

COMPLEX COMPARISON OF BAVARIAN AND BOHEMIAN FOREST NATIONAL PARKS FROM GEOGRAPHICAL PERSPECTIVE: IS THERE MORE SIMILARITY OR DIFFERENCE?

TOMÁŠ JANÍK¹, DUŠAN ROMPORTL¹

¹*Faculty of Science, Charles University in Prague, Albertov 6, 12843, Prague 2, Czech Republic, e-mail: janikt@natur.cuni.cz*

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ABSTRACT

This article focuses on comparison of the landscape of two National Parks (Bavarian and Bohemian Forest), which together create the largest area of wilderness in Central Europe. The article shows how different they are in social-economic and physical-geographical perspective. Social and economic conditions were introduced from perspective of path dependency and recent situation and its perception. Furthermore, we integrated social-economic and environmental perspective in the ecosystem services concept. Despite the lesser number of tourists arriving to the Bavarian part of the area, perception is better than among mayors of municipalities on the Czech side. Different history, management and *top-down* and *bottom-up* approaches usage can explain these differences. The typologies of environmental conditions help us to distinguish differences between both National Parks. In the Bavarian Forest we can find more equal share of forests (coniferous, broad-leaved, mixed) and surprisingly, thanks to large unmanaged part bigger relative share of regenerating forest landscapes than in the Bohemian Forest. Physical-geographical typology distinguishes five classes. Relative distribution of the classes is similar, but we can determine area of high plateau mainly on Czech side and on the other hand class of steeper terrain is located mainly in Bavarian Forest. Ecosystem services were presented by integrating landscape capacity analysis showing small differences between both National Parks in this case and no relation between land cover and attractiveness for tourism.

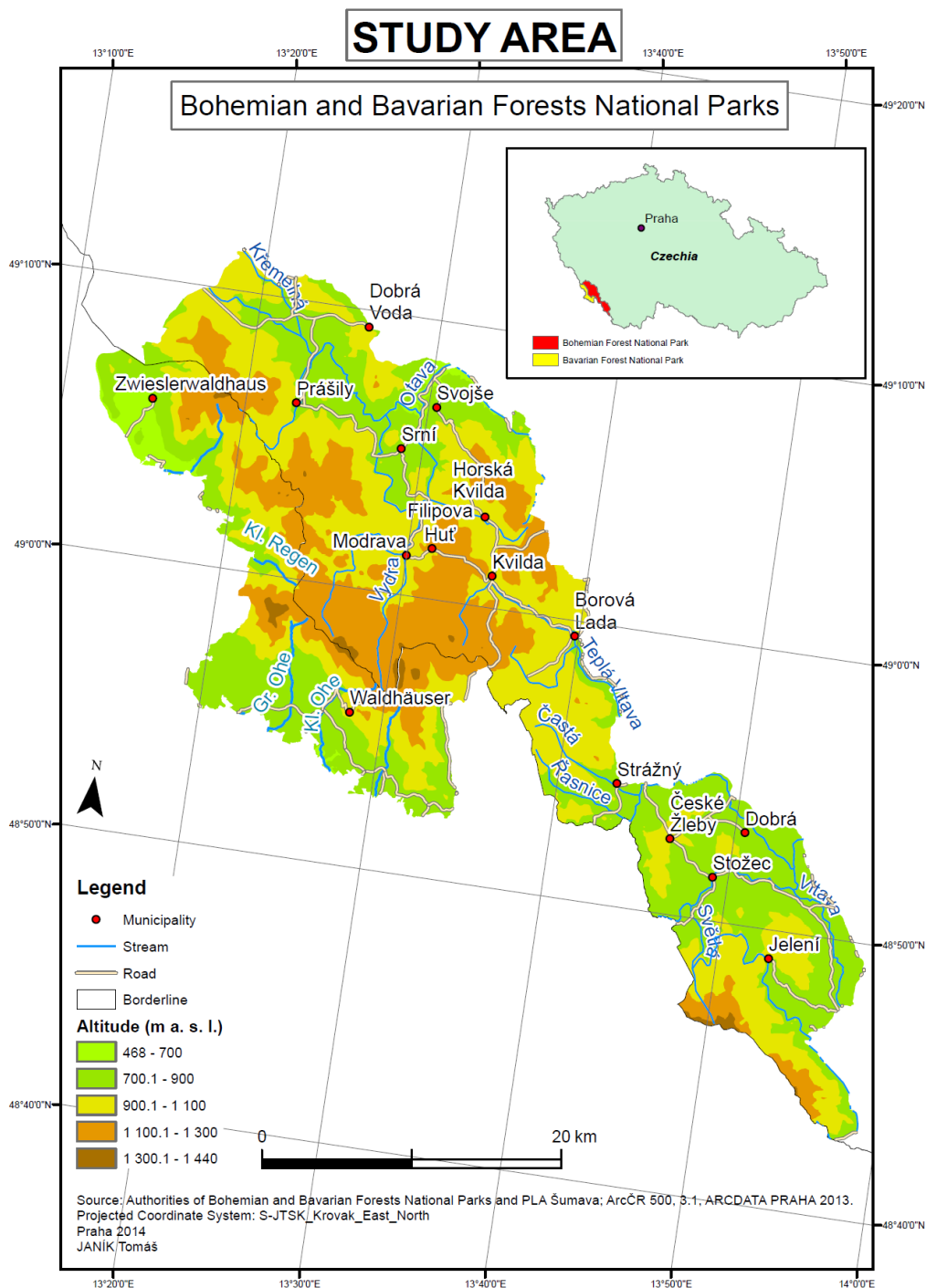
Keywords: Bavarian Forest, Bohemian Forest, National Parks, comparison, typology, ecological services

INTRODUCTION

Study area

The Bohemian and Bavarian Forests make up together the largest wilderness area in Central Europe (Křenová & Hruška, 2012). The area is protected by two national parks. The Bavarian Forest National Park (NP) is significantly smaller (246.6 km²) than the Bohemian Forest National Park (684.5 km²). Areas of both NPs belong to same geomorphological unit, one of the largest and oldest mountain systems in Central Europe (Czech Geological Survey, 2012); on the other hand we can find differences in physical-geographical conditions (Fig. 1). The mean altitude of study area (both NPs) is 922 m a.s.l. and the highest peak is Mt. Rachel 1,453 m a.s.l. (Křenová & Kiener, 2012).

Fig 1: Map of study area, Bohemian Forest NP and Bavarian Forest NP



Typical landscape consists of flat mountain ridges and plateaus especially in core area along the border of the NPs with a mosaic of dominant Norway spruce forests, peat bogs and meadows; peat bogs are in high numbers especially on the Czech side of mountains (Spitzer & Buřková, 2008).

Flat elevated plateau is surrounded by deep valleys and steep slopes, especially on German side of the focal area. This fact contributes to different biotopes and vegetation patterns in both NPs (Bavarian Forest NP 2014). However, abandoned landscape is in both NPs; old pastures and meadows, so-called “schachten” (Dohnal *et al.*, 2011) are legacy after more intensive agricultural usage of landscape in the past, even in the highest parts of the mountain. Average annual temperature is between 3 °C and 6 °C (Tolasz *et al.*, 2007) and precipitation varies from 800 mm to 1600 mm (Dohnal *et al.*, 2011).

In the 19th century mountains were inhabited and afforested the most. After the big windstorms in late 19th century (Brůna *et al.*, 2013) and subsequent lack of jobs in forestry region became poorer (Dohnal *et al.*, 2011). The biggest differences in both regional and landscape development started after World War II when Czech Germans had to leave Czechoslovakia and access to the border zone was restricted. On the other hand development was uninterrupted in the Bavarian Forest National Park. The number of inhabitants in municipalities of the Bohemian Forest NP decreased from 61 000 in 19th century to 17 000 nowadays (Perlín & Bičík, 2010).

In 1970 the Bavarian Forest NP was founded and after fall of communism in Czechoslovakia in 1989, in Czechia respectively, the Bohemian Forest NP was established in 1991. Nowadays, regional development is strongly based on tourism due to a “brand” of NPs. NPs as a player in development has a different position in Czechia and in Germany.

Social-economic and Environmental comparison

Top-down and bottom-up dichotomy

Protected areas provide important services to society (Brown *et al.*, 2015) but their management influences local community within the areas. “Dichotomy” and different objectives between local development and nature protection can be a result (Brandon & Wells, 1992; Martín-López *et al.*, 2011). Generally, there are *top-down* and *bottom-up* approaches. *Top-down* represents centralization and state level of nature protection and *bottom-up* articulates interests of local community. Trend of protected areas management is leading to decentralisation and diversity of key players, who influence the management (Lockwood, 2010).

Natural protected areas face the above-mentioned dichotomy problem between natural conservation and development (Brandon & Wells, 1992; Martín-López *et al.*, 2011). In our research we compared historical background and recent social, economic and management conditions, which affect recent state of both NPs. We mainly focused on management, tourism as a big part of economy and perception of dichotomy by mayors of Czech municipalities.

We hypothesize more ambiguous perception in Czechia, because in post-communist states distrust in government, low level of civic participation and centralisation are still persisting (Brown *et al.*, 2015).

Landscape classification

Classifications are useful method for comparison. Despite the simplification (Mücher, 2003) classifications are based on objective data (Chuman & Romportl, 2010) and can provide tool for evaluation and subsequently for protection of focal area. We carried out physical-geographical and land cover typology. Physical-geographical typology is based on

physical-geographical variables, which are integrated statistically (Chuman & Romportl, 2010). Typological approach for land cover classification (Metzger, 2005; Wascher, 2005; Chuman & Romportl, 2010) based on quantitative statistical methods was chose to identify differences in nature conservation, forest management and further human activities. GIS software offers many ways for these types of analyses (Chuman & Romportl, 2010). We use typologies like a frame for comparison of both NPs.

Ecosystem services

For integration of social-economic and environmental perspective and for evaluation of both NPs we use the ecosystem services concept. We distinguished four categories of the ecosystem services 1) ecological integrity (supporting services, 2) provisioning services, 3) regulating services and 4) cultural services (Burkhard *et al.*, 2009). We can assess landscape by its capacity. Burkhard *et al.*, (2009) carried out values of land cover type's capacities to provide the ecosystem services. In addition, provision of ecosystem services depends on environmental conditions driven and changed by human-induced land cover and land use (Burkhard *et al.*, 2012). Therefore, we used this approach.

Our aim is to contribute to detection of main differences between the NPs and human-driven factors explaining them. Moreover, we derived values of land cover capacities for land cover in the study area and evaluated differences between NPs and compared whether people use the most valuable places as ecosystem cultural services and how it differs between both NPs.

METHODS AND DATA

Socio-economic comparison

Different path dependency and relationships of key players in both NPs are, therefore, important factors that we take into account in national park comparison. In the Bavarian Forest NP, researches about economy and perception by actors were carried out (e.g. Mayer & Job, 2008). On the other hand, there is a lack of similar studies from Czech side. We compared the studies, which have been done from the Bavarian Forest NP and bring data for the Bohemian Forest NP. We collected current data from Czech statistical office and from mayors's questionnaires.

Data from Czech statistical office contain development of number of inhabitants since NP foundation and number of tourists per year (for years 2002 and 2010).

Questionnaire was sent to mayors of seven municipalities within the Bohemian Forest NP (Prášíly, Srní, Modrava, Horská Kvilda, Kvilda, Strážný, and Stožec) in April 2014. There were questions concerning the relationship with National Park, the social, economic, and environmental situation.

Questionnaire contained following topics:

- Perception of National park (positive, rather positive, neutral, rather negative, negative)
- Social situation in your municipality (good, rather good, neutral, rather bad, bad)
- Economic situation in your municipality (good, rather good, neutral, rather bad, bad)
- Environmental conditions in your municipality (good, rather good, neutral, rather bad, bad)

- The most important economic activity (selection: forestry, tourism, NP administration)
- Preferences of municipal and spatial development (text answer)
- Transboundary collaboration evaluation (text answer)
- Opinions on national park management (text answer)

Environmental comparison

We used typologies, which have been done (Janík & Romportl, 2016). Furthermore, based on the typologies we analysed differences between both NPs in proportion of given landscape types. Typology was derived from data describing the landscape. Twelve Land Cover types provided by GEODIS Company (2006) were distinguished. Data were aggregated into five relatively homogenous classes (Janík & Romportl, 2016).

Physical Landscape Typology was described by twelve variable: mean altitude, mean slope, heat load index, incidence of south facing slopes, annual mean temperature, seasonality (the difference between annual min and max temperature), the difference between average temperature in the coldest and warmest month, mean temperature of the warmest quarter of the year, mean temperature of the coldest quarter of the year, annual precipitation, mean precipitation in the coldest quarter of the year and mean precipitation in the warmest quarter of the year. Topography data were provided by the authorities of the Bohemian and Bavarian Forest National Parks in 15 m pixel resolution; the climatic data were obtained from the WorldClim database (Hijmans *et al.*, 2005). After standardization of data we used cluster analysis in STATISTICA 12 software for integration and cluster analysis. Data were visualized in ArcGIS 10.2 software (ESRI) for each grid cell 100x100m covering NPs area and we obtained five classes (Janík & Romportl, 2016).

Integrative approach – Ecosystem services

We integrated both above-mentioned perspectives in the ecosystem services concept (Burkhard *et al.*, 2009; Burkhard *et al.*, 2012). We derived values for land cover type's capacities (Burkhard *et al.*, 2009; Tab. 1). We chose municipalities within the study area and also in 500 m buffer. For each municipality we prepared 5 km buffer clipped by NP and state border. In this area for each municipality (17, see Tab. 5, Fig. 5) we computed landscape capacity based on Burkhard *et al.*, (2009) for grid 100x100m. We used land cover data provided by GEODIS Company (2006). Analysis was carried out in ArcGIS 10.5 software (ESRI). The sum of landscape capacity for each municipality based on 100x100m units were divided by area of clipped buffer. We obtained average per km² for each municipality. In addition, we correlated landscape capacity for each municipality with number of visitors staying overnight in SPSS 20, we used Spearman correlation coefficient. We obtained data from the Czech statistical office for Czech municipalities and estimations from Mayer & Job (2008) research for Bavarian part. Data was used for year 2010 in case of Czechia and 2007 in case of Bavaria.

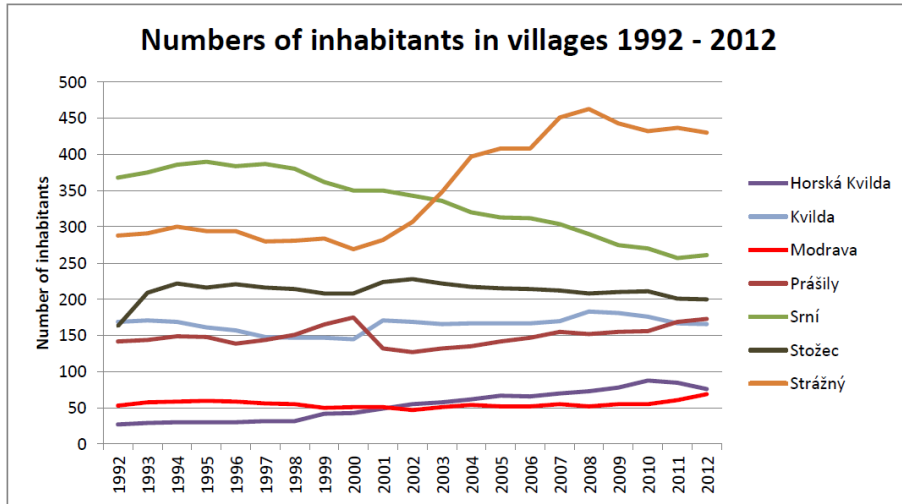
Table 1: Land cover types and capacity values – derived from Burkhard *et al.*, (2009)

Land cover	Landscape Capacity Value
Clear-cuts	9
Coniferous forest	30
Broad-leaved forest	31
Meadows	24
Peatbogs	29
Rocks	6
Mixed forest	32
Dead-lying forest	25
Dead-standing forest	30
Succession	30
Built-up areas	0
Water	23

RESULTS

Path dependency: History and legislative frameworks of nature conservation

“Path dependency” differences started to rise after World War II. Development of Czech part was disrupted and inhabitants were displaced. Strip along the borderline became a restricted area without people during the communist era (1948-1989). On the other hand “settlement-continuity” persisted on German side and decrease of inhabitants is a part of the urbanization process, which is taking place throughout Europe. After political change NP was established (1991) in Bohemian Forest and also people started to return to the area, number of inhabitants in villages within NP is slowly increasing (Fig. 2). Situation is similar to villages in other mountains regions in Czech Republic (Perlin & Bičík, 2010).

Fig. 2: Number of inhabitants. Source: Czech statistical office, 2013

The NP is a legislative framework within the actors play a role and they represent their interests. Among actors we can list mainly Administration of the NP (*top-down*) and mayors of municipalities (*bottom-up*).

We obtained three questionnaires from mayors of Modrava municipality and two mayors wanted to stay in anonymity. Two of them perceived National Park positively or rather positively, one rather negatively. Especially, all of them mentioned the NP as a “*good brand*” and also *good partner*. Evaluation of social, economic and environmental conditions varied a lot and did not bring any clear information. According to mayors, economic activity is dominated by tourism and they see only way for municipality development in tourism. They complained about restriction of National park for tourism and spatial development. Ambiguously, they use the NP “*good image*” (the most important association for the NP for them) of beautiful nature, which attracts people and on the other hand they feel pressure due to the NP legislation results to smaller framework for decision-making processes and spatial development of municipalities.

Villages and their surroundings in Bavarian Forest are not incorporated in NP (Heurich *et al.*, 2012). The next big difference is an approach to Nature conservation in both NPs. In the Bohemian Forest National Park actors have not found any compromise and there is no agreement about most important goals for area.

Founding of the Bavarian Forest NP was related to disturbances, natural processes which changing landscape. Windthrows and subsequent bark beetle outbreaks are the most common disturbances in the mountain forest of Central Europe (Jonášová & Prach 2004; Nováková & Edward-Jonášová, 2015). In the Bavarian Forest NP non-management zones was founded and from windthrow in 1983 have been increasing. Nowadays, 75% of area is in non-intervention (non-management) zone. In spite of disturbances forest is able to restore (Fischer *et al.*, 2002; Jonášová & Prach, 2004; Nováková & Edward-Jonášová, 2015). A different approach to nature management is an obstacle for broader transboundary cooperation and creation of “Wild heart of Europe” project – one huge non-intervention area (Křenová & Kiener, 2012). Another proposal of the Bohemian Forest National Park zonation incorporated to non-intervention zone NATURA 2000 sites and *Tetrao urogallus* habitats (Bláha *et al.*, 2013). NATURA 2000 sites and *Tetrao urogallus* habitats together form circa

50 % of National Park. The main goal is a big non-fragmented area suitable for natural processes and development considering ecological connections in landscape (Křenová & Hruška, 2012). Future transboundary cooperation can contribute to coordination activities and sharing information and knowledge among local actors – villages, NPs authorities and can also cause better and more effective Nature conservation and sustainable tourism development. Even Czech mayors in questionnaires expressed they favour to collaborate with German municipalities and also the Management Plan of Bavarian Forest National Park mentions the same (Linner & Wanninger, 2010)

Recent economic conditions

Tourism is a new big part of economy. In the Bavarian Forest tourism is the most important part of economy (Mayer & Job, 2008). In 2007 760 000 tourists visited the Bavarian Forest NP (Mayer & Job, 2008), in comparison ca. 2 000 000 tourists visited Bohemian Forest every year (Dickie & Whiteley, 2013; Perlín & Bičík, 2010). Despite this amount of people and income from tourism and obviously good label of the NP, mayors of Czech municipalities are not fully satisfied. They want to be in the NP but do not want to respect legislative framework, which guarantees the value of the NP. They rather could aim at prolongation of days of stay. “Overnight” tourists spend much more money in region; in the Bavarian Forest, in comparison 11.4 Euros per day of day-tourist and 49.6 Euros per day of “overnight” tourist (Mayer & Job, 2008). On the one hand the number of tourists is increasing and on the other hand average time of stay is decreasing in the Bohemian National Park (Tab. 2). Emphasis on sustainable tourism can be one of the opportunity for further social and economic development of the area and it goes hand in hand with solving of “dichotomy problem” (Dickie & Whiteley, 2013). Sustainable development and tourism aiming at longer stay of tourists with wider offer of soft and ecologically friendly activities rather than building the big infrastructure (e.g. ski lifts and slopes); deeper collaboration between NPs in both management and development can improve recent situation and even attract new tourists from neighbourhood countries

Table 2: Number of Tourist in Bohemian Forest Natural Park. Source: Czech statistical office, 2013

Municipality	Year	Number of Tourists	Number of overnight stays	Average number of overnight stays	Average number of stay in days
Horská Kvilda	2002	1385	4397	3.2	4.2
	2010	4097	14024	3.4	4.4
Kvilda	2002	7830	26792	3.4	4.4
	2010	9009	31906	3.5	4.5
Modrava	2002	1975	7566	3.8	4.8
	2010	6108	20261	3.3	4.3
Prášíly	2002	1489	5623	3.8	4.8
	2010	2706	8273	3.1	4.1
Srní	2002	29046	104877	3.6	4.6
	2010	32603	101085	3.1	4.1
Stožec	2002	6265	21260	3.4	4.4
	2010	4253	12550	3	4
Total	2002	47990	170515	3.5	4.5
	2010	58776	188099	3.2	4.2

Environmental differences

Physical-geographical landscape classification shows five classes (Fig. 3, Tab. 3) - more in Janík & Romportl (2016). The largest one (class no. 5 - upper land (plateaus)) covers plateau on top. That is a flatty area mostly in the Bohemian Forest (28.3 % of NP) in comparison with the Bavarian Forest (25.6 %). This class has the lowest slope (6.65°) thus a lot of peat bogs are situated here. Class 2 (upper transitional class - edge of plateaus) is on the edge of the plateau and it is the steepest class which includes valleys and canyons. The Bavarian Forest has a bigger share (19.3 %) than the Bohemian Forest (11.5 %). Class 1 (middle land) spreads in "middle heights" with significantly small slope and higher share is in the Bohemian Forest NP (19%) than in the Bavarian Forest NP (26.7 %). Distribution is similar in both NPs. Another class 3 (lower transitional class) is more scattered than others and it has higher slope. It covers 15.2 % of the area of the Bohemian Forest NP and 9.6 of the Bavarian Forest NP. Class 4 (lower land) is situated in the flatty lowest parts of National Parks and creates more than one quarter of the Bavarian Forest NP (26.6 %) and 18.3 % of the Bohemian Forest NP.

We can see topographical determination of landscape classification, especially the relatively flat top of the mountain and significantly shorter and steeper part of the area where the decrease of altitude from border to inland is situated in the Bavarian Forest.

Table 3: Relative distribution physical-geographical typological classes in both Parks

Typological class	Bohemian Forest 684.49 km ² (%)	Bavarian Forest 246.64 km ² (%)
1 (Middle land)	26.7	19.0
2 (Upper transitional class - edge of plateaus)	11.5	19.3
3 (Lower transitional class – scattered one)	15.2	9.6
4 (Lower land)	18.3	26.6
5 (Upper land - plateaus)	28.3	25.6

Land cover classification aggregated data also into five classes (Fig. 4, Tab. 4). On the border line is "regenerating forest" (2). In relative distribution creates 8.7 % of the Bohemian Forest NP and 17.5 % of the Bavarian Forest NP. Difference is in distribution of forest types. In the Bohemian Forest NP coniferous forest dominates (3) – 58.9 % on the other hand in the Bavarian Forest we can find mainly broad-leaved (26.2 %) and mixed forests (29.3 %). Different management enables on the one hand a lot of human-impacted areas (1) in the Bohemian Forest (13.8 %) and on the other hand exclusion of the villages from the Bavarian Forest NP caused much lesser share of human-impacted areas (2.2 %).

Table 4: Relative distribution of landscape typological groups in both Parks

Typological group	Bohemian Forest 684.49 square km (%)	Bavarian Forest 246.64 square km (%)
1 without forest. human impact area	13.8	2.2
2 regenerating forest. suffering from disturbances	8.7	17.5
3 mainly coniferous forest	58.9	24.7
4 mainly broad-leaved forest	3.6	26.2
5 mainly mixed forest	15.0	29.3

Fig. 3: Maps of classifications (Janík & Romportl, 2016)

PHYSICAL-GEOGRAPHICAL LANDSCAPE CLASSIFICATION
Bohemian and Bavarian Forests National Parks

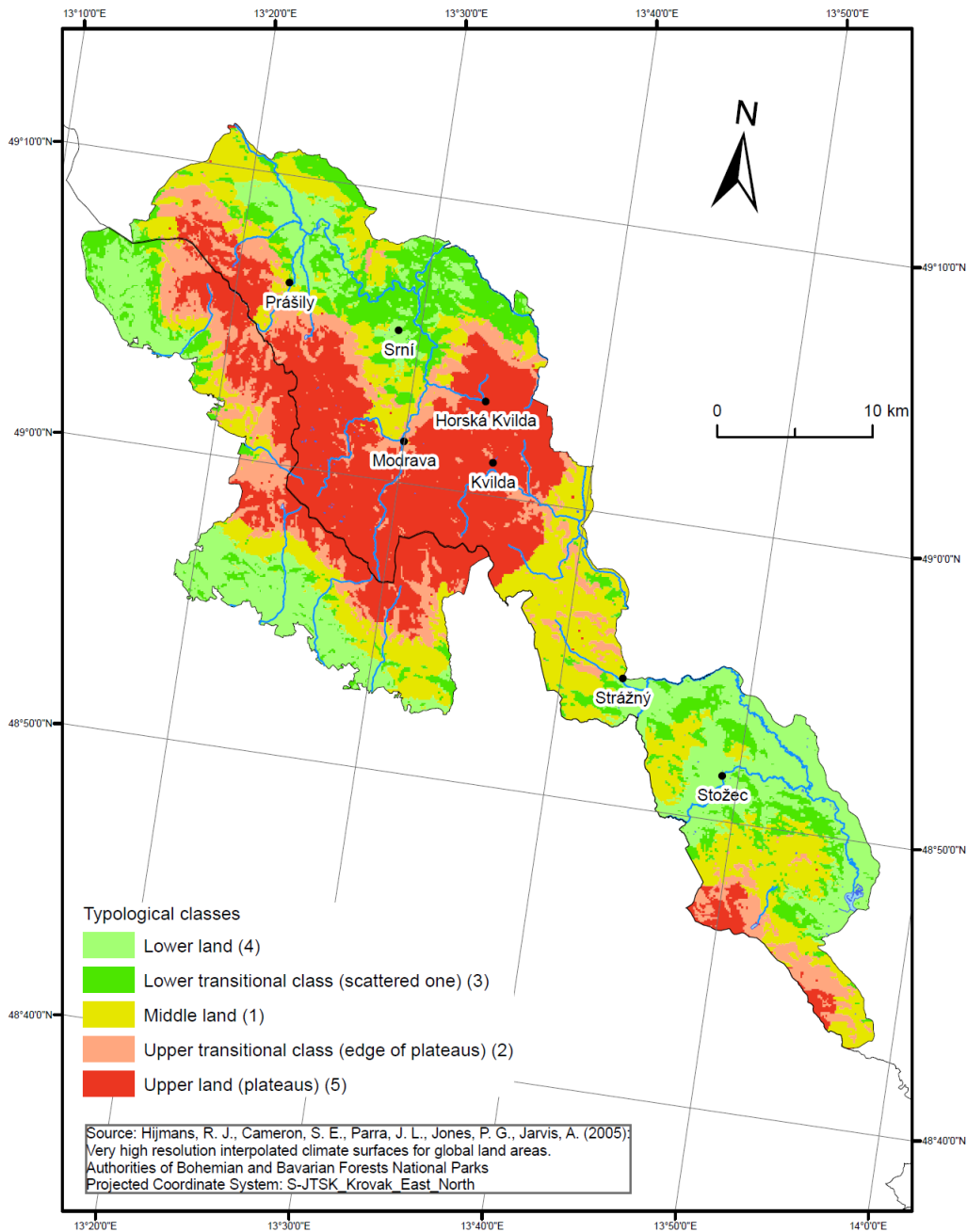
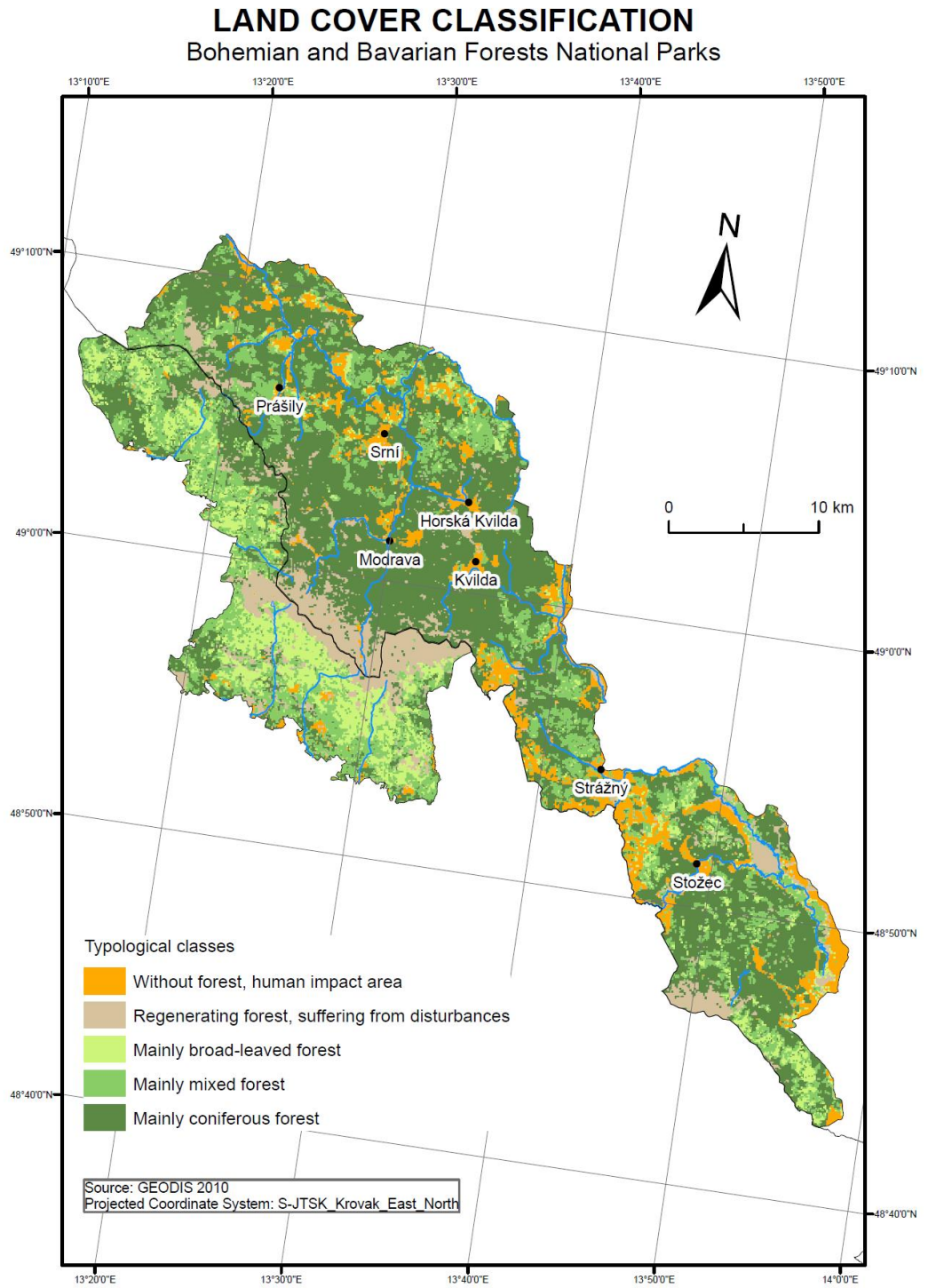


Fig.4: Maps of classifications (Janík & Romportl, 2016)



Landscape capacity and services

Results show similar landscape capacities for all municipalities (Tab. 5) and for both NPs. Slightly higher landscape capacity we can find in the Bavarian Forest NP (4604) than in the Bohemian Forest (4577). Surprisingly, few municipalities on the edge of the area have bigger landscape capacity (Borová Lada, Želnavá, Rejštejn, Spigellau) than municipalities in core area (Fig. 5).

Table 5: Landscape capacity for each municipality surroundings and overnight stays as an indicator of tourist attractiveness

Municipality	Landscape capacity (sum)	Landscape capacity per km ²	Overnight stays
Borová Lada	203215	4817.89	14059
Buchenau	179318	4211.62	No Data
Horská Kvilda	328917	4253.75	14024
Kvilda	292556	3915.37	31906
Ludwigsthal	127214	4566.27	100000
Modrava	273904	3672.41	20261
Neuschonau	164702	4541.35	100000
Nová Pec	317165	4719.71	18275
Prášíly	331682	4455.15	8273
Rejštejn	273245	4901.53	5648
Spigellau	156823	5023.99	200000
Srní	365957	4659.63	101085
Stožec	387519	5006.77	12550
Strážný	231370	4733.78	No Data
Waldhauser	303990	4803.79	No Data
Zwieslerwaldhaus	220749	4475.42	No Data
Želnavá	186364	5215.32	No Data

Moreover, analysis of relation between landscape capacity providing ecosystem services (including cultural services) and tourism (Fig. 6) was carried out. We hypothesized that higher landscape capacity is also attractive for the visitors. However, we were limited by a lack of the data and Spearman correlation coefficient is even negative (-0.18) and not statistically significant (sig. 0.957). We do not find any relation in this analysis integrating social-economic and environmental perspective.

Fig. 5: Landscape capacity in municipality's surroundings. Based on GEODIS Company Land Cover data (2006) and Burkhard *et al.*, (2009) landscape capacities evaluation

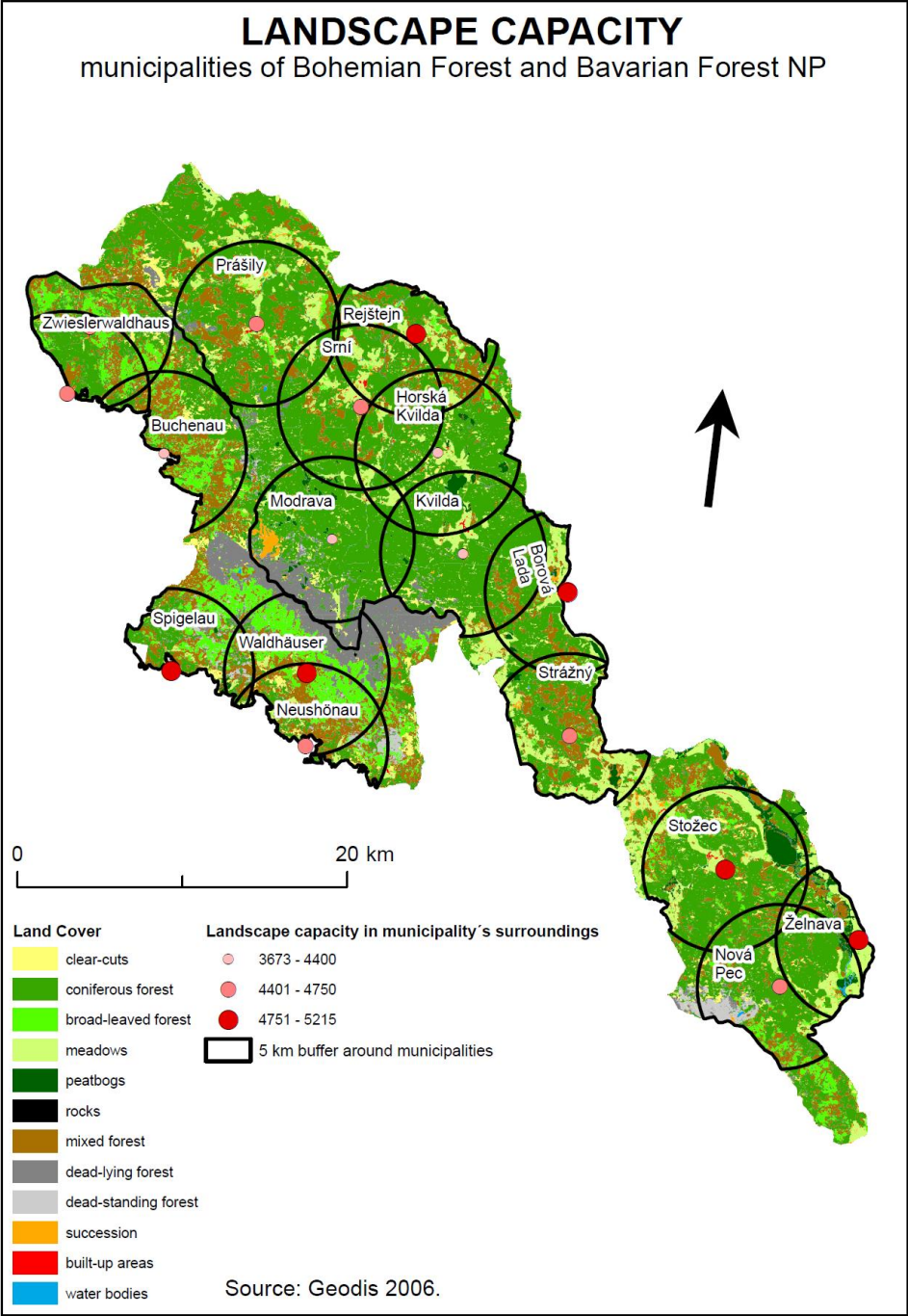
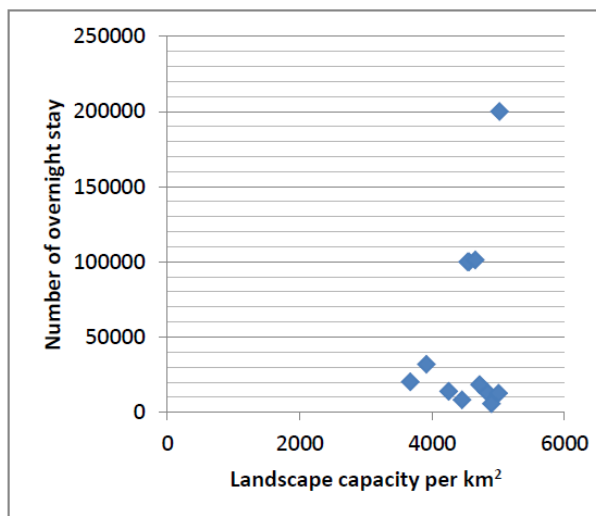


Fig. 6: Municipalities of both NPs and their values in analysis – visitors and ecosystem services



DISCUSSION

Municipalities in Bavarian Forest are more satisfied and thus dichotomy problem is more prevalent in the Bohemian Forest due to communist legacy (Brown *et al.*, 2015) and unclear role of key actors. Despite the bigger amount of tourists and increasing number of inhabitants (Fig. 2), unsatisfactory with recent conditions by mayors of municipalities in the Bohemian National Park is more obvious. On the other hand, due to historical path dependency the Bohemian Forest is younger and processes last longer time than in the Bavarian Forest NP. It may be solved by better communication and also by deploying the sustainable development concept and appropriate combination of *top-down* and *bottom-up* approaches, which can lead to involve local community to decision-making process and find the way how to handle with protection. Recent unclear and unstable situation do not guarantee any agreement. Municipalities in the Bohemian Forest can improve services for tourism and can try to attract tourist to stay for longer time (Dickie & Whiteley, 2013). We can see much more activity in this way in municipalities of Bavarian Forest (Mayer & Job, 2008).

Surprisingly, physical-geographical relative distribution is quite similar. The Bavarian Forest NP have much more relative distribution of steep class 2, and on the other hand also big share of flatty classes – 5 on the top and 4 on the lowest parts. Bohemian Forest is dominated by class 5 flatty plateaus on the top.

Different management approaches in the NPs determine land cover distribution. Villages are excluded from the Bavarian NP and therefore human impact area is bigger in the Bohemian Forest NP, despite the long period of restriction in border zone. The non-intervention management in the Bavarian Forest NP resulted to more various forests with equal share and also due to significantly large share of regenerating forest. Bohemian Forest is predominantly covered by coniferous forest affected by timber industry.

Ecosystem services (landscape capacity) are similar in surroundings of the municipalities and also between both NPs. There are surprisingly municipalities with high landscape

capacity on the edge of the area. We did not find significant effect of attractiveness of the surroundings (measured by land cover – landscape capacity) of the municipalities on tourism (number of overnight stays).

CONCLUSION

We carry out the complex comparison of two National Parks on the Czech-German borders. From our research we can point out:

- Management and legislative framework, path dependency and *top-down* and *bottom-up* approaches usage create significant differences towards the NPs and cause deeper “dichotomy problem” on the Czech side of area;
- NPs are good label for attracting the tourists and new jobs and income creator;
- We propose transboundary management and economic collaboration, development of soft and ecologically friendly tourism causing longer stay of tourists. These initiatives can lead to better both – nature conservation and economic profit;
- Physical-geographical classification do not show big differences in relative distribution but the Bavarian Forest NP is significantly smaller and has higher slope, in the Bohemian Forest NP the top-plateaus covered the largest share;
- Land cover classification differs much more. Due to legislative framework the Bohemian Forest NP with municipalities within the National Park has bigger share of human-impacted areas and coniferous forest dominates in Czech NP. In the Bavarian Forest NP is share of forests (coniferous, broad-leaved, mixed, regenerating) due to large unmanaged zone quite equal and big;
- Integrative approach of landscape capacity (ecosystem services) shows similar conditions in both NPs and no relation between landscape capacity (= ecosystem services, also attractiveness for tourism) and tourism staying overnight.

The results can be used as a framework for further analysis. We stressed importance of differentiated approach to management with respect for specific conditions and great field for interdisciplinary researches contributing to transboundary cooperation and understanding of similarities and differences in both National Parks.

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