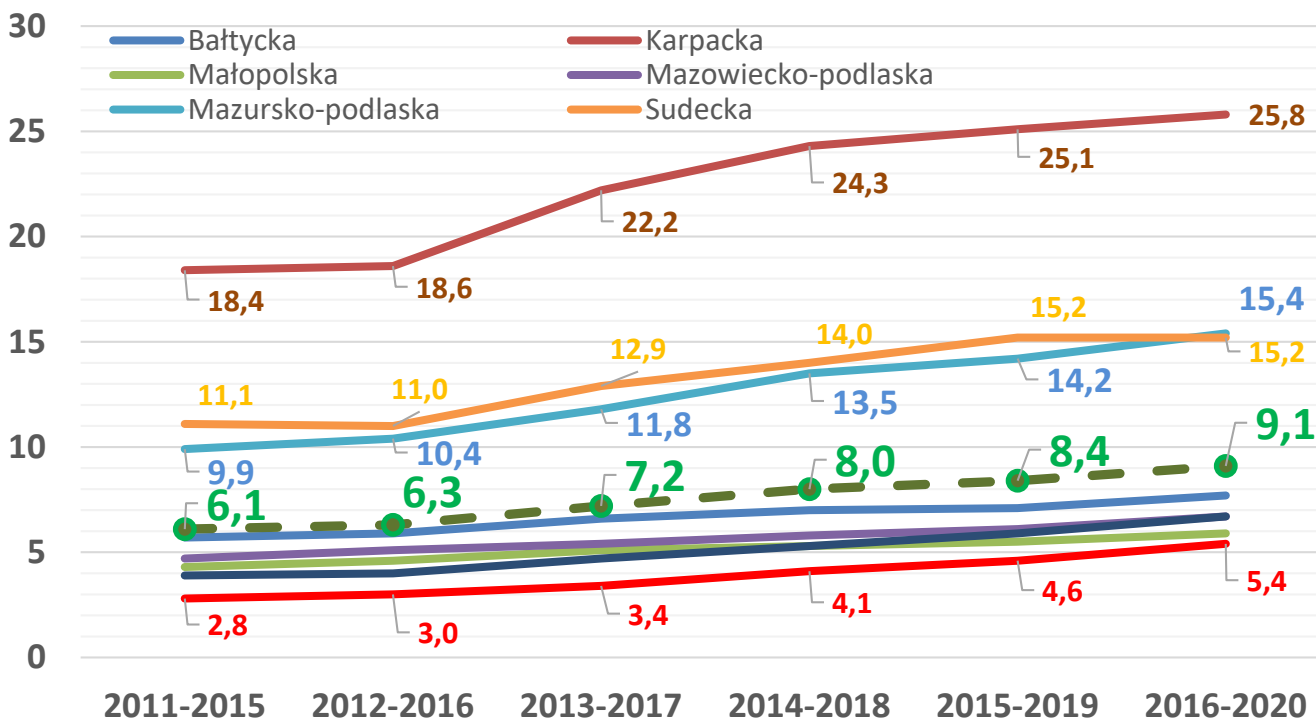


NFI Results 2016-2020

Indicators	Carpathian Region	Poland
Forest Area [ha]	815 269 (8,8 %)	9 258 843
Growing Stock [million m ³]	284,4 (10,8%)	2 657,0
Volume [m ³ /ha]	351,2	287
Mean Age [years]	68	59
Dead wood [m ³ /ha]	28,8	9,1
Current volume increment [m ³ /ha/year]	11,46	9,29
Harvest	5,73	6,1
Species composition by dominant species [%]	Coniferous – 55,3 (Fir 29,7) Broadleaved – 44,7 (Beech – 27,5)	Coniferous – 68,2 (Pine 58,1) Broadleaved – 31,8 (Oak – 8,1)

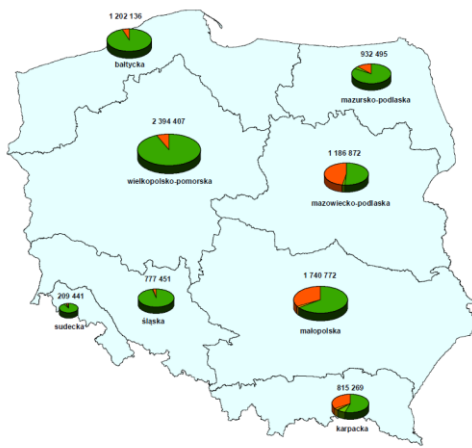


Dead wood by natural forest divisions m³/ha

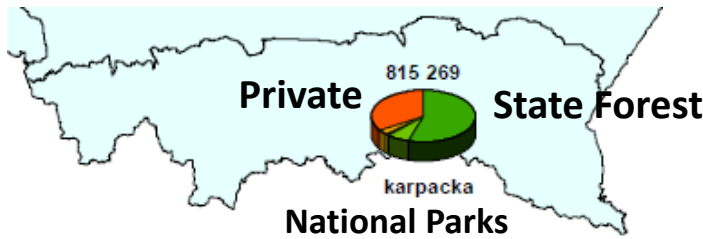


Carpathian region

Poland



Ownership forms of forest



BACCARA Publications

International project “Biodiversity And Climate Change, A Risk Analysis (BACCARA)”, 7. Framerkork Program, 2009-2012.

Poland: Radziejowa (Beskid Sądecki), Pilsko (Beskid Żywiecki)
Altitudinal transects – gradient to simulate climatic variability (change)

Publications:

Rabasa S. G., Granda E., Benavides R. Kunstler G., Espelta J.M., Ogaya R., Peñuelas J., Scherer-Lorenzen M., Gil W., Grodzki W., Ambrozy S., Bergh J., Hódar J.A., Zamora R., Valladares F. 2013. Disparity in elevational shifts of European trees in response to recent climate warming. *Global Change Biology* 19: 2490–2499. DOI: 10.1111/gcb.12220

Ambrozy S., Grodzki W. 2013. Biodiversity And Climate Change, A Risk Analysis (BACCARA). Carpathian Case – goals and assumptions. J. Kozak et al. (eds.), *The Carpathians: Integrating Nature and Society Towards Sustainability, Environmental Science and Engineering*, Springer-Verlag Berlin Heidelberg: 425-428. DOI: 10.1007/978-3-642-12725-0_29

Grodzki W., Ambrozy S., Gil W. 2013. The growth and biodiversity of spruce stands in variable climate conditions (Radziejowa Case Study). *Folia Forestalia Polonica, Series A – Forestry*, 55(3): 146-156. DOI: 10.2478/ffp-2013-00016.



Biodiversity And Climate Change, A Risk Analysis (BACCARA), Carpathian Case - goals and assumptions
Sławomir Ambrozy, Wojciech Grodzki
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BACCARA is a research project supported by the European Community's Seventh Framework Programme (FP7) under the contract no. 246447. The project is coordinated by the Forest Research Institute in Kraków, Poland. The project is aimed to present the goals and approach of this project both species-rich in the Carpathian Case.

The main goal of BACCARA is to build the tools that will enable forest managers and policy makers to evaluate the risk of European forest biodiversity and productivity loss under climate change. BACCARA will consist of 2-dimensional risk assessment model (Fig. 1) linking climate change, functional diversity and forest productivity. The approach will be applied to the main European forest landscapes. One of the study areas is located in the Polish part of the Carpathians (Fig. 2).

Radziejowa in the Carpathians – forest biodiversity response to climate change (case study)
Wojciech Grodzki, Sławomir Ambrozy
Forest Research Institute, Kraków, Poland

Introduction
Climate change could lead to transformation of forest vegetation and related organisms e.g. herbivory insects and their natural predators in forest zones, the vegetation in the mountains appear to be particularly vulnerable to such changes. Because of this the diversity of ground vegetation and forest stands according to the number of species forming the stands.

Material and methods
The study area has been located in the Carpathians in Radziejowa Massif (Beskid Sądecki, Poland). In the altitudinal gradient 500, 700, 900, 1100 m a.s.l. (Fig. 1) a series of 15 experimental plots was established. An inventory from 2004 to 2010 was carried out. In each direction the plots represented the forest vegetation gradient from pine forest stands to mixed stands. In total 100 000 m² a.s.l. and 15 sections on elevation 1100 m a.s.l. were used to estimate tree species diversity. This means that each elevation had an equal number of plots for each species stand and the total area - stands with the most rich species composition. The field studies were carried out in the years 2010 and 2011.

Results
In the altitudinal gradient the diversity has been observed to phylogenetic diversity using the Shannon-Wiener species diversity index was calculated. The species coverage index in the range from 0.8000 to 0.9000 has been observed for elevation 1100 m a.s.l. On each plot the number of plots have been recorded to determine the diversity of bark and wood boring insects living on spruce and their densities, expressed by biomass (mean value).

Radziejowa in the Carpathians – an example of forest biodiversity in altitudinally diversified landscape
Wojciech Grodzki, Sławomir Ambrozy, Dorota Hilszczyńska, Jacek Hilszczyński, Anna Zielińska
Forest Research Institute, Silesian Study - Kraków, Poland

Radziejowa Massif is located in the Beskid Sądecki in Western Carpathians (Fig. 1, 2). The study area is covered by mixed Picea abies, Fagus sylvatica and Abies alba stands. Mean altitudinal forest floor measurement plots (500, 700, 900 and 1100 m a.s.l.) is expected to cover local climatic variability (Fig. 3) and spectrum of forest types and species (Fig. 4).

A set of 15 plots (4-3) diversity levels per altitude – was established in altitudinal gradient (Fig. 2). On each plot (2725 m²) all trees were identified and measured (Fig. 5, Table 1). The occurrence of root pathogens (Heterobasidium parvum, Armillaria cephalone and A. cylindrica) (Fig. 6) and the abundance of mycorrhizas (Fig. 6) was recorded on individual attributes. Selected spruce bolts (Fig. 10) were used to estimate the diversity of bark- and wood boring insects and associated species (Fig. 10).

Pilsko Massif in the Carpathians – biodiversity of Norway spruce stands in altitudinally diversified landscape
Wojciech Grodzki, Sławomir Ambrozy, Dorota Hilszczyńska, Jacek Hilszczyński, Maciejewski Kosciuszko, Anna Zielińska
Forest Research Institute, Silesian Study - Kraków, Poland

BACCARA is a research project which main goal is to build the tools that will enable forest managers and policy makers to evaluate the risk of European forest biodiversity and productivity loss under climate change. Investigations in the Carpathians are located in two areas: Radziejowa (Radziejowa Massif - mixed stands with Picea abies) and Pilsko (Pilsko Massif - spruce-dominated stands) (Fig. 1) (Ambrozy, Grodzki 2010).

The area of presented study is located in Pilsko Massif (Beskid Żywiecki). A set of 4 experimental plots in the altitudinal gradient: 500, 700, 900, 1100 m a.s.l. (Fig. 2) representing thermal profile (Fig. 3), was established in stands dominated by Norway spruce. The field studies were carried out in the years 2010-2012. On each plot (2725 m²) all trees were identified and measured (Fig. 3) and the ground vegetation was recorded using phytosociological procedure (Fig. 4, Table 1). The occurrence of root pathogens (Fig. 6) and the abundance of mycorrhizas (Fig. 6) was recorded on individual attributes. To estimate the diversity of bark- and wood boring insects and associated species (Fig. 10) selected spruce bolts (Fig. 11) were used. Results from Radziejowa, already presented (Grodzki et al. 2012), are used for comparison.

Forum Carpaticum 2010

Forum Carpaticum 2012

Tackling climate change: the contribution of forest scientific knowledge
Tours V 2012

IUFRO 7.03.10, Palanga (Lithuania) 2012

Abstracts and scientific papers from the Forum Carpaticum 2010 and 2012, IUFRO 7.03.10, and Tours V 2012.

The abstracts include:

- 1.4 Abies alba-Abies balsamita community**: A study on the diversity of natural enemies of herbivory insects in the species composition of herbivory insects and their larval remains, including fungi (mycorrhizas) and fungal root pathogens associated with Norway spruce as main forest species.
- 1.5 A study on the diversity of natural enemies of herbivory insects in the species composition of herbivory insects and their larval remains, including fungi (mycorrhizas) and fungal root pathogens associated with Norway spruce as main forest species.**
- 1.6 The diversity of natural enemies of herbivory insects in the species composition of herbivory insects and their larval remains, including fungi (mycorrhizas) and fungal root pathogens associated with Norway spruce as main forest species.**
- 1.7 The diversity of natural enemies of herbivory insects in the species composition of herbivory insects and their larval remains, including fungi (mycorrhizas) and fungal root pathogens associated with Norway spruce as main forest species.**
- 1.8 The diversity of natural enemies of herbivory insects in the species composition of herbivory insects and their larval remains, including fungi (mycorrhizas) and fungal root pathogens associated with Norway spruce as main forest species.**
- 1.9 The diversity of natural enemies of herbivory insects in the species composition of herbivory insects and their larval remains, including fungi (mycorrhizas) and fungal root pathogens associated with Norway spruce as main forest species.**
- 1.10 The diversity of natural enemies of herbivory insects in the species composition of herbivory insects and their larval remains, including fungi (mycorrhizas) and fungal root pathogens associated with Norway spruce as main forest species.**

TATRA NP Publications

Tatra National Park

Detection and definition of the altitudinal distribution of 2 bark beetle species not recorded earlier in the Tatra Mts. Altitudinal transects 1000-1400 m a.s.l.

Grodzki W. 2020. On the vertical distribution of *Ips duplicatus*, *I. cembrae* and some bark- and longhorn beetles (Col.: Curculionidae, Scolytinae; Col.: Cerambycidae) in the Tatra National Park in Poland. Folia Forestalia Polonica Series A – Forestry, Vol. 62 (2): 68–77. DOI: 10.2478/ffp-2020-0008

The upward spreading of the studied insects as a possible effect of climate change and the resulting environmental conditions favourable for those organisms.

Example of forest management under disaster pressure

Programme for the Beskydy Mountains (2003) - support for spruce forest disaster management in the Beskydy Mountains and their reconstruction (State Forests and Forestry Faculty in Cracow)





COST Action CA15226 CLIMO, Oct 2016 – Oct 2020, brings together international scientists, experts and young scholars to develop Climate-Smart Forestry (CSF) concept for European mountain regions. The [Management Committee](#) comprises of representatives from 28 COST Member Countries, as well as [Observers](#) from 5 Near Neighbour Countries (NNC) and 5 International Partner Countries (IPC).

1. Definition of Climate-Smart Forestry and identification of “smartness” criteria for the European mountain forests
2. Creation of an European Smart Forest Network (ESFONET)
3. Analysis of the requirements for the development of a cybernetic web of experimental structures
4. Development of innovative schemes of payment for environmental services (PES)
5. Dissemination of research results to the general public and to stakeholders



BOOK (Springer)
Expected in 2021

<https://www.youtube.com/watch?v=qouZ-AUavlQ>



Summary

the most pressing vulnerabilities of forests and their ecosystem services to climate change

- A new situation for which owners and managers are not fully prepared (pests, droughts, floods, changing expectations of forests). Monitoring and trends observed are important

scientific studies

- From Baccara project to Climo COST Action

Which responses to identified climate impacts and risks are already being implemented?

- Programme for the Beskydy Mountains

What are the main challenges, but also opportunities, when dealing with current and future climate variability in forest ecosystems?

- Permanent forest monitoring need, exchange of knowledge science - practice, education of forest managers. Involving local communities in discussions

