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The perspectives of biogeography at forestry environmental modelling

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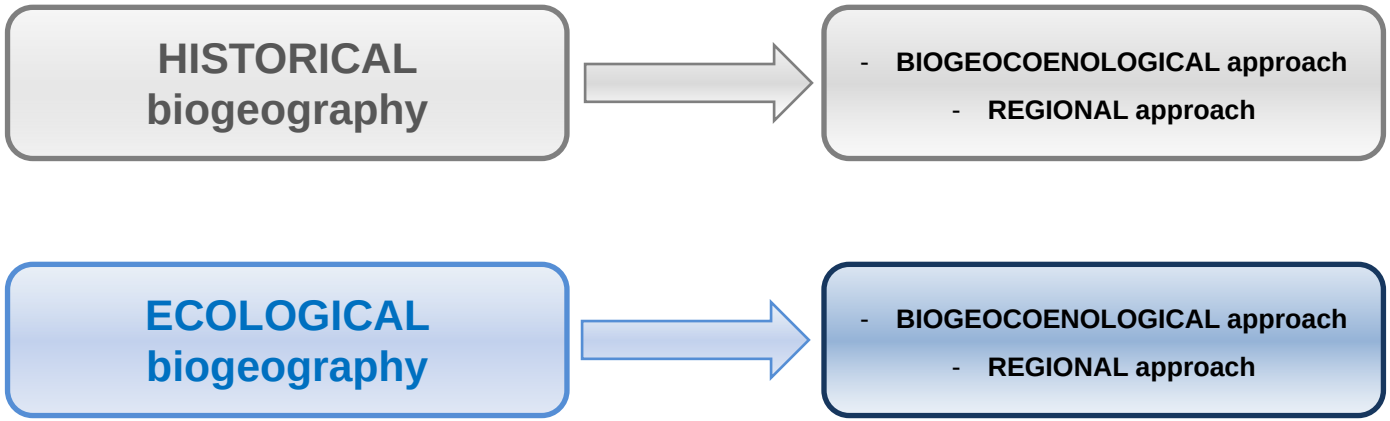
Introduction

Biogeography is a multidisciplinary science including geography, ecology, phytocoenoloy, paleontology and evolutionary biology.

Aims:

- Mapping of organism spreading development according to plate tectonics and evolution
- Mapping of spatial relations between biota and inorganic environment



Relations between regional and biogeocoenological biogeography

Regional biogeography
defines a unique, unrepeatable, continual formations with a characteristic heterogeneity:

- Area
- Subarea
- Province
- Subprovince
- Bioregion

BGC biogeography focuses on scattered repeatable phenomenas occuring at sites with similar predictors within a regional BG unit:

- Vegetational zones
- Biomes
- Vegetational tiers
- Biochores

Regional biogeography focuses on internally consistent tracks of particular BGCU different from the surroundings

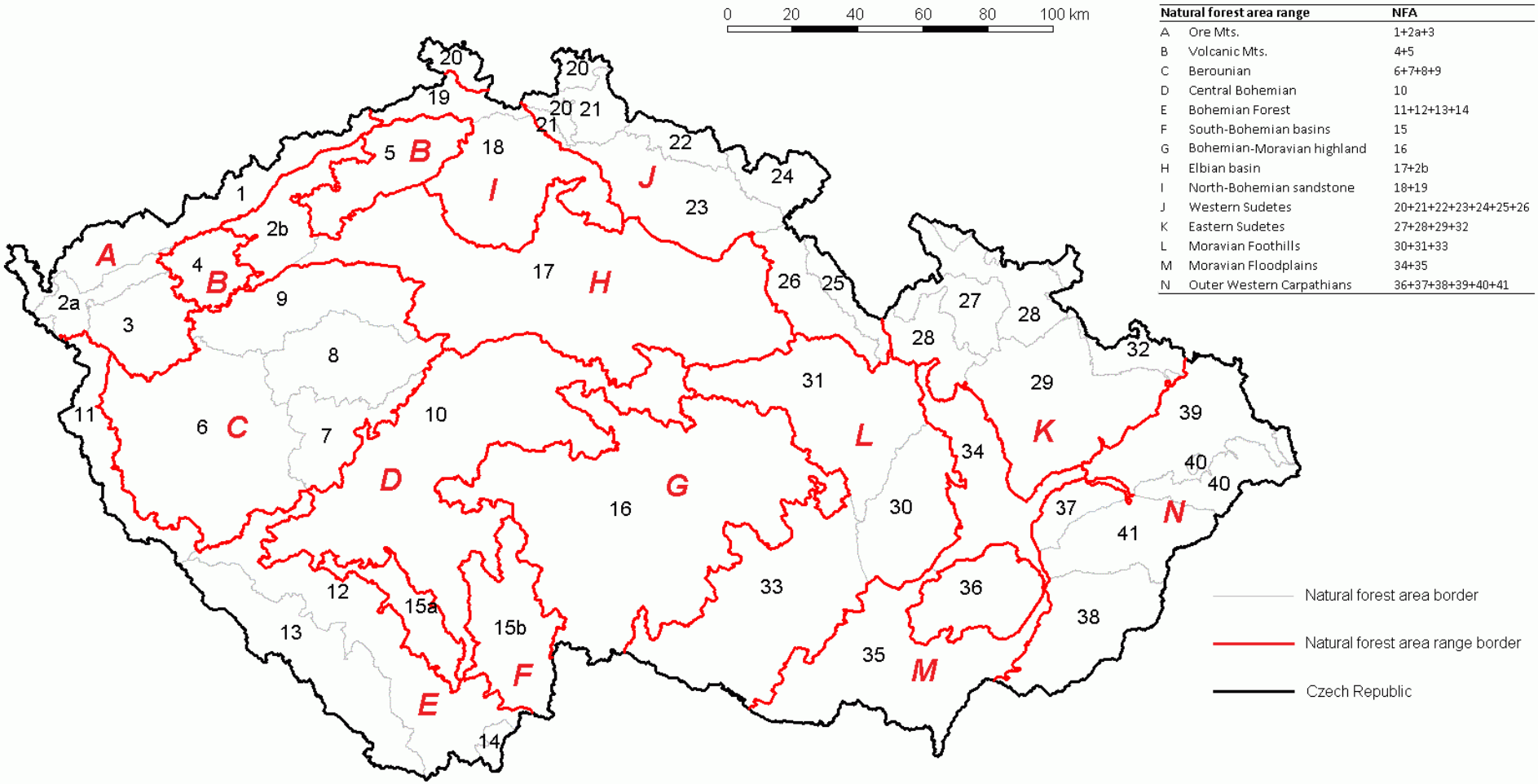
Biogeocoenological biogeography defines:

- Zonal communities
- Azonal communities
- Intrazonal communities

Relations between biogeography and forestry EM

- Forestry specifically uses the knowledge about the conditions of forest growth and spread of forest tree species according to **applied forestry biogeography**.
- Biogeographical information is used to adjust the balance between economic and environmental optimization of tree species composition.
- The optimizing of the tree species composition is based on keeping the tolerances between the target forest structure and their natural state.
- The forestry biogeography deals with the application of the natural division of forests for spatial differentiation in their management.

The natural forest area ranges in the Czech Republic



Natural forest area range		NFA
A	Ore Mts.	1+2a+3
B	Volcanic Mts.	4+5
C	Berounian	6+7+8+9
D	Central Bohemian	10
E	Bohemian Forest	11+12+13+14
F	South-Bohemian basins	15
G	Bohemian-Moravian highland	16
H	Elbian basin	17+2b
I	North-Bohemian sandstone	18+19
J	Western Sudetes	20+21+22+23+24+25+26
K	Eastern Sudetes	27+28+29+32
L	Moravian Foothills	30+31+33
M	Moravian Floodplains	34+35
N	Outer Western Carpathians	36+37+38+39+40+41

The aggregated management populations of forest types in the Czech Republic

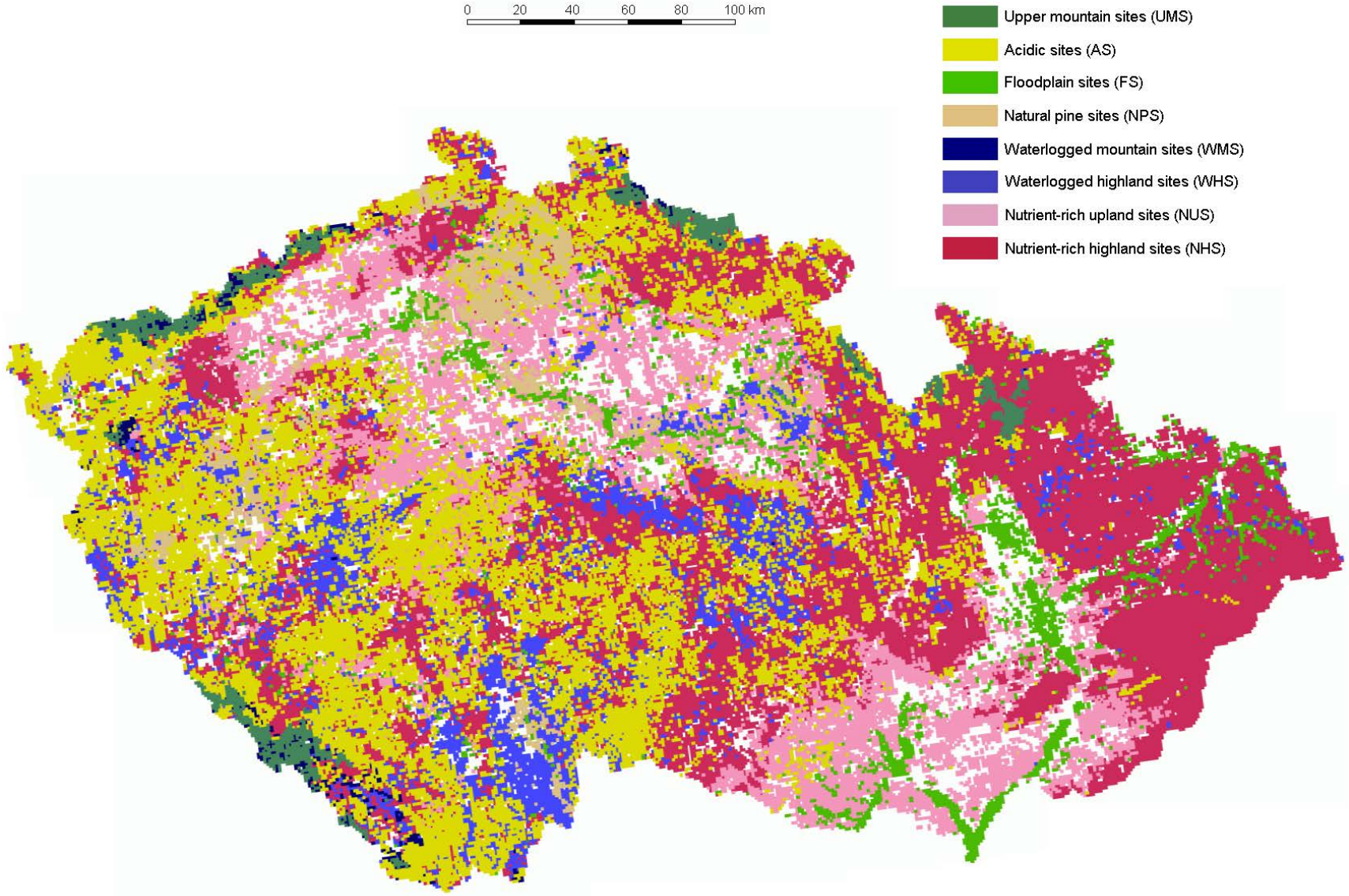


Table 1. Generalized system of natural ecosystem diversity in the Czech Republic (according to Viewegh et al., 2003) and consequences for definition of the aggregated management population of forest types. O – oak; B-O – beech-oak; O-B – oak-beech; B – beech; F-B – fir-beech; S-B – spruce-beech; B-S – beech-spruce; S – spruce; DP – dwarf pine.

Ecosystems		Intrazonal associations							Azonal associations							Zonal associations											
Unit	Ecological series	Wet			Gleyed				Floodplains		Extreme					Acidic				Nutriet-rich							
		T	G	R	Q	P	O	V	U	L	J	X	Y	Z	M	N	K	I	S	B	H	W	C	D	A		
Vegetation tier	DP, S, B-S	Waterlogged mountain sites													Upper mountain sites												
	S-B, F-B, B, O-B, B-O, O	Waterlogged highland sites							Floodplain sites		Extraordinary unfavourable sites				Acidic sites					Nutrient-rich highland sites							
													Natural pine sites							Nutrient-rich upland sites							

Table 2. Concequences between potential natural vegetation and aggregated management populations of forest types (AMP) in the Czech Republic.

AMP	Potential natural vegetation	Area (km^2)	Composition (%)	Pits Density (*n*/km^2)	
Floodplain sites (FS)	*Alnion incanae* *Salicion albae*	601	2.38	590	0.98
Natural pine sites (NPS)	*Dicranio-Pinion* *Erico-Pinion*	976	3.86	1148	1.18
Acidic sites (AS)	*Melampyro nemorosi-Carpinetum* *Genisto germanicae-Quercion* *Luzulo-Fagion*	5,667	22.40	5699	1.01
Nutrient-rich upland sites (NUS)	*Carpinion* *Eu-Fagenion* *Tilio-Acerion*	2,660	10.51	2226	0.84
Nutrient-rich highland sites (NHS)	*Acerenion* *Dentario enneaphylli-Fagetum*	10,654	42.11	8368	0.79
Waterlogged highland sites (WHS)	*Alnion glutionosae* *Betulion pubescentis*	3,157	12.48	2958	0.94
Waterlogged mountain sites (WMS)	*Sphagnion medii* *Vaccinio uliginosi-Pinetum rotundatae* *Sphagno-Piceetum* *Mastigobryo-Piceetum*	582	2.30	601	1.03
Upper mountain sites (UMS)	*Calamagrostio villosae-Piceetum* *Dryopterido dilatatae-Piceetum*	1,002	3.96	1417	1.41

Material and methods

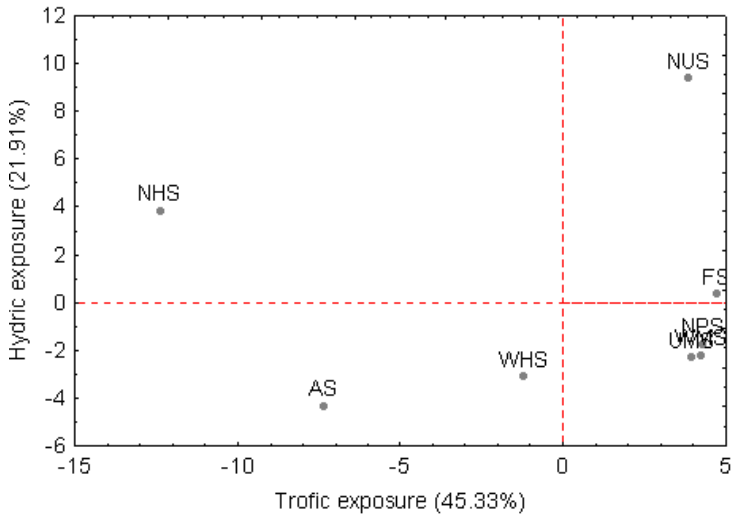
- Defining appropriate spatial frameworks for environmental modeling depends on whether the observed phenomenas in the landscape are more conditioned by biogeocoenological or regional characteristics of ecosystems.
- Perspectives of biogeography at FEM were assessed by comparing the significance of any regional or biogeocoenological effects on biogeocoenose ecotope and comparison of biogeocoenological units within different units of the regional division.
- Perspectives of biogeography at FEM were performed using exploratory analysis of disaggregated data, selection of suitable spatial frameworks for modelling and comparison BGCU's composition within the various units of the regional division in the Czech Republic.
- Natural forest area ranges (NFAR) generally associate areas with similar forest growth conditions.
- The grouping of the forest types with similar forest ecology form the framework for management populations . Similar relations of the MP’s with zonal, intrazonal, azonal as well as extrazonal vegetation create frameworks for their generalization upto aggregated MP’s (AMP’s) .
- the BGCU’s were characterized by interim absolute changes and average absolute changes of selected site characteristics.
- Soil characteristics were used for the evaluation of the forest biogeographical attributes according to the soil properties naturally build permanent site conditions and they have direct relation with ecological series of the BGCU.
- Mutual separability of the selected forest division units was verified by discrimination analysis.
- The composition of BGCU’s in the particular selected units of regional division of the CR has been explored by principal component analysis (PCA) and compared by ANOVA.

Results and discussion

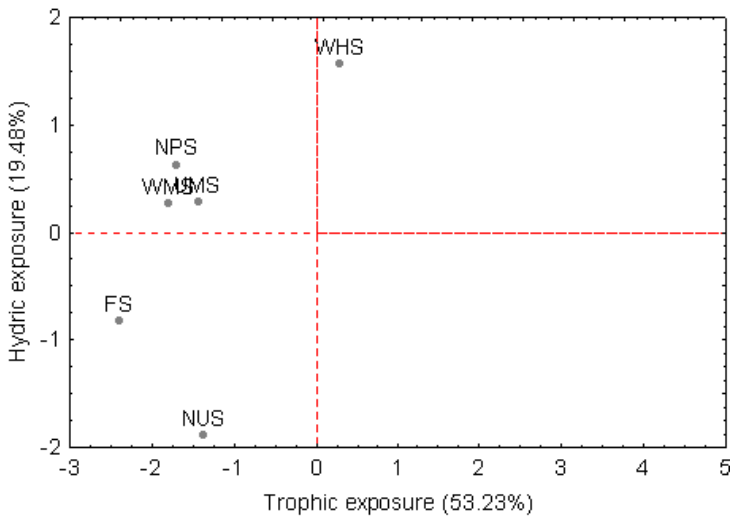
- Biogeocoenological forest division influenced the differences in the variability of soil properties much more significantly than NFAR’s.
- The most frequent AMP’s in the CR are nutrient-rich highland sites (NHS) (42%), acidic sites (AS) (22%), and waterlogged highland sites (WHS) (13%).
- Most NFAR’s usually include all AMP’s. Only in NFAR’s outside the main mountain systems in the CR, or in NFAR’s with little ecotope diversity some AMP’s are usually missing or occur in negligible amounts (<1 % of forest soil area).
- In NFAR’s with practically all AMP’s the total representation of usually two or three AMP’s is >50 %.
- The most representative NFAR’s by AMP are the Western Sudetes (J) and the Bohemian Forest (E).
- The most important component factors diversificating wide defined BGCU's were the trophic exposure (factor 1), hydric exposure (factor 2) and altitude exposure (factor 3).
- Totally 56 biochoral distributional features describes >90% of the individual bioregion variance and 72 features describes the same statistically significant majority of the EPM variance.

The aggregated management population distribution factors at selected segments of the individual landcape division in the Czech Republic.

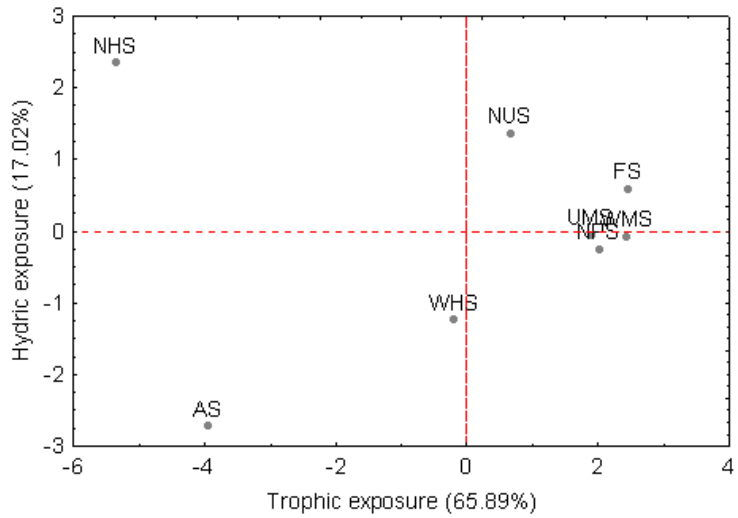
a) AMP at bioregions of the CR



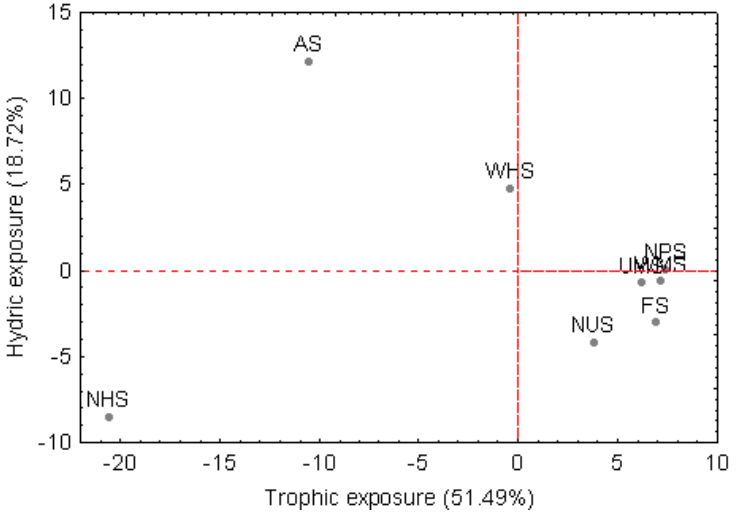
b) AMP at natural forest area ranges of the CR



c) AMP at districts of the CR

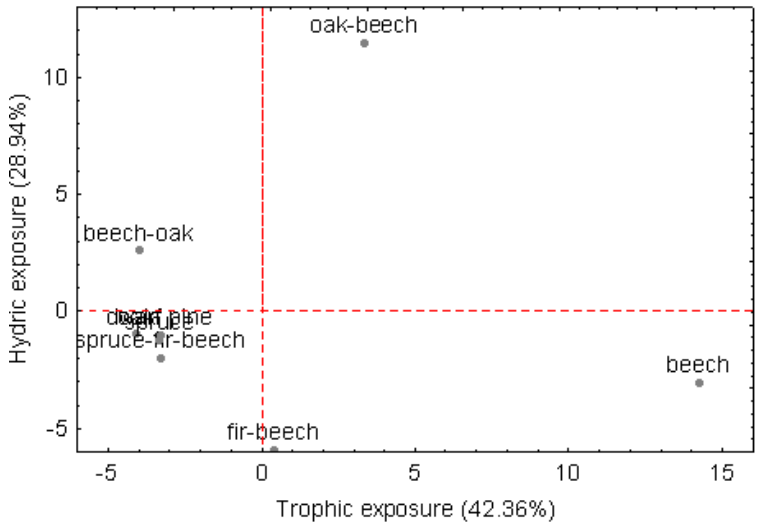


d) AMP at extended power municipalities of the CR

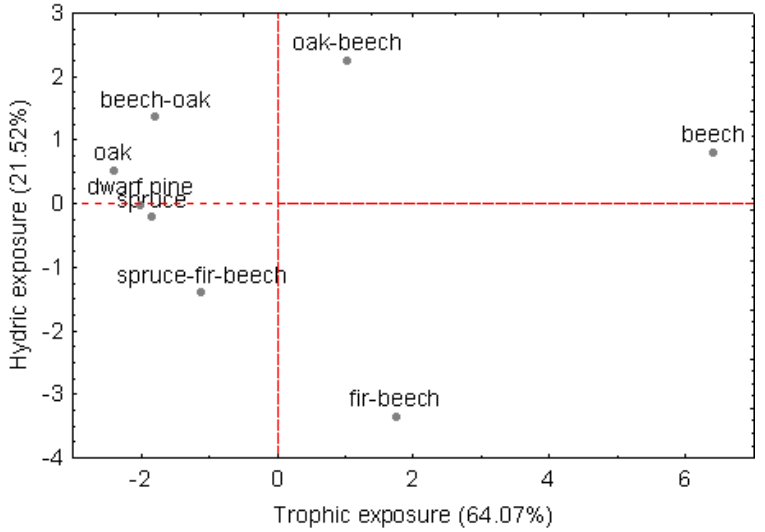


The vegetational tiers distribution factors at selected segments of the individual landcape division in the Czech Republic.

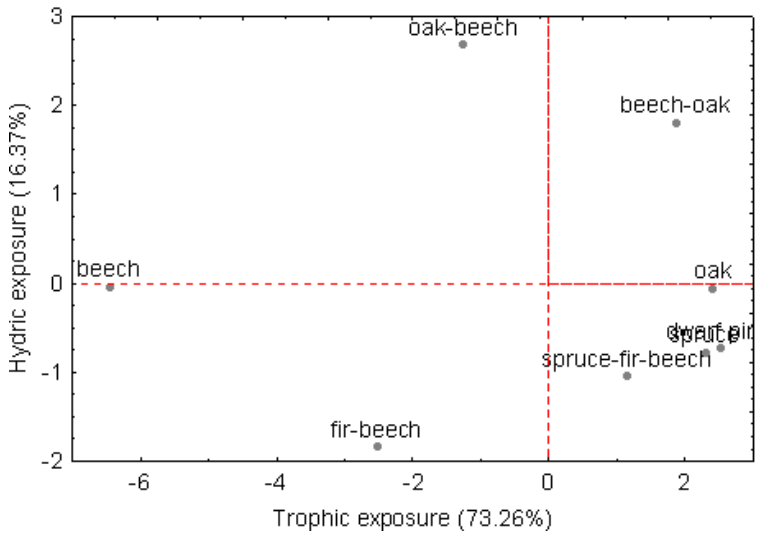
a) VT at bioregions of the CR



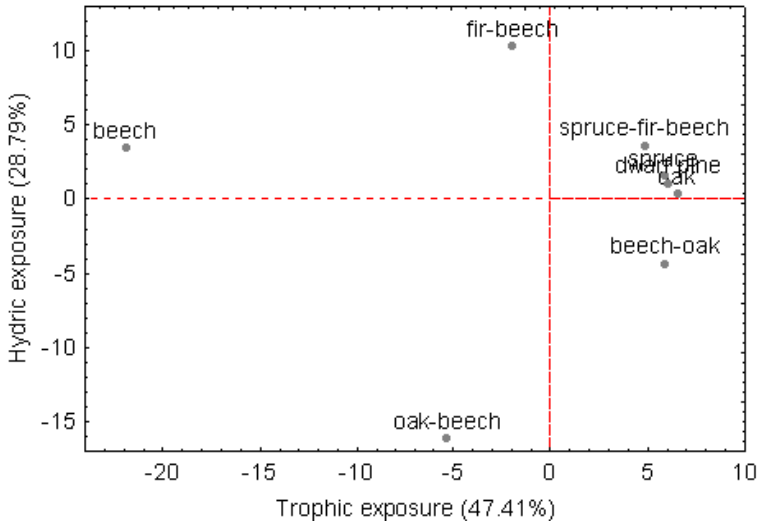
b) VT at natural forest area ranges of the CR



c) VT at districts of the CR



d) VT at exposure power municipaties of the CR



Summary

- Biogeocoenological forest soil properties division in the Czech Republic differentiate ecosystems more than regional division.
- The variability of chemical and physico-chemical properties of forest soils in the Czech Republic was significantly different in forest biogeocoenological units, but generally were not different in various regions of the country.
- The proposed management populations of forest types indicate regional diversity of biogeocoenological units like vegetation tiers.
- Natural forest area ranges indicate the regional diversity of forest growth conditions like the districts.
- Diversity of the aggregated management populations and vegetation tiers was significantly indicated by the three component factors.
- Trophic exposure divided units with wide ranges of physico-chemical soil properties and units with narrow intervals of soil properties. It explained almost 66% of the total diversity of AMP and >73% of VT diversity. Hydric exposure divided drying units and units hydric normal to wet. It explained >19% of AMP diversity and 29% of VT diversity. Altitude exposure explained >16% of AMP diversity and 13% of VT diversity.

References

BARBATI A. et al. (2007): European forest types. Categories and types for sustainable forest management reporting and policy. European Environment Agency, Copenhagen – Luxembourg.

BUČEK A. (2006): Geobiocenologická typologie krajiny. In: Význam lesnické typologie pro současné lesní hospodářství. Česká lesnická společnost, Křtiny: 13.

BUČEK A., LACINA J. (1999): Geobiocenologie II. Geobiocenologická typologie krajiny České republiky. MZLU v Brně (textbook).

CULEK M. (2007): Biogeographical division of the Czech Republic. In: Dreslerová J. (ed.), Ekologie krajiny (Journal of Landscape Ecology). Lesnická práce, Kostelec nad Černými lesy: 50–57.

CHERNOV Y.I., MATVEYEVA N.V. (1997): Arctic ecosystems in Russia. In: WIELGOLASKI F.E. (ed.), Ecosystems of the World 3. Polar and Alpine Tundra. Elsevier, Amsterdam – Lausanne – New York – Oxford – Shannon – Singapore – Tokyo: 361–507.

COX C.B. (2001): The biogeographic regions reconsidered. Journal of Biogeography 28: 511–523.

ELLENBERG H. (1996): Vegetation Mitteleuropas mit den Alpen in ökologischer, dynamischer und historischer Sicht. Verlag Eugen Ulmer GmbH & Co, Stuttgart.

KORPEĽ Š. (1989): Pralesy Slovenska. Veda, Bratislava.

McGLYNN T. (2010): Effects of Biogeography on Community Diversity. Nature Education Knowledge 1: 32.

OLSON D.M. et al. (2001): Terrestrial Ecoregions of the World: A New Map of Life on Earth. BioScience 51: 933–938.

PITKO J., PLÍVA K. (1967): Hospodárské súbory lesných typov a ich využitie. Lesnický časopis 13: 905–924.

SAMEC P. (2009): A check on biogeographical regionalisation of forest soil buffering. Acta Musei Beskidensis 1: 1–22.

SAMEC P. et al. (2010): Soil component vectors in the southwestern Silesian Beskids. Electronical Journal of Polish Agricultural Universities 13: #14.

SKALICKÝ V. (1988): Regionálně fytogeografické členění. In: Hejný S., Slavík B. (eds.), Květena České socialistické republiky 1. Academia, Praha: 103–121.

TOMÁŠKOVÁ I. (2004): Evaluation of changes in the trees species composition of Czech forests. Journal of Forest Science 50: 31–37.

UDVARDY M.D.F. (1975): A Classification of the Biogeographical Provinces of the World. IUCN, Occasional Paper, no. 18, Morges.