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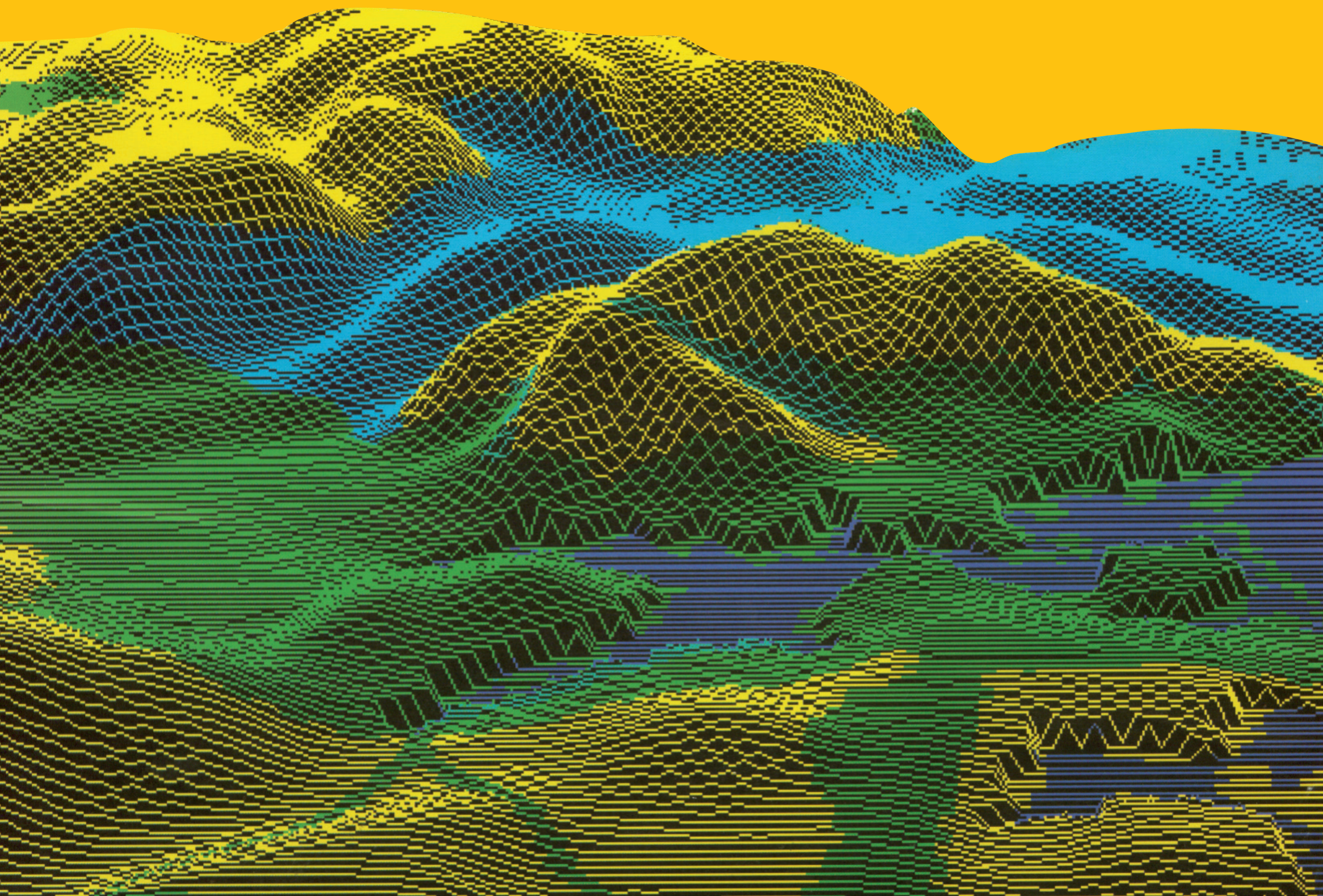

Fig. 2: Pavlov municipality (with four wind turbines in the background)

Fig. 3: Drahany municipality with the nearest wind turbine

Illustrations related to the paper by B. Frantál and P. Kučera

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MAILING ADDRESS

MGR, Institute of Geonics ASCR, v. v. i.
Drobného 28, 602 00 Brno
Czech Republic
(fax) 420 545 422 710
(e-mail) geonika@geonika.cz
(home page) http://www.geonika.cz

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EDITORIAL

Today, when the energy crisis affects the whole world, we can see global efforts focused on using non-traditional and renewable energy sources. Apart from the so-called energy crops, our attention is increasingly paid to other renewable energy sources, too, such as tidal power plants, wind-power installations and power plants utilizing solar energy (photovoltaic energy conversion plants).

The use of renewable sources for electric energy generation is promoted both by bodies of the European Union and by the Czech government. The currently in force Directive of the European Parliament and of the Council 2009/28/EC of 23 April 2009 on the promotion of the use of energy from renewable sources establishes binding proportional shares of energy (heat, transport, electricity) from renewable sources in gross energy consumption for individual EU member countries. The proportional share for the Czech Republic in 2020 has been set up to 13%, which is approximately a double of the present amount. Although the use of renewable energy sources has been recently increasing in the Czech Republic as compared with the previous years, the commitment is likely to be much too difficult to fulfil and sanctions have to be expected from the European Union.

Wind energy and its use has become a subject of interest of not only politicians and experts in power engineering but also economists, geographers, landscape ecologist and sociologists. The issue is also in the limelight of various environmental and civic initiatives from the concerned areas. The development of wind power engineering is a global phenomenon, which has been raising considerable social conflicts.

Advocates of the construction of wind power plants argue that wind parks generate clean energy with no exhalations, waste and landscape devastated by mines. By helping in the reduction of record carbon dioxide emissions, they contribute to prevent the change of global climate.

Opponents ground their reasons on the fact that the generation of wind energy by wind power plants is expensive, dependent on weather conditions and that it is necessary to have backup energy sources available. At the same time, landscape character is devastated and the wind parks represent a potential danger for wild animals and birds notwithstanding the fact that under certain weather conditions some general hazards occur such as hard rime, deterioration of environment quality etc. Not negligible are other social aspects of the construction, often presented by negative attitudes of local communities towards the placement of wind parks in their cadastral areas and insufficient preparedness of the Czech energy scheme.

This issue of Moravian Geographical Reports brings several papers (presented not only by geographers) that are based on expert studies devoted to wind parks and wind power plants.

Jana Zapletalová

COMPARISON OF GLACIAL RELIEF LANDFORMS AND THE FACTORS WHICH DETERMINE GLACIATION IN THE SURROUNDINGS OF ČERNÉ JEZERO LAKE AND ČERTOVO JEZERO LAKE (ŠUMAVA MTS., CZECH REPUBLIC)

Klára VOČADLOVÁ, Marek KŘÍŽEK

Abstract

Conditions for the Pleistocene glaciation in the regions of Černé Jezero and Čertovo Jezero lakes in the Šumava Mts. are analyzed in this paper, with a comparison of the resulting glacial landforms. Although the two cirques are immediate neighbours, have approximately the same area, altitude and relative vertical relief-dissection, their glacial erosion and accumulation relief segments exhibit many distinctive features. The most noticeable differences are slope gradient, slope aspect and overdeepening. The analysis revealed that increased heat load was more important for the extent of glaciation in the surroundings of Černé Jezero and Čertovo Jezero lakes than the surface area of deflation plateaus. This is evidenced by the small extent of glaciation in the surroundings of the Čertovo Jezero lake, which has unfavourable aspect and higher heat load index (HLI).

Shrnutí

Srovnání glaciálních forem reliéfu v okolí Černého a Čertova jezera na Šumavě (Česká republika)

Příspěvek se zabývá srovnáním podmínek vzniku pleistocénního zalednění v okolí Černého a Čertova jezera na Šumavě a porovnáním výsledných glaciálních tvarů reliéfu. I přesto, že se jedná o dva bezprostředně sousedící kary s přibližně stejnou rozlohou, nadmořskou výškou a relativní výškovou členitostí, vykazují jejich glaciální destrukční i akumulační segmenty reliéfu řadu odlišností. Nejvýraznějšími rozdíly jsou sklonové charakteristiky, orientace svahů a přehloubení. Ukázalo se, že důležitějším pro rozsah zalednění v okolí Černého a Čertova jezera byl vliv zvýšeného tepelného toku než rozloha deflačních plošin. Dokladem toho je menší rozsah zalednění okolí Čertova jezera, které má nevýhodnou orientaci a větší index tepelného toku (HLI).

Keywords: *glaciation, glacial landforms of the relief, cirque morphometry, heat load, the Šumava Mts. (the Bohemian Forest), Czech Republic*

1. Introduction and objectives

The first research works devoted to glaciation in the Czech and German parts of the Šumava Mts. (Bohemian Forest) emerged already 150 years ago. The most important geomorphological works originate from the end of the 19th century and from the first half of the 20th century (e.g. Partsch, Bayberger, Priehäusser, Rathsburg, Vitásek mentioned in Kunský, 1933). A summary of works and theories related to glaciation in both parts of the Šumava Mts. are presented in the articles of Kunský (1933) and Chábera (1975). Votýpka (1975, 1979) and recently Mentlík (2004, 2005), Vočadlová and Křížek (2005), Vočadlová et al. (2007), Steffanová and Mentlík (2007) took up the research from the beginning of the 20th century. A number of works devoted to glaciation came to existence in the Bavarian part of the Šumava Mts. during the last 30 years, e.g. Hauner (1980), Pfaffl (1998), Raab and Völkel (2003) and Reuther (2007). Hauner described even 43 glaciers in 5 cirques and 38 cirque-like landforms in the German part; his findings seem to be exaggerated though.

Presently a range of modern progressive methods making use of computer technology and complicated instrumentation equipment can be used besides the classical methods. As to the state of research in localities with remainders of the Pleistocene glaciation in the Šumava Mts. problems of the glacial form of relief spread; exact size, stratigraphy, thickness and age of glacigenous sediments; extent, age and number of glaciations.

The aim of this article is to compare conditions that contributed to the formation of Pleistocene glaciers in the cirques of Černé jezero Lake and Čertovo jezero Lake in the Šumava Mts. and to establish whether the two nearby cirques are similar in their morphology and if the glacier modelled the same landforms in their surroundings (Tabs. 1 and 2).

2. Study area

The study area (49°10'22'' N, 13°11'21'' E) is located about 5 km northwest of the town Železná Ruda in the Klatovy district, Pilsen region (Fig. 1). It includes a glacial erosion relief segment of two cirques, a glacial accumulation relief segment (adjacent glacial accumulation landforms) and adjacent ridge areas. The study area has an elevation range of 750–1,343 m a. s. l., average slope inclination is 11° and dominant slopes have an inclination between 5 and 15°. Bottoms of the two cirques are lakes – Černé jezero Lake (max. depth 40.1 m, size 18.8 ha – Fig. 2 – see cover p. 4) and Čertovo jezero Lake (max. depth 35.3 m, size 10.7 ha – Fig. 3 – see cover p. 3) (Janský et al., 2005). The neighbourhood of the two lakes belongs in the Šumava Protected Landscape Area (CHKO Šumava) and its greater part also in the National Nature Reserve „Černé and Čertovo jezero Lakes". The Šumava Mts. is in its northwestern part of senile nature with planation surfaces rejuvenated by erosion valleys of upper stream of Úhlava River and Svarožná River (Sekyra in Kodym Jr. et al., 1961). Both cirques are situated on the boundary ridge of the Královský hvozd Mts., stretching away from the town Železná Ruda via the Václavák Ridge and the Jezerní hora Mt. (1,343 m a. s. l.) with the eastern saddlebow of Mt. Špičák (1,202 m a. s. l.) over Mt. Svaroh (1,333 m a. s. l.) as far as Mt. Ostrý (1,280 m a. s. l.). The study area can be classified into the geomorphological system of regionalization (Balatka & Kalvoda, 2006) as follows: geomorphological province – the Bohemian Highland (Česká vysočina), geomorphological subprovince of the Šumavská hornatina Highlands, geomorphological region – the Šumava Mts., geomorphological subregion – the Železnorudská hornatina Highlands and geomorhpologic district – the Královský hvozd district.

From the geomorphological point of view, the study area is a part of the Bohemian moldanubic. It is formed by a stratigraphic-tectonic unit called the "Group of Královský hvozd" (Kodym Jr. et al., 1961). This group is in the study area formed by garnet-biotite-muscovite mica schist and muscovite-biotite gneiss. Intercalations of quartzite are frequent in the area. They can be found in mica schist and gneiss where they form lenticular

locality	number of moraines	number of glacial stages	area (ha)		author
			accumulation part	destruction part	
Černé jezero Lake	5	2	86.45	85.15	Vočadlová
Čertovo jezero Lake	3	2	33.15	45.51	Vočadlová
Prášilské jezero Lake	3	2	5.21	35.32	Mentlík (2006)
Stará jímka Lake	3	2	46.63	161.09	Mentlík (2006)
jezero Laka Lake	3	2	17.63	67.15	Mentlík (2006)
Plešné jezero Lake	2	2	–	–	Votýpka (1979)

Tab. 1: Glacial localities and glacier characteristics in the Czech part of the Šumava Mts.

locality	min. elevation of moraines (m a. s. l.)	length (km)	author
Kleiner Arbersee	830	2.60	Raab (1999)
Rachelsee	900	2.25	Hauner (1980)
Alten See			
Rachel - North	925	1.25	
Gruftbach	870	1.40	
Grosser Arbersee	850	1.75	Pffafl (1998)

Tab. 2: Glacial localities and glacier characteristics in the Bavarian part of the Šumava Mts.

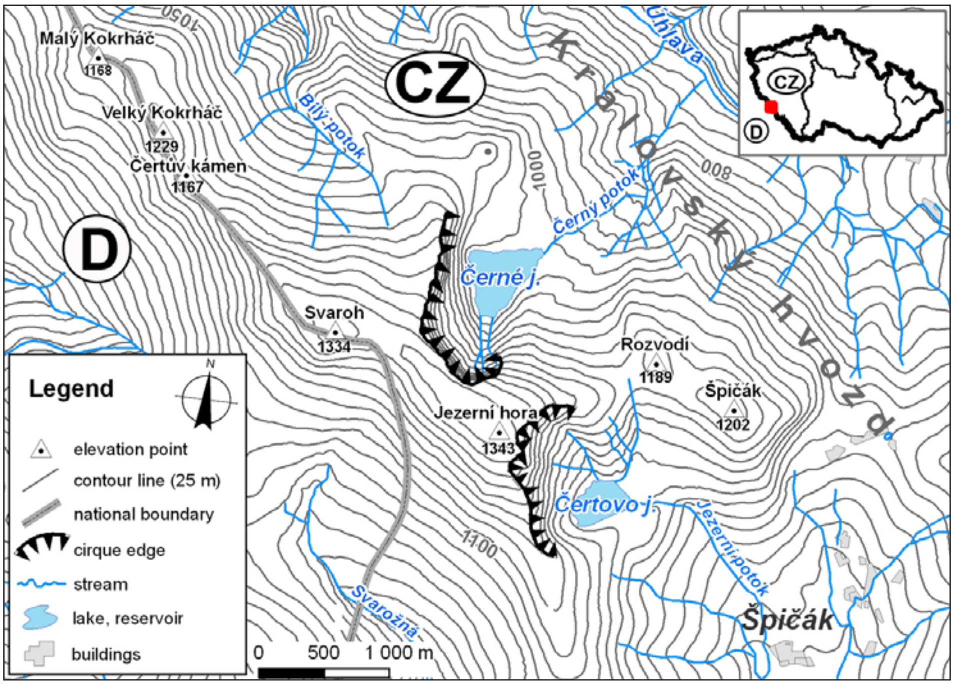

Fig. 1: Location of the study area

forms whose thickness is up to tens of meters. They are of heavy-bedded nature and they sometimes alternate with thinner layers of quartzite mica schist even mica schist, which are very rich in mica (Vejnar, 1961). The presence of these stable rock fillers is significant in the morphostructure of this area. Mica schist in the study area has uniform foliation of NW–SE direction with the surface foliation oriented to NE. Towards the southwest, the foliation verges from subvertical into subhorizontal position (Babůrek, 1993). Foliation in the southern part of the Černé jezero Lake cirque corresponds with the position of its cirque headwall. Both cirques are elongated in the direction of main faults of the massif.

In the immediate neighbourhood of both lakes, Quaternary unconsolidated sediments of glaciofluvial origin can be found. They are formed by blocks of various sizes, whose diameter if often larger than 1 m. These blocks build skeleton, which is filled with the fine sandy and gravelly matrix originating from weathering.

Climate of the cirques of Černé jezero Lake and Čertovo jezero Lake is influenced by the anemoorographic system of the Weisser Regen River valley, which is located on the other side of the main ridge of the Královský hvozd Mts. (Sofron and Štěpán, 1971). The main air flow passes upstream through the valley, first in WE direction which later changes into direction NW–SE (Fig. 4). It subsequently crosses the ridge and proceeds through the Svarožná River Valley to the Železnorudská kotlina Basin. The cirque of Černé jezero Lake and the valley of the upper Úhlava River have total precipitation lower than the cirque of Čertovo jezero Lake. The cirques can be denoted as a leeward turbulent area of the anemoorographic systems of the Weisser Regen River.

The Černé jezero Lake and the Čertovo jezero Lake have basins banked by frontal moraines of the glacier. Currently, both barriers are anthropogenically modified. The Černé jezero Lake is being used as an upper basin of the pumped storage power plant. Its water level is at an elevation of 1,007.5 m a. s. l. and the lake basin is divided into two parts of which the larger one reaches a maximum depth of 40.1 m (Janský et al., 2005). These two basins are divided from each other by a submerged moraine from the last phase of glaciation (Vočadlová et al., 2007). The total area of the lake is 18.8 ha and water volume is 2.9 mil m^3. The Čertovo jezero Lake has only one basin and occupies an area of 10.7 ha, its water level altitude is 1,027.2 m a. s. l. and its maximum depth is 35.4 m (Janský et al., 2005). Between the catchments of the two lakes, there is an important hydrological boundary – the Elbe-Danube main European watershed.

3. Theoretical and methodological approach

Evans (1977) claims that in many areas the incidence of sunrays is a dominant factor for glaciation. The most important element in the thermal balance of most glaciers is considered radiation, which affects air temperature and albedo. Secondary factors include greater ablation on exposed windward slopes and

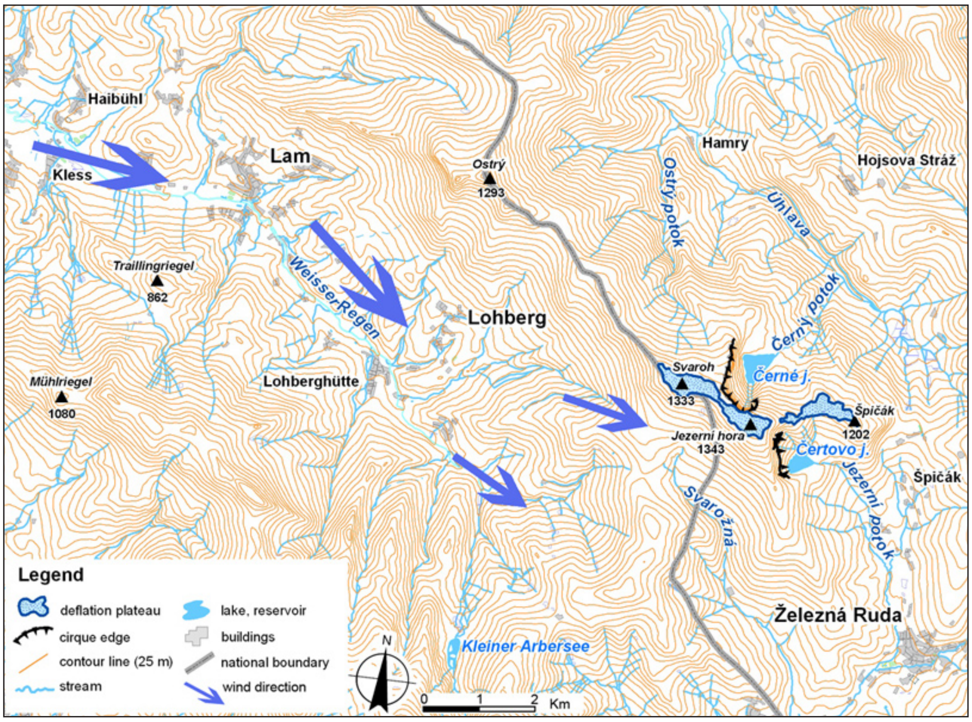

Fig. 4: The position of deflation plateaus in relation to the anemoorographic systems of the Weisser Regen River valley (sensu Sofron and Štěpán, 1971)

east-west differences due to regular diurnal weather regimes (the morning-afternoon effect). Evans (1977) mentions also an overestimated importance of snow being drifted by wind.

Glacier balance is a function of (Evans, 1977):

- surface altitude, aspect, gradient, convexity
- regional and local topographic position (position and area of deflation plateaus, microclimatic factors)
- macro-climatic factors

Beside these factors, it is important (in case studied areas) to consider also the influence of geologic conditions such as rock types, direction of foliation, fissure system (Votýpka, 1979; Raab, 1999; Mentlík, 2006).

In respect of the orientation towards cardinal points, the representation of slopes with warm and cold aspect is relevant from the viewpoint of radiation. Potential direct incident radiation is symmetrical about the north-south axis, but temperatures are not, because a slope with sun in the afternoon will have higher maximum temperatures than an equivalent slope with sun in the morning (McCune, 2007). Maximum and minimum values lie in SW and NE directions, respectively. The relative difference of radiation (i.e. ratio between radiation in northern and in southern slopes) is the biggest in the middle of winter while the absolute difference of radiation (i.e. difference between radiation in southern and in northern slopes) is the biggest in the spring and in the autumn (Evans, 1977). Steep cirque walls with the aspect in N- and E-quadrant show the lowest solar radiation values during ablative (summer) time, increase albedo and provide better conditions for longer snow deposition, formation of glacier and related processes. Areas with the northern aspect at the foot of steep slopes prove to be optimal for snow accumulation and development of glaciation.

Slope gradient in cirque walls is only approximate because their age and genesis are not uniform but they rose during a long period with various climatic conditions and were modelled by different geomorphological processes. Therefore, their current shape does not correspond in details to the state at the time of glaciation.

Not only in the Krkonoše Mts. (Giant Mts.) (sensu Šebesta and Treml, 1976), but also in the Šumava Mts. the presence of snow source areas (i.e. deflation summit plateaus near the cirque) influenced the development of glaciation. On the plateau edges, the wind blows the snow away, which drifted onto lee slopes in the cirque. During the Pleistocene, west winds prevailed in the current temperate zone (Enquist in Vilborg, 1984; Evans, 1977; Prosová and Sekyra, 1961). Winds that influence the glacier location are not only those in winter and spring times but also those in ablation (summer) time (Evans, 1977). Their turbulent movements increase the heat load change, thereby also ablation (they increase evaporation) on exposed windward slopes. The deflation summit plateaus are important also for the calculation of high regional topographic TP-ELA. Summit parts of surrounding ridges with the slope gradient 0–12° which are located to the west from the study area were defined as potential deflation plateaus. Deflation plateaus in the Krkonoše Mts. were defined by Šebesta and Treml (1976) as a summit source area of snow, which has a slope gradient of up to 5–7° including the surrounding exterior slopes. In case that the planation surfaces were affected by cryoplanation, they could reach the slope 1–12°, most often about 7° (Demek, 1969). Šebesta and Treml (1976) admit that avalanches had a subsidiary impact on the refilling of snow, too.

The following methods were used to determine equilibrium line altitude (ELA): CFA – cirque floor altitude; MELM – maximum elevation of the lateral moraine; THAR – toe-to-head altitude ratio (Nesje, Dahl, 1992; Benn, Evans, 1998).

Vector database DMÚ-25 (base scale of 1:25 000 with contours at 5 m interval), which includes areas behind the state boundary in Germany was used for the analysis as input topographic data (source GIS server: http://geoportal.cenia.cz). Depth data of the lakes Černé jezero and Čertovo jezero were obtained through geoprocessing and manual vectorization from bathymetric maps created by Janský et al. (2005). Digital elevation model (DEM) of the study area with the grid sized 5 × 5 m was created from the named databases. On this DEM, the following main morphometric and morphological analyses were carried out in programmes ArcView 3.2 and ArcGIS 9.2: analyses of slope inclination, aspect, heat load index (in McCune, 2007), transverse and longitudinal profiles, indices of cirque overdeepening (k-curve by Haynes, 1968). Heat load index was calculated as 45° rotation of the potencial direct incident radiation that is the function of latitude, aspect and slope (more in McCune, 2007).

The morphometric indices were created according to Federici & Spagnollo (2004). The 3D/2D analysis was created by ArcGIS 9.3, using the tool Area and Volume in 3D Analyst. For the chosen Šumava´s cirques in the Šumava Mts. it was used for the first time by Mentlík (2006). The rest of input data came from the field geomorphological mapping (mapping of placement and morphological characteristics of glacial accumulations, constructing of profiles).

4. Results

Source areas for snow transport to leeward positions were deflation plateaus in the summit parts of mountains. Relicts of old planation surfaces were the source area of snow mass in the study area. Two deflation plateaus of approximately 87 ha are located in the background of the cirques of Černé jezero Lake and Čertovo jezero Lake. The deflation plateaus fed both cirques with snow. The plateau between Mt. Svaroh (1,333 m a. s. l.) and Mt. Jezerní hora (1,343 m a. s. l.) sized 57.6 ha supplied the cirque of Černé jezero Lake. The plateau in the surrounding of Mt. Rozvodí (1,189 m a. s. l.) and Mt. Špičák (1,202 m a. s. l.) with an area of 29.3 ha had rather a function of deflation plateau for the cirque of Čertovo jezero Lake. The cirque of Čertovo jezero Lake could also use the eastern part of the plateau around Mt. Jezerní hora with an area of approximately 19 ha.

Representative basic morphometric characteristics describing the cirque and the cirque headwalls of Černé jezero Lake and Čertovo jezero Lake are listed in Tabs. 3 and 4.

The cirque of Černé jezero Lake is slightly elongated and as compared with the cirque of Čertovo jezero Lake, its overdeepening level, relative vertical relief-dissection and cirque headwall are higher. Contrary to this, the cirque of Čertovo jezero Lake is rather wider than longer and its mean altitude is higher; total mean slope gradient is almost the same (Fig. 5). The mean and maximum slope gradient of the cirque headwall is much bigger than in the Černé jezero Lake.

Slopes of the Černé jezero Lake cirque are mainly oriented to E, NE, NW and N. Slopes of the Čertovo jezero Lake cirque are oriented to E, SE and S. Slopes with the N, NE, E orientation cover 58.4% of the Černé jezero Lake cirque and 54.5% of the Čertovo jezero Lake cirque. The share of cirque headwall slopes with the cold aspect from N to E is more significant (see Tab. 4); slopes with cold orientation create even 84% of slopes in the cirque headwall of Černé jezero Lake.

The decreasing HLI with the increasing inclination and the lower rate of index on slopes with N – E aspect are obvious (Fig. 5). Average rate of HLI for the cirque of Čertovo jezero Lake is by 9% higher than for the cirque of Černé jezero Lake (Tab. 5). Comparing the glacial accumulation relief segments (place where the glacier tongue was located), it is evident that the area of moraines of the Černé jezero Lake shows lower values of heat load than the area of moraines of the Černé jezero Lake. Total heat load was by 15% higher in the area of Čertovo jezero Lake accumulations.

Characteristics	Cirque	
	Černé jezero Lake	Čertovo jezero Lake
H [m] - height	352.60	323.3
L [m] - length	1,111	901
W [m] - width	887.00	1,100
area [ha]	86.40	71.4
L/H ratio	3.15	2.79
L/W ratio	1.25	0.82
W/H ratio	2.52	3.40
3D/2D area	1.16	1.10
k-curve index	0.74	0.61
mean slope [o]	24.90	23.0
mean elev. -cirque floor [m a. s. l.]	1,002	1,016
N–E aspect [%]	58.40	54.5
HLI - mean	5,386	6,165
median axis aspect	30°	95°

Tab. 3: Selected characteristics of the cirques; k-curve index – description of the cirque overdeepening (sensu Haynes, 1968); HLI – Heat Load Index – unitless characteristic, value range 0–10,000 (sensu McCune & Keon, 2002)

Characteristics	Cirque headwall	
	Černé jezero Lake	Čertovo jezero Lake
min elevation [m a. s. l.]	1,007.5	1,027.2
max elevation [m a. s. l.]	1,317	1,305
mean elevation [m a. s. l.]	1,136	1,139.5
height [m]	309.5	277.8
area [ha]	63.4	51.6
N-E aspect [%]	86.4	55.8
max. slope [o]	62.6	51.6
mean slope [o]	32.2	25.8

Tab. 4: Selected characteristics of the cirque headwalls

The glacial accumulation relief segment with moraine accumulations is in both cases located on a relatively flat part of the relief with inclinations of up to 10°. Exceptions are right lateral moraines, which are pushed to the steep slope (25–30°) near the Černé jezero Lake. It is similar for the youngest right lateral moraine on the lakeside of Čertovo jezero Lake. In both cases, frontal moraines are also spread all over the steep slope (25°). Some characteristics of moraines in both study areas are summarized in the following review.

Černé jezero Lake moraines (more in Vočadlová and Křížek, 2005):

- 88.4 ha accumulation area (107.9 ha including the lake bottom)
- 5 generations of moraines, 5th moraine below the lake level (Vočadlová et al., 2007)
- frontal moraines at a distance of 760 m (moraine ridge at 900 m a. s. l.) from the current lake dam
- right lateral moraines at elevation higher than the left one (10–70 m), situated on steep slope
- maximum height of lateral moraines 20 m, mean slope of moraine wall 18°
- maximum elevation of lateral moraines is 1,115 m a. s. l.

Čertovo jezero Lake moraines:

- 33.2 ha accumulation area (44.2 ha including the lake bottom)
- 3 generations of moraines
- frontal moraine at a distance of 300 m (moraine ridge at 1,020 m a. s. l.) from the current lake dam
- right lateral moraine at elevation higher than the left one (20–40 m), situated on steep slope
- maximum height of lateral moraines 13 m, mean slope of moraine wall 15°
- maximum elevation of lateral moraines is 1,080 m a. s. l.

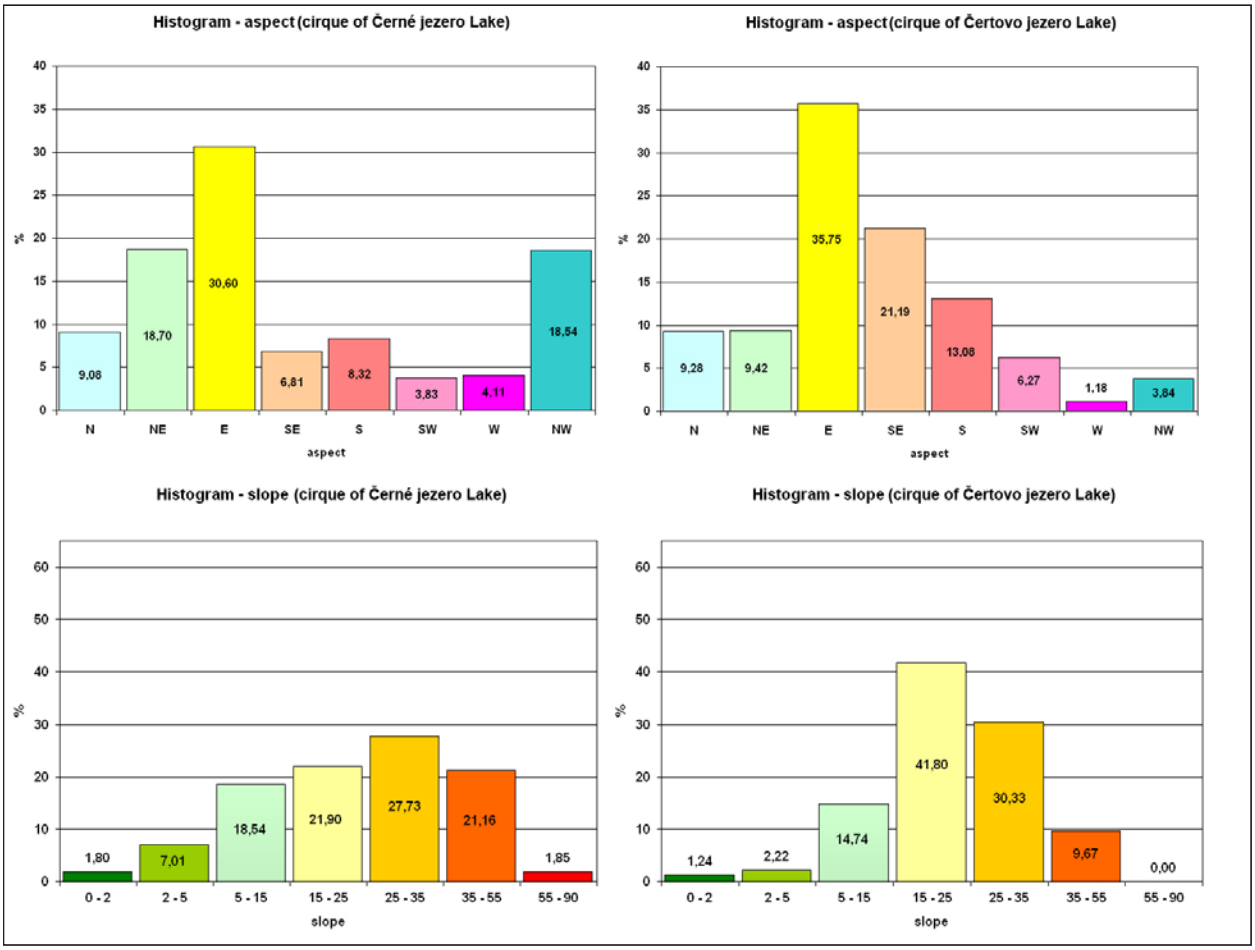

Fig. 5: The percentage of aspect and slope categories in the cirques

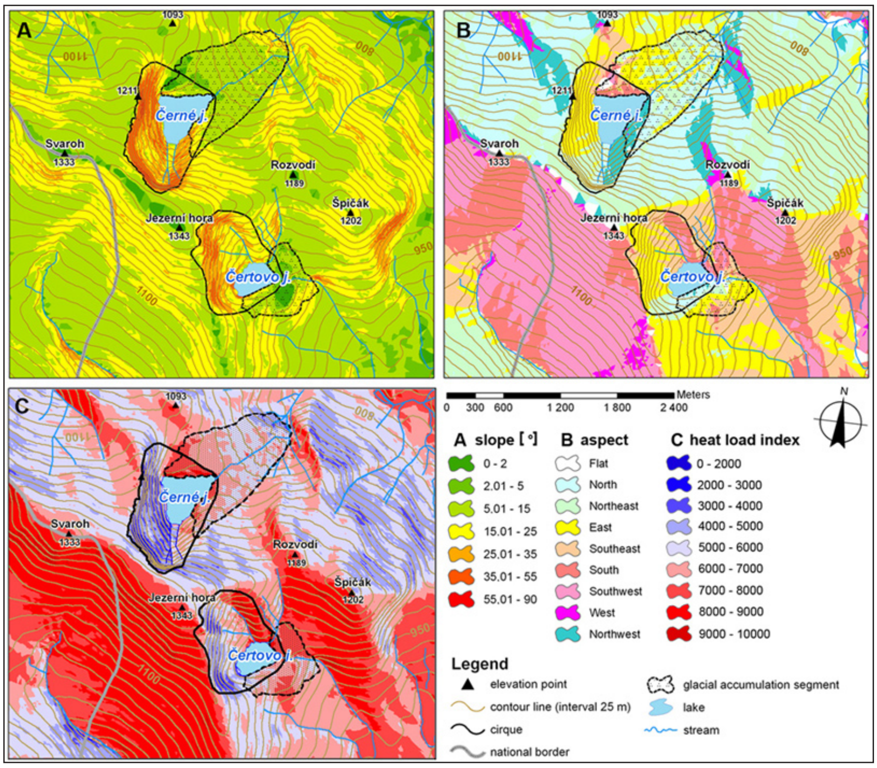

Fig. 6: The map of slope gradients, aspects and heat load index

		Heat Load Index						
		Min	Max	Range	Mean	Std	Median	HLI/ha
moraines	Černé jezero Lake	2,483	10,000	7,517	6,249	787	6,174	70.7
	Čertovo jezero Lake	4,402	9,263	4,861	7,168	767	7,342	100.4
cirque	Černé jezero Lake	1,171	10,000	8,829	5,386	1,833	5,254	62.3
	Čertovo jezero Lake	2,132	9,968	7,836	6,165	1,638	5,971	86.4

Tab. 5: Heat Load Index for glacial accumulation segments (moraines) and cirques

ELA calculated for the Černé jezero Lake is by 14–28 m lower than ELA for the Čertovo jezero Lake (Tab. 6) except for the calculation by using MELM where maximum ELA for the Černé jezero Lake Area lies by 45 m higher than for the Čertovo jezero Lake Area.

5. Discussion

Generally, the resulting vector direction of the Šumava Mts. cirques is 75°; i.e. ENE-aspect (Steffanová and Mentlík, 2007). The cirque of the Čertovo jezero Lake is not the only cirque with predominant orientation to the south quadrant in the Šumava Mts. The second such case is the SE-oriented cirque of Rachelsee Lake in Bavaria. Nevertheless, the cirque of the Rachelsee Lake is morphologically more significant than the nearby-situated cirque Kleiner Rachel-Nordkar oriented to NNE. It is possible that the position of the cirque towards the deflation plateau and the dominant wind direction were very important for glaciation in the Šumava Mts. (Fig. 4) Based on the mentioned example it seems that the orientation of cirques was less important than the position of deflation plateaus and the direction of flow. The anemoorographic system of the Weisser Regen River valley mentioned in Sofron and Štěpán (1971) was probably the factor, which partly balanced the disadvantage of higher heat load in the area of the cirque of Černé jezero Lake and enabled the formation of glacier there. It is possible that a similar anemoorographic system existed in the Úhlava River valley too, and it probably influenced the cirque of the Čertovo jezero Lake. However, the influence was probably lesser in this case because the position of the valley toward the predominant wind direction is not optimal. The northern part of the valley has N–S direction but the predominant wind direction was from northwest.

Serving as snow source areas in the study area, summit plateaus do not have such surface like e.g. in the Krkonoše Mts. and they usually have elongated shape. It is probable that the surface of deflation plateaus in the preglacial era was larger than today because cirque headwalls are dimpled into the remainders of planation surfaces. The deflation plateau of the glacier of Černé jezero Lake had an area by 19% larger than the deflation plateau of the glacier of Čertovo jezero Lake. Comparing the area of corresponding deflation plateaus to the areas of single cirques, the snow source areas of Černé jezero Lake and Čertovo jezero Lake were smaller by ⅓ than their cirques. The area share of plateaus and the accumulation segment of the glacial relief of Černé jezero Lake is similar but this proportion is totally inverse in the Čertovo jezero Lake and the deflation plateau is bigger by 46% than the area of the glacial accumulation segment of glacial relief. The area of the glacial accumulation segment of the relief of the Černé jezero Lake is bigger (by 166%) than in the case of the Čertovo jezero Lake. A greater difference is also in HLI per ha, area of cirque and glacial accumulations of the Čertovo jezero Lake has its values higher by ⅓. It would mean that a relatively small difference in the deflation plateaus area and a comparable difference in the size of cirques would cause such a diametrical difference in glacial accumulation areas. Therefore, it seems that the difference in the size of snow source area was intensified by the difference in relief insolation, i.e. in variable heat load.

Tab. 7 represents percentual difference in the basic characteristics of Černé jezero Lake cirque and Čertovo jezero Lake cirque. Biggest differences are related to the area of cirques and characteristics related to relief heat load balance: N–E aspect for headwall, HLI/ha. The table shows that characteristics ELA and HLI

ELA (m a. s. l.)	area	
method	Černé jezero Lake	Čertovo jezero Lake
THAR	1,082	1,110
MELM	1,115–1,030	1,070–1,040
CFA	1,002	1,016

Tab. 6: ELA values for both areas (CFA – cirque floor altitude, MELM – maximum elevation of the lateral moraine, THAR – toe-to-head altitude ratio)

reflecting climatic factors have a response in the morphology of cirques even though the cirques are located practically at the same altitude. The HLI/ha ratio is more than by 30% smaller for the cirque and moraines of the Černé jezero Lake comparing to the cirque and moraines of the Čertovo jezero Lake. A larger glacier could have developed in the cirque of the Černé jezero Lake and it formed a larger cirque (+ 21%) with a higher (+ 9.1%) and steeper (+ 24.8%) headwall with a higher degree of overdeepening (+ 21.3%). The comparison of planar morphometric characteristics – width and length of the cirques – is also interesting. Ratios of width and length of both cirques are completely opposite. The Černé jezero Lake cirque is rather longer than wider conversely the Čertovo jezero Lake cirque is rather wider than longer. It is not caused by exogenetic geomorphological processes but by geological conditions of the area – direction of foliation of mica schist and gneiss which build the study area.

Fig. 7 shows the change of potencial solar radiation depending on the change of orientation and slope gradient for 50° N in ablation time of the last glaciation. Coloured lines define segments corresponding to the cirques of the Černé and Čertovo jezero Lakes. Difference in solar radiation can be up to 70 Kcal/ cm^2. Extreme minimum values (20 Kcal/cm^2) were measured in the southern part of the cirque headwall of Černé jezero Lake, which has northern aspect and is most deepened. Extreme maximum value (90 Kcal/cm^2) is in the northern part of the cirque headwall of Čertovo jezero Lake, which has southern aspect. In the study area, the smallest difference (lower than 10 Kcal/cm^2) in the potential solar radiation can be found in the flat parts of the glacial accumulation areas.

Therefore, it is very important to observe heat load expressed by Heat Load Index not only in the accumulation part of the glacier, i.e. in the cirque, but also in the localities of moraines because they mark the boundary of the area where the glacier tongue was located, so where the glacier ablation area was located. In the case of Černé jezero Lake, this area reaches up to 760 m distance from the cirque border and its HLI per hectare is only one third comparing to the ablation area of the glacier of Čertovo jezero Lake. The glacier tongue of the Černé jezero Lake was exposed to much smaller heat load.

We can compare the values of heat load (expressed by HLI) for single parts of the glacial accumulation segment in the study areas. Then the difference between the colder right side and the warmer left side

	Characteristics	Černé jezero Lake Area
morphometry and morphology	H [m] - cirque height	+ 9.1%
	L [m] - cirque length	+ 23.3%
	W [m] - cirque width	− 19.4%
	cirque area [ha]	+ 21.0%
	L/H ratio	+ 12.9%
	L/W ratio	+ 52.4%
	W/H ratio	− 25.9%
	3D/2D area	+ 5.5%
	k-curve index	+ 21.3%
	mean slope [o] - cirque	+ 8.3%
	mean slope [o] - headwall	+ 24.8%
	mean elev. -cirque floor [m a. s. l.]	− 1.4%
	N-E aspect [%] - cirque	+ 7.2%
	N-E aspect [%] - headwall	+ 54.8%
HLI	mean HLI - cirque	− 12.6%
	mean HLI - moraines	− 12.8%
	HLI/ha - cirque	− 27.9%
	HLI/ha - moraines	− 29.6%
ELA	THAR	− 2.5%
	MELM	+ 4.2%
	CFA	− 1.4%

Tab. 7: Differences in some characteristics between the Černé jezero Lake Area and the Čertovo jezero Lake Area (Čertovo jezero Lake Area characteristic equals 100%)

of glacial accumulation segments is evident. In the case of Čertovo jezero Lake, this difference is noticeable in the whole glacial accumulation segment; in the case of

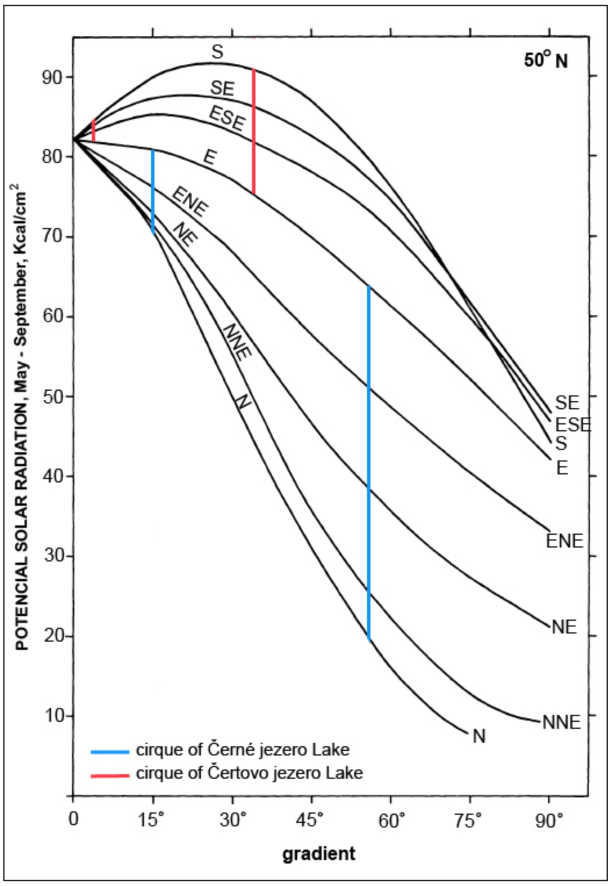

Fig. 7: Dependence of the potential solar radiation on aspect and gradient (under cloudless condition and with a free horizon) from May to September at 50° North (From Evans, 1977; modified)

Černé jezero Lake, the difference is most visible in the vicinity of the lake. We can get the same results when we compare the ratio between HLI values in selected points of the single generations of left and right moraines (Fig. 8). Index HLIL/HLIP for moraines of the Čertovo jezero Lake glacier is in all cases higher than 1 and the ratio slowly increases inward the cirque. The value of HLI ratio of left and right moraines of the Černé jezero Lake is also always higher than 1 except for the moraines of the 1st generation (0.88). The moraines of the 2nd and 4th generation of Černé jezero Lake reach values 0.97 and 0.98, respectively. Generally it holds true: the closer to cirque, the higher value of HLI and the value of ratio HLIL/HLIP changes from value <1 to >1.

The position of moraines of the Černé and Čertovo jezero Lakes where right moraines are above the corresponding left ones (by 40 m at the Čertovo jezero Lake, by 70 m at the Černé jezero Lake) implies that both glaciers were obviously asymmetric in elevation. The asymmetry can be explained by different heat load. Right part of moraines had more profitable colder northern aspect and lower HLI, the glacier had better conditions here and could become thicker and could push moraines up to steep slope. Compared to this, the area of left side moraines had higher HLI and the glacier did not become so thick. Right moraines of the Černé jezero Lake are connected to the most overdeepened area of the cirque and to the part of the cirque with the most favourable position towards deflation plateaus. The nearest deflation plateau of Čertovo jezero Lake is located above the central part of the cirque. Position and shape of the cirque of Čertovo jezero Lake is more asymmetric and moraines are placed more asymmetrically towards the cirque.

The different number of moraines indicates that during the last glacial period, glaciation of higher intensity is likely to have occurred more often in the area of Černé jezero Lake (higher number of extant moraines, larger area of glacial accumulation segment, more evident shapes of glacial landforms) than in the area of Čertovo jezero Lake. On the other hand, the fact could also be interpreted in such a way that due to higher heat load the climatic fluctuations were so small that they did not show in the area of Čertovo jezero Lake and the glacier did not grow at all.

However, it is necessary to realize that the presented models, the heat load model in particular, are based on the currently existing relief. The model would be different for the area of cirques at the time of developing glaciation and would depend on glacier surface gradient. On the other hand, it cannot be presumed that exposure and other relief changes were significant enough to cause entirely different results.

6. Conclusions

Common determining factors in the glacier formation in the Bohemian Forest were: deflation of snow, leeward position of the cirques and predisposition of the preglacial relief. It shows that the cirque characteristics of the two study areas are, in some cases, very similar. It applies to morphological characteristics e.g. height characteristics (mean elevation, vertical relief-dissection), mean slope of the cirque area. At first, the highest differences can be found in L/W index, headwall aspect, HLI of the headwalls and HLI of the glacial accumulation segments of the relief.

The favourable position of the cirque of Čertovo jezero Lake to prevailing winds direction, which increased snow supplies into the cirque compensated for the unfavourable orientation to southern quadrant, respectively increased the heat load and made the

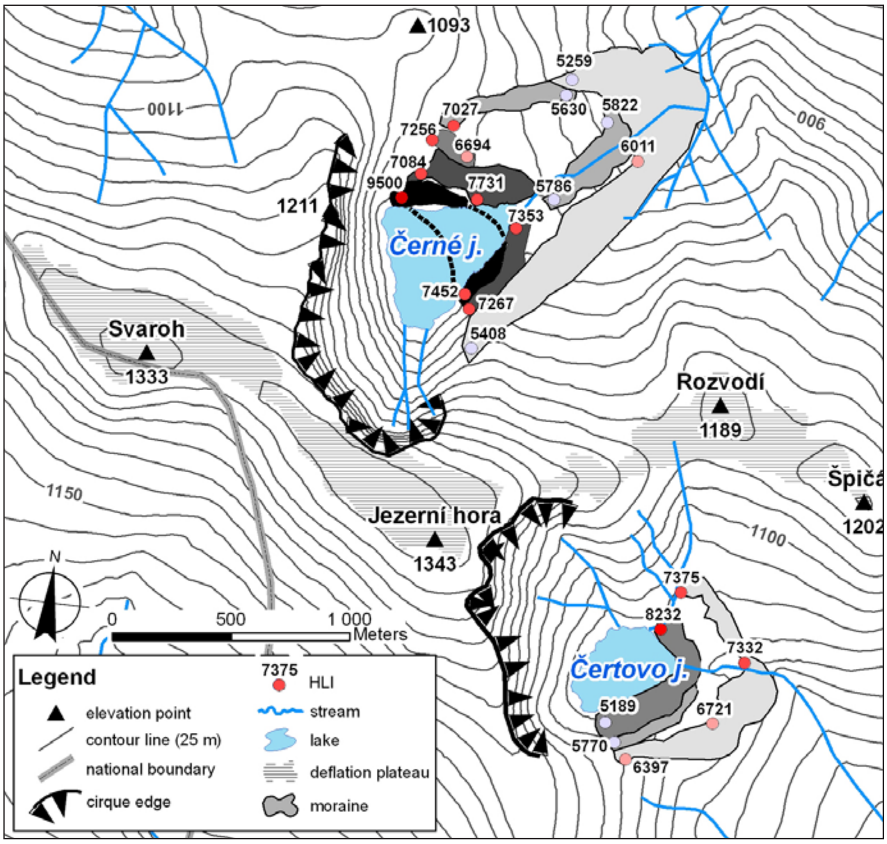

Fig. 8: Position of moraines, deflation plateaus and HLI for selected points

formation of glacier in this area possible. However, intensive heat load in the cirque and in the glacial accumulation relief segment of Čertovo jezero Lake caused differences in glacial accumulation relief segments. More noticeable and really more extensive glacial landforms developed in the Černé jezero Lake cirque. A cirque glacier nearly without tongue developed in the Čertovo jezero Lake cirque. Thus, a more important factor for the extent of glaciation in the area of Černé jezero Lake and Čertovo jezero Lake is the effect of heat load rather than the size of deflation plateaus. Heat load was not different only between the two localities but also within them. Heat load in the right and left side of the moraines differentiated. It resulted in the glacier height asymmetry in its accumulation part.

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Authors' adresses:

Mgr. Klára VOČADLOVÁ, *e-mail: vocadlov@natur.cuni.cz*
RNDr. Marek KŘÍŽEK, Ph.D., *e-mail: krizekma@natur.cuni.cz*
Department of Physical Geography and Geoecology
Faculty of Science, Charles University in Prague,
Albertov 6, 128 43 Praha, Czech Republic

CYCLE TRANSPORT IN CITIES – BEST PRACTICES IN WESTERN EUROPE COMPARED TO THE SITUATION IN BRNO (CZECH REPUBLIC)

Eva KALLABOVÁ, Veronika ZEMANOVÁ, Josef NAVRÁTIL

Abstract

Cycling is a timeless form of individual transport, constituent of tourism and a regional structure synthesizing natural predispositions and the constructed infrastructure. Inspiration for the support of its development and for 'best practices' can be drawn from many Western European countries and cities. The situation in the Czech Republic, studied in detail for the case of Brno, reflects the real conditions of cycle transport and identifies some of its deficiencies, based on the results of a questionnaire survey.

Shrnutí

Cyklistická doprava ve městech – dobrá řešení v západoevropských městech ve srovnání s Brnem (Česká republika)

Cyklistická doprava je nadčasovou formou individuální dopravy, prvkem cestovního ruchu a regionální strukturou kombinující přírodní predispozice s vybudovanou infrastrukturou. Inspiraci k podpoře jejího rozvoje lze najít v mnohých západoevropských státech a městech. Situace v České republice, podrobně zkoumaná na příkladu Brna, odráží její reálný stav a pojmenovává nedostatky – to celé s využitím výsledků vlastního dotazníkového šetření.

Keywords: *cycling; best practice examples; questionnaire survey; Brno, Czech Republic*

1. Introduction

Cycle transport is an integral and fully-fledged component of the transport system and in conjunction with suitable public transport, pedestrian traffic, and, last but not least, re-evaluated approach towards parking solutions (park-and-ride yards on the fringes of cities, below-grade parking, parking houses) it can considerably help ameliorate the environment and residential conditions (http://www.brno.cz). The objective ought to be a network of integrated routes ensuring relatively speedy and chiefly safe connections between destinations of both major and minor significance. One of the frequently used options in cities is the transport of bicycles by the public (also integrated regional) transport and the still more common conveyance by trains.[1]

Argument for respecting the bicycle as a means of transport is its financial benefits. Annual cost for bicycle maintenance stated by surveys (service, maintenance, repairs) are EUR 180 per year; for comparison, annual cost for an automobile amounts to EUR 5,230 per year and EUR 385 per year for public transport (VCÖ, ÖAMTC, Wiener Linien in http://cyklotrasy.sk). Among other cycle transport merits are also low spatial demands along with the absence of emissions.

[1] Transport of bicycles, e.g. in Brno trams, trolleybuses, and buses, is always allowed if the vehicle has empty space and the driver is notified thereof. With a prepaid card (monthly, quarterly, yearly), the bicycle can be carried free of charge; in all other cases, the charged bicycle fare is a half of the regular fare. On longer distances, the bicycle can be shipped by train. It can be transported in two ways: bicycle as an accompanied baggage (special stands in one part of the carriage) or by way of "mobile left-luggage car". In the first case (the railway guide indicates the trains equipped with this type of service by a bicycle logo), you alone take care of the loading, storing, and unloading of the cycle; with the second option, the Czech Railways employees do it for you. Recently, the Czech Railways have nonetheless led a rather retrogressive policy towards cyclists since they introduced compulsory reservations, etc.).

2. Material and methods

Cycle transport is a form of mobility that belongs to the basic human needs (Hrala, 2002). It is one of the segments of regional structures, which is primarily affected by natural constituents of the landscape sphere. Manmade infrastructure should respect its constituents and also take into account other functions of the townscape in an urbanized environment. Of prime importance are the impact of the relief, water elements, forests and the organization of existing residential system (both urban and rural) interconnected by transport infrastructure.

Relief (ascent, descent) determines the ride energy intensity. The serviceability of the route by all age categories, i.e. at least international and regional routes shall be planned on roads with the lowest differences in elevation, but at the same time through varied landscape with panoramic viewpoints. In urban areas, this factor additionally conflicts with safety and heightened likeliness of collision with motor transport.

Watercourses were already of significance at the period when our territory was being settled. They are favourable connecting lines (of minimum declivity) between the individual municipalities and towns; a ride along a watercourse concurrently increases its attractiveness and frequently enables other types of recreational activities as well (bathing, fishing, feeding the waterfowl, etc.).

Passages through sections of forest or at least through landscape with forests, meadows, and fields alternating in a mosaic fashion are highly attractive for cycle transport. Forest provides natural protection against excessive sunlight and wind and it is generally a symbol of rest and relaxation.

Cycle transport in rural environment is a means of commuting to work, civic amenities, and schools (worse transport services) and it simultaneously serves as a means of recreation (for both the rural and urban populations).

Urban environment still requires the construction of an appropriate transport infrastructure between locations of highest population concentrations. In other words, we need to work towards connecting urban residential areas to zones of accumulated work opportunities and amenities, such as the downtown and production and administration areas, and to recreational routes or tourist regions located in the cities hinterlands in order to have alternative commuting means to work or to other destinations. Complementary infrastructure, i.e. resting areas, refreshment, left-luggage offices and bicycle repair shops, bicycle parking racks, waste litterbins, etc. must be also born in mind.

Some people use cycling as a means of commuting to work or to school. With this type of journeys the priorities are safety, maximum economy in time, and good quality of the road surface. The majority of cyclists are however those who ride bicycles for recreation in their leisure time and among their chief objectives are new knowledge, relaxation and the fact that self-powered mobility is good for health. Into the third category fall sport cyclists who require special conditions and enclosed racing tracks and circuits, such as the Brno Favorit Velodrome.

Over 80% of the European population live in towns and big cities. The quality of life is, among other things, negatively affected by a sharp rise in traffic intensity. Motor transport in particular is the source of noise and vibrations, it has a negative visual effect (parked cars in the streets), it implies higher energy consumption, and it contributes to the increase in emissions. Between 1975 and 1995, the daily individual travelled distance doubled. It is presumed that by 2025 the distance will have doubled again (http://www.europa.eu.int). In urban areas, one half of all journeys is below 5 km and one third is shorter than 3 km, which are ideal distances for a bicycle. Other surveys state that between 1995 and 2030 the total volume (measured by the number of kilometres travelled) of road transport in urban areas will grow by 40% (Dekoster, Schoellaert, 1999). Cycle transport has additionally low spatial requirements, while concurrently complying with high transport demands.

Accident rate of cyclists represents another frequently discussed issue (http://www.udi-praha.cz). In the long run in fact (2000–2007), it accounts for one hundredth of all traffic accidents (annual averages of the City of Brno state 50 accidents involving cyclists, while an injury is sustained in roughly 35 cases). The majority of accidents occur during workdays between 3 and 6 pm and in April and May, if the months of the year are considered. Proportion of accidents caused by cyclists in all of the accidents involving cyclists ranges between 48% and 55%. Non-compliance with the right of way, incorrect way of riding, and lack of caution are among the main causes. Further aspects of the accident rate of cyclists are the quality of the tracks surface and their illumination, while of no less importance are ambiguous legal regulations on cycle crossings.

Sustainable strategies of the cities development should endeavour to find a solution for aiding the use of alternative means of transport (public transport, cycling and walking) (Ball and Stobbarl, 1998) as

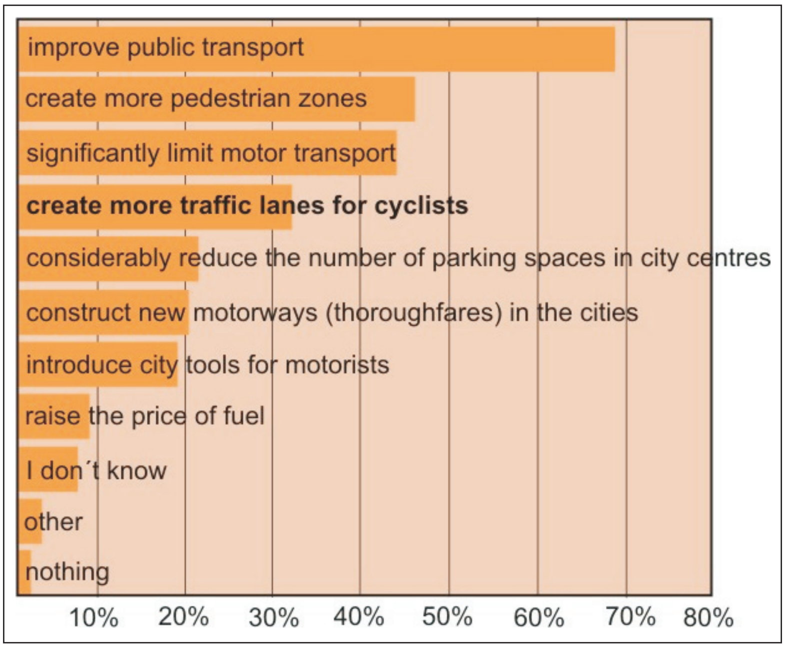

Fig. 1: Responses of the inhabitants of European cities to the question: "In your view, which of these measures would most efficiently solve environmental protection problems related to urban transport?"
Source: Eurobarometer, 1999 (51.1) (http://www.euractiv.cz)

expressed by the respondents in selected European countries in 1999 (Fig. 1). It further follows out from the chart that cycling as such – in terms of its role as an ecological, cost-saving, healthy, and fast means of transport – needs to be promoted. The creation of conditions for safe movement of cyclists shall be an indicator for a soundly developing area.

3. Examples of cycle transport promotion in European countries

A wave of support to cycle transport swept the European countries earlier than the Czech Republic. Thanks to this, we could avoid some mistakes and conversely become inspired by well-tried solutions (Pucher, Buehler, 2008). Rising gradient exceeding 5%,[2] which corresponds to a ride against strong wind in a flat terrain, is considered as unsuitable for cycle transport in urban terrains. Most information on the situation in European cities in the Netherlands, Sweden, Finland, Denmark, France, Great Britain, Austria and Germany can be found at http://www.nakole.cz and in the publication of the Office for Official Publications of the European Communities (OOPEC) (2005). Active cycle transport (as an equivalent means of transport) promotion by the municipal council always constitutes a necessary precondition. Each urban project dealing with the road space redistribution forms part of a transport strategy with a series of complements, including public transport and pedestrian facilities improvement.

Germany, for example, has a law instructing that each road reconstruction or construction needs be accompanied by the building of a safe, distinctly detached bicycle track. Thanks to this law, out-of-town cyclotourism enjoys an unprecedented popularity and it is a widespread leisure activity. Bicycle is truly a fully-fledged means of transport for all walks of life and generations. Towns are interwoven by bicycle tracks that are fully utilized.

In Berlin, which statistically does not rank among cities with the best cycling infrastructure, the carriage of cycles for students in public means of transport with well adapted subway and tramway cars, is free of charge. Freiburg disposes of a special cycling centre with not just a multi-storey bicycle parking, but also a cycle café, office and advisory centre, shop selling bicycles and cycling accessories of all sorts, travel agencies offering bicycle trips all over the world, and freely distributed cycling magazines and other printed materials informing on cycling events and news from the bicycle world.

[2] In Trondheim, the so-called "cycle elevators" were constructed in locations characterized by a rising gradient of over 8%.

The city centre of Austrian Vienna could serve as an apt example for the solution of cycle transport right in the downtown. Rules of entry to the pedestrian zone were established (and are being adhered to) and the cyclists, for instance, can even use special left-turning lanes on multiple-lane city avenues. The fondness for bicycles as means of transport into the city centre is best documented by the always full bicycle racks anywhere in the pedestrian zone and by the self-service racks for hiring cycles. The racks pay for themselves by advertisements that are not much tolerated anywhere else in the protected city centre. Repressive measures for cyclists became stricter; for example, in the matter of alcohol consumption before riding the cyclists are equated do drivers. Bicycle tracks on the Danube Island (the quality of which suffices also for inline skaters) that continue along the river maintaining the same quality also in the eastern and western directions present another Viennese merit. Their popularity and quality are manifested by the fact that rides on Viennese bicycle tracks (flat relief) were added to the advertised destinations list of several Czech travel agencies a long time ago.

Cycling in the Netherlands has had a long tradition thanks to the country's flat relief. Active approach (e.g. the so-called "Bike and Ride" – bicycle parking racks at public transport stops) succeeds in forcing automobiles out of the city centres at the concurrent elaboration of promotional programmes to bicycle as regular means of transport (separate lane for cyclists between the pavement and the road). As a matter of fact, bikes are used there almost by everybody – Amsterdam has 600,000 bikes for the population of 730,000. Bicycles can be hired in bike rentals and commonly in hotels, too. A curiosity is the specialized Ostade Bike Hotel which is fully prepared for tourists on bicycles. The personnel has completed a special training and will provide the quests with complete information on cycle transport in Amsterdam and on the recommended routes.

Up until 1992, the Czech Republic had shared common history with Slovakia and we therefore deem important to mention the situation in Bratislava. The website http://cyklotrasy.sk shows a map of transit and regional routes and operational sections of the principal city routes with an option of interactively displaying the designed, not yet implemented sections. Since 1993, 90 km out of the total 130 km of bicycle routes have been realized, out of which the Danube Bike Trail accounts for 35 km. Further cycling infrastructure is also at a higher level as Bratislava can boast printed cycle guides, bike rental services, and even the possibility of "buying" a guided cycle tour. A cyclist-tourist will surely appreciate the carefully processed information of the so-called "cycling tips" specifying the ride duration, distance in kilometres, difficulty, inclination of terrain, differences in elevation, marking, convenience, safety, and attractiveness of the chosen journey.

Apparently, the biggest progress among the cities of the post-socialist European states has been achieved in Budapest. While only several hundred people take part in the Brno bike rides and the maximum of 3 thousand in Prague, the number of participants in the Budapest bike ride, including the republic's president, reached 50 thousand in the spring of 2007.

The total number of people in Budapest utilizing bicycles for their daily rides to work or school has seen a twofold increase in the past three years. As a result of the bike rides, the speed of new cycling lanes construction and bicycle tracks went up from 1–2 km per year to 30 km per year. The Hungarian Ministry of Transport also includes the Ombudsman's Office for Cycling (http://www.ekolist.cz).

4. Cycle transport promotion in the Czech Republic

The Czech Republic has adopted a series of steps that are in line with the European trends. The most important documents are:

- Transport Policy of the Czech Republic for the period 2006–2013 – Resolution 882/2005 (http://www.mdcr.cz)
- National Strategy for Cycle Transport in Czech Republic – Resolution 678/2004 (http://www.cyklostrategie.cz/).

Within the framework of the CR, Brno and its immediate hinterland cannot be counted among areas in which bicycle would be considered as a traditional means of transport although the railway stations in the southern (flatland) part of the Brno Region used to be standardly fitted with sheltered racks for bicycles in the B+R (bike and ride) system.

The situation somewhat differs in the flat terrain of the Uherské Hradiště Region where the share of cyclists in the overall transport labour division reaches 15% of economically active citizens (according to the results of the Transport Master Plan for the conurbation of Uherské Hradiště, Kunovice and Staré Město – according to an oral statement of the Uherské Hradiště Municipal Office from 2008). Thanks to intermunicipal collaboration and joint projects, the region has succeeded in constructing over 30 km of cycling network since 1999 and thus leading the cycle transport away from busy 1st class roads. The connection to the wine trail additionally offers further prospects for recreation and tourism development in the larger region.

One can find good examples also in other regions of the Czech Republic. Worth mentioning are particularly the bicycle tracks Kolín–Velký Osek and Kolín–Ovčáry, which are integrated into the transport infrastructure of the Kolín car manufacturer, gradual construction of the Labská, Vltavská, and Otavská bicycle tracks, cycle transport organization in Prostějov and Olomouc, etc.

Since 2007, the South Moravia Region has had an elaborated Programme for Developing Cycle Roads Network in Minimum Contact with Motor Transport in the South Moravia Region. It is not, however, a binding document and its application aspect is addressed only marginally in the form of recommendations (inspirations and motivations). In 2008, the implementation aspect managed to secure an investment in the amount of CZK 48 million aimed to assist cycling.

The socialist regime prior to 1989 generally suppressed cycle transport in all its forms, and if not, then the regime ignored it. Bicycle was rather considered an outdated means of transport, a toy for children, or part of sports gear. Transition away from this philosophy inspired efforts striving at cycle transport rehabilitation. First concrete activity in Brno commenced in 1992, when the fist section of the bicycle track between the Komín neighbourhood and Bystrc wharf was built. The same year also witnessed the elaboration and authorization of the first survey (master plan) of bicycle routes in the City of Brno to prevent chaotic construction of tracks.

Another document is the Study of Bicycle Routes and Tracks in the Territory of the City of Brno (2006). It maps existing situation of the city cycle transport in detail and it delimits a set of most exigent measures for the nearest stage. It also gives examples of specific steps leading to an increase in bicycle utilization in its function of a means of transport. Brno's plans regarding the cycling network calculate with the total length of approximately 84 km. A foreign survey (http://www.bicyba.sk) however states that a city with over 360,000 inhabitants, which is the case of Brno, should have a network of at least 100 km.

The survey suggests enhancing the quality of subsections and constructing interconnections between the bicycle tracks. With respect to growing, but still insufficient funds invested in Brno into cycle transport, it cannot be assumed that the bicycle routes and tracks map would have prospectively been finished by 2013. Although the truth is that road construction for cyclists is not spatially demanding and, in comparison to motor transport, only a fragment of financial expenses is needed. Field research from the end of 2007 moreover demonstrated on selected sections of existing bicycle routes and tracks numerous absurdities, mistakes, and poor examples of what cycle transport should actually look like in Brno (Zemanová, 2008). On the other hand, a favourable example is the organization of traffic at an interchange near the Brno fairgrounds (Fig. 2).

5. Basic information about Brno bicycle routes

The issue of bicycle routes and tracks needs to be conceived of at different levels ranging from the European and national, over transregional and regional, down to the network of local bicycle routes. Good communication of all of the concerned parties is important at all levels, since the essence of roads has always consisted in geographical linking of places (Čeřovská, Dekoster, 2002; Martinek, 2007). Even on bicycle routes, their users may not be aware of crossing administrative borders (city districts, municipalities, regions) and frequently of crossing state borders due to the existence of the Schengen space.

Due to its geographic location at the confluence of two rivers (potential natural cycle corridors), the City of Brno has become one of the poles of growth of the European cycle route network, the plans of which were created and came to be implemented by a workgroup of the European Cyclists' Federation between 1995–1997. The project develops the Eurovelo (EV) network which consists of 12 trans-European cycle routes (Fig. 3) connecting all European countries (http://www.eurovelo.com). The project's aim is to support cycle transport and simultaneously promote cycling as a “vacation tip” and provide motivation for using the bicycle for regular journeys.

The Population and Housing Census (2001) results show that 3,070 Brno households did not own any passenger car which, given the average household size of 2.45 persons, corresponds to 7,520 people. It would not be reasonable to claim that bicycle represents an alternative means of transport for all of them. Yet if we consider nearly 5,000 recreational cyclists counted in one day on four Brno bicycle tracks (http://www.brnonakole.cz), riding a bike is obviously one of the most wide-spread leisure activities with the people living in Brno. We additionally need to take into account that growing standard of living will make the number of cars rise further. Population ageing will cause increased automobilization among the older generation as it is common in the highly developed EU countries. These people will not use bicycles for objective reasons.

6. Hierarchy of Brno bicycle routes and tracks

Cycle routes in Brno can be classified based on their significance into so-called "hierarchical levels" from the most important (trans-European) cycle tracks to the local cycle routes.

Two international bicycle routes meet in Brno (the North-South EV 9 and West-East EV 4); they intersect in the Brno-Komárov quarter. Their course is as follows:

- EV 9, bicycle route of the CR No. 5 – From the Baltic to the Adriatic (Amber Route): (total length of 1,930 km): Gdańsk (intersection with EV 10)–Poznań (intersection with EV 2)–Brno (intersection with EV 4)–Vienna (intersection with EV 6)–Maribor–Ljubljana–Terst (intersection with EV 8)–Pula. The route in Brno runs along the Svitava River and it thus forms part of the city system in the directions north-east and south; in the regional context it serves as a connection between the city's recreational hinterland and the Moravian Karst.

Fig. 2: Modern interchange between the Svratecká and Kohoutovická (Starobrněnská) bicycle tracks in Brno (Photo E. Kallabová, 2008)

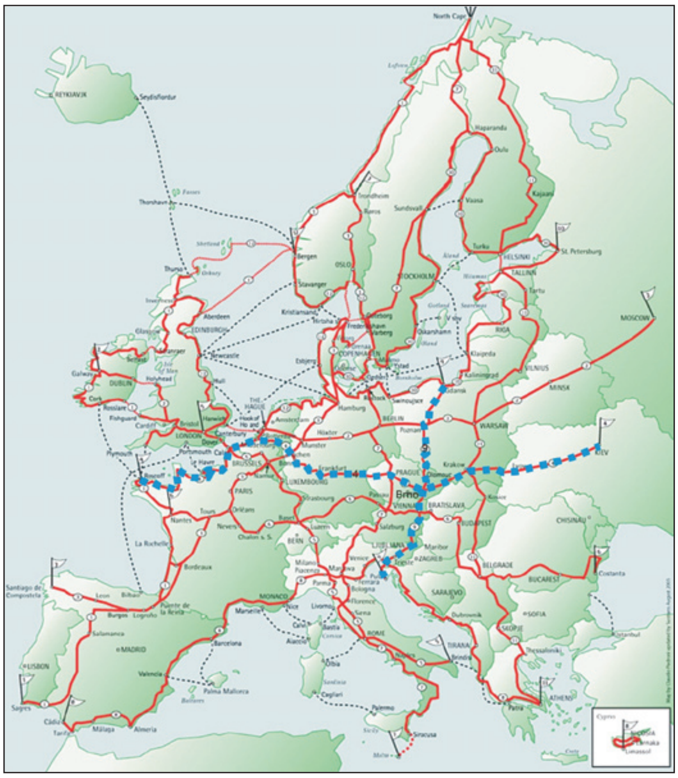

Fig. 3: The European Eurovelo network (http://www.cyklotoulky.com

- EV 4, bicycle route of the CR No. 5 – Roscoff – Kiev (in the Czech environment it is referred to as the "Prague Route") (total length 4,000 km): Roscoff (intersection with EV 1) – French coast of the Atlantic Ocean – Le Havre – Calais (intersection with EV 5) – Middelburg – Aachen (intersection with EV 3) – Bonn – Frankfurt – Prague (intersection with EV 7) – Brno (intersection with EV 9) – Krakow (intersection with EV 11) – Lviv – Kiev. It leads past the Brno dam and then goes onward along the Svratka river. It is also part of the principal city system in the directions north-west and south. At the confluence with the Svitava R. it becomes a Greenways trail, a term used for tracks and routes beneficial for the environment and contributing to the quality of life for the people living in their vicinity.

No supra-regional routes pass through the City of Brno. The closest route that can be considered supra-regional is the east-west route No. 472 (leading from Zlín, over Ždánický les Forest, Újezd u Brna, Rajhrad, and Dolní Kounice to Moravský Krumlov). Connections to such significant towns in the region, as for instance Ivančice and Vyškov, is rather complicated for cyclists. For further information on this type of cycle tracks refer to the paper Programme for Developing Cycle Roads Network in Minimum Contact with Motor Transport in the South Moravia Region (2007). Their cartographic depiction can be found at the website http://www.mapy.cz which also provides a tool for measuring their lengths or individual distances.

Regional routes – their task is to link the city to significant recreational areas within the conurbation. The following Brno routes fall into this category:

a) route No. 5231 – 20 km – on the traces of past railway lines (leading from Brno – through Mokrá Hora and Kuřim to Veverská Bítýška)
b) beer trail leading to the brewery in Černá Hora – 25 km – (leading from Brno – through Mokrá Hora to Černá Hora)
c) cycle route to the south of Brno passing through the natural park of Bobrava – 21 km – (through the Bobrava R. valley) from Želešice to Rosice.
d) the Brno round ("Brněnské kolečko") – 70 km – a route of medium difficulty around Brno – it encircles the city and passes mostly on side streets and roads away from the heavy road traffic.

It can be generally said that the least attractive region for cyclists is the one to the south-east of Brno, which is characterized by terrain of small differences in elevation but lacks watercourses, forests or at least scattered greenery; i.e. landscape features attractive for cyclists.

The network of city cycle routes and tracks – the basic network (Fig. 4) – is most substantially formed by the aforementioned routes leading along the Svratka (the Svratka cycle route) and Svitava (the Svitava cycle route) Rivers belonging to the international bicycle network. Further route fragments are opened in the Chodská, Botanická (Student cycle route), Královopolská, Svatopluka Čecha (Industrial cycle

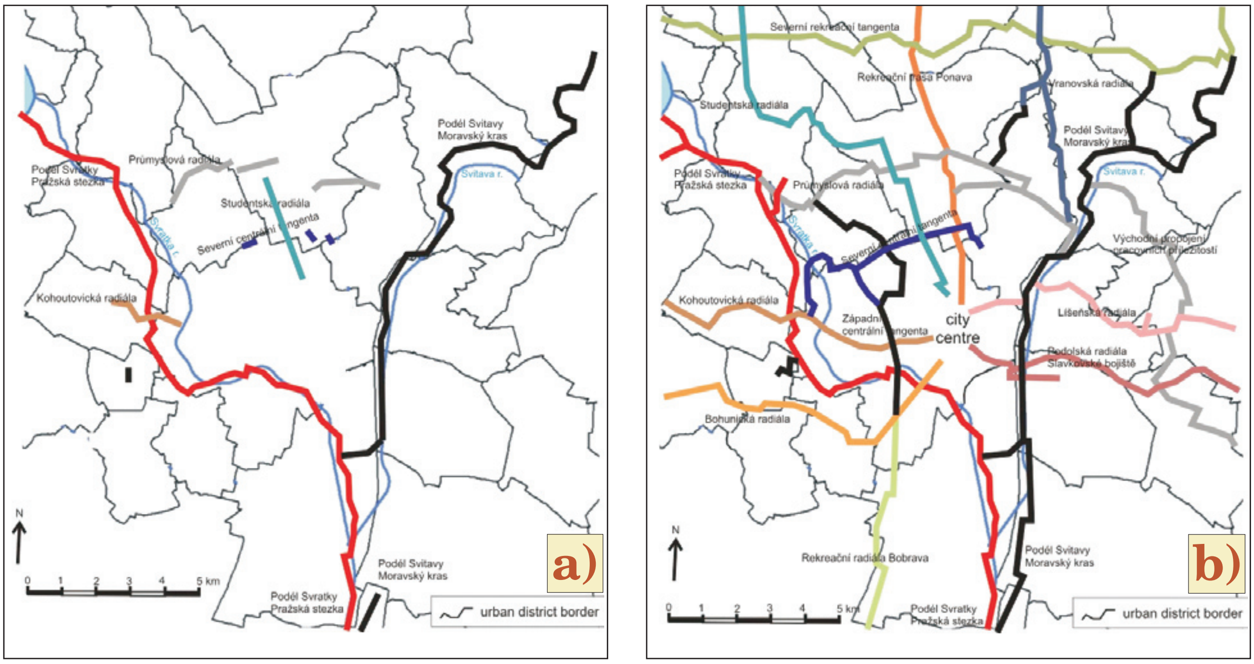

Fig. 4: Bicycle tracks and routes in Brno: a) implemented as of and including 2008; b) theoretical network (according to the Study of Bicycle Routes and Tracks in the Territory of the City of Brno, http://www.brno.cz)

route), Antonína Procházky, and Hlinky Streets (Starobrněnská–Kohoutovická cycle route). These routes shall constitute the basic grid of the city bicycle routes, but at present only their sections are operational.

A detailed characterization of the 2008 situation with photodocumentation forms a component of the publication by Zemanová (2008). We should at least mention the Student cycle route the title of which derives from its intended function of linking the most significant university complexes in the city (the Palacký vrch student complex, the city centre, and the university campus in Starý Lískovec). So far, only 2 km out of the total 14 km have been realized. The Industrial cycle route passes through areas offering job opportunities (Technological park, former Královopolská machine works, Hády, Zetor, Černovické terasy industrial zone). The ratio between the implemented and planned lengths equals the state of the Student cycle route. The scheduled accessory routes tend to interconnect urban districts by at least one safe road. The actual downtown (pedestrian zone) is unfortunately made accessible to cyclists only from 5 pm to 9 am. At least until 2013, there is no plan in place intending to earmark its part for a mixed pedestrian and bicycle zone. The city representatives argue that, apart from other things, the combination of the cycle transport with the city centre is obstructed by the still not clarified situation and plans for the relocation of the railway station. The location of the new railway station will moreover rather aggravate the possibilities of cyclists and chiefly its accessibility for pedestrians; the pressure of automobiles on the space in question is hence going to intensify.

The truth is that all of the sections of the Brno bicycle routes and tracks have a complete absence of information boards with relevant maps showing the course of the particular trail or possibly a list of places of interest which can be encountered or visited throughout the journey, where refreshments can be found, and where intersections with other directions are located and communicating to the recreational cyclists in what ways their ride can be enriched.

6.1 Opinions of Brno inhabitants concerning the cycle transport

Although cycle transport is generally acknowledged as one of the most efficient forms of passenger traffic in cities (Bramwell, 1998; Kopáčik, 2001), only a relatively small percentage of people actually use it. The reason for dissatisfaction is an underdeveloped network of cycle tracks and lanes which would link the individual urban districts to the Brno centre and the absence of safe bicycle parking facilities. The local workgroup of the Hnutí Duha (Rainbow Movement) NGO in cooperation with the Partnership Foundation publicly stress the inadequate conditions for cycle transport in the city; they for instance organize Brno bike rides twice a year (http://www.brnonakole.cz) marking the occasion of the Earth Day and the Day Without Cars, they also initiated a petition "For the Rights of Cyclists"[3], published a promotional leaflet with representative information and proposals concerning cycle transport in Brno, etc.). These are traditional methods of drawing attention to the issue; the first bike ride calling for safer streets for pedestrians and cyclists was held in San Francisco (USA) in 1992. Another activity of Hnutí Duha consisted in counting the cyclists and addressing them with a questionnaire survey (on a free day in September 2006 between 8 am and 6 pm) in four locations: at the kilometre zero of the Brno–Vienna bicycle track, in Bílovice nad Svitavou, at the Brno dam and in the Mariánské údolí Valley. In total, 4,950 cyclists (out of which 63% were men) were counted with additional 740 inline skaters on the Brno-Vienna cycle track who frequently come here, too.

One can learn from the results of the survey (http://www.brnonakole.cz) that 72% of the questioned cyclists are discouraged from more riding around Brno by fear for their safety while on a bicycle because they feel threatened by the motor-vehicle traffic and because the city has very few cycle tracks and lanes. More than one third perceive cycling in Brno as unhealthy due to car exhaust fumes and non-negligible 36% of respondents feel the lack of safe parking facilities for bicycles.

The commonly repeated argument of the city representatives referring to the hilly Brno terrain and its consequent unsuitability for cycle transport is countered by the fact that only 7% of respondents share this view. When asked about potential modifications that would help improve the cycle transport situation in Brno, 75% of respondents agreed on the necessity of investing more resources in the construction of bicycle tracks. It is indisputable that the quality of the tracks should be as high as possible and that drawing attention to their deficiencies is correct. One of the benefits of a cycle (and inline skating) track is that it makes do with light, i.e. less financially intensive road. More than a half of the survey participants would welcome an adjustment to the system of road signs and cycle lanes on roads and 41% would focus on better access of cyclists to the city centre and on its linkage to

[3] Rights of Cyclists Petition – over 8,500 signatures were collected between July and September of 2006, which considerably highlighted the position of people interested in cycle transport for the Brno City Municipality employees.

Fig. 5: A difference in quality between the Svitava (left) and Svratka (right) cycle tracks (Photo E. Kallabová)

other urban districts. One quarter of respondents view a campaign for higher safety of cyclists in the streets of Brno as meaningful.

These fairly negative conclusions of the survey have served as motivation to perform a similar survey of our own which came to be held at the beginning of 2008. The collection of primary data was further conditioned by the inaccessibility of information on the structure of bicycle use by the inhabitants of the City of Brno and its surrounding areas. Considered the financial resources and the research objectives, the alternative of a questionnaire survey was opted for (Flowerdew and Martin, 1997). The selection of respondents was random and limited only to those who expressed their interest in the issues concerning cycle transport in the City of Brno. The questionnaires were distributed throughout January and February of 2008. Out of the total of 650 distributed questionnaires, 493 were handed back in which stands for a 75% rate of return. Fifteen of these respondents stated that they did not own a bicycle and these questionnaires therefore became disqualified for further analyses.

The sample of respondents can be characterized by the basic demographic and socio-economic data, which are demonstrated in Fig. 6. The questions were directed at three rounds of issues: use of bicycle as a means of transport, attitude of bicycle owners towards cycle infrastructure, and differences in preferences

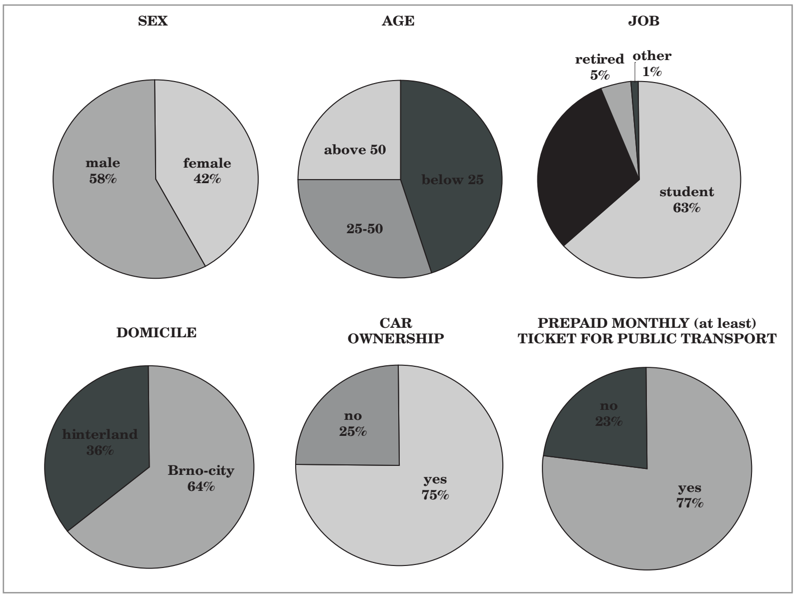

Fig. 6: Basic characteristics of the sample of respondents
Source: own research, 2008

of cycle transport to walking. The questionnaire was supplemented by a free-answer task asking the respondents to name a feature that most impedes their use of bicycles in the Brno traffic.

In the course of processing the answers to the posed questions, the chief employed methods were descriptive statistics – frequency and mean value (median) – and comparative statistics – chi-square test, one-way analysis of variance at the level $p < 0.05$ with results undergoing the Tukey's Post-Hoc Test for an unequal number of cases (Robinson, 1998). All analyses were executed in the Statistica environment of the firm StatSoft.

Use of bicycle as a means of transport was categorized into three basic types: transport to work (school), utilization for other journeys throughout the working week, and bicycle use during the weekend. From the surveyed sample, 22% use bicycle as a means of transport to work at least once per month; nonetheless, mere 5% cycle to work or school regularly (three and more times per week). Incomparably more frequent is the use of bicycle throughout the working week for activities other than commuting to work – 58% make use of the bicycle to go shopping, for culture or sports. Frequent use (three and more times per week) of the bicycle for these activities accounted for 12% of answers. Even more common are weekend trips: 81% of respondents; 6% use the bike every weekend. The length of one journey is mostly between 6 and 10 kilometres (55% of answers) and more than a half (58%) of respondents usually ride on cycling tracks. One of the most remarkable findings ensuing from the comparison of partial segments is the confirmed difference between the use of bicycle as a means of commuting to work that is more common for men than women (chi-square = 30.998, $p < 0.001$); conversely, a difference in bicycle use during weekends and for other trips throughout the working week was not affirmed. Another variation was identified in the mean distance of a journey according to age; while for age categories of up to 25 years and between 25 and 50 years medium length journeys (6–10 km) clearly predominate, in the age category of over 50 the shares of medium length and long journeys (10 km and more) are practically identical (chi-square = 23.4166, $p < 0.001$). The expected impact of the place of residence on the utilization of cycle routes in the City of Brno was verified as well. The city inhabitants utilize bicycle routes in the city to a considerably greater degree than people do from the surrounding municipalities who commute to Brno for work or school (chi-square = 13.8473, $p < 0.001$).

Respondents' opinions on the infrastructure were surveyed since the use of bicycle can be affected by perception of the quality of the available cycling routes. The respondents expressed a predominant dissatisfaction with the condition of the cycle tracks and their majority would be using them if their current shape improved (Fig. 7). Assessments of infrastructure vary mainly based on the origin of respondents. The rate of satisfaction is higher with inhabitants from outside the city (one-factor ANOVA, $F = 6.433$, $p < 0.05$) and enhanced standard of the bicycle tracks infrastructure would be more welcomed by the city inhabitants (one-factor ANOVA, $F = 8.811$, $p < 0.01$). This is a fairly logical situation in the light of the previous findings that can also reflect the actual condition of the cycle track network in the city and its hinterland. Another fact of significance for future utilization of a potentially enhanced cycle tracks infrastructure by way of its expansion is the determination of relation between the current use of cycle tracks and their use shall their network become denser.

The welcoming of the expansion of the cycle network is far more favoured by those who are already using the bicycle tracks (one-factor ANOVA, $F = 78.721$, $p < 0.001$); in simple terms, prospective changes in the cycle tracks system in the City of Brno and its

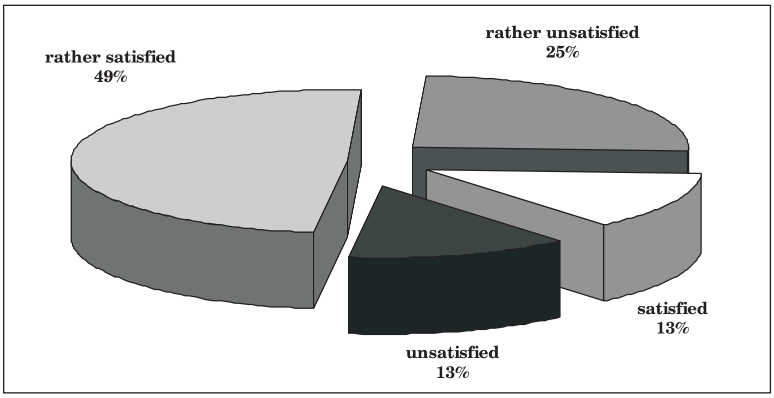

Fig. 7: Satisfaction of respondents with the condition of bicycle tracks in Brno
Source: own research 2008

hinterland will entail higher rate of utilization by the existing users as opposed to new users. As regards these conclusions, it needs be nevertheless pointed out that no relation between the contemporary use of bicycle tracks and the satisfaction with their condition was determined and therefore we cannot say that the cycle track shape has influence on their use, as indicated above.

The prime factor for choosing a bicycle as a means of transport in Brno are low costs (for 36% of respondents), while 27% of respondents have other reasons apart from the choices listed in the questionnaire (comfort and safety, time accessibility of the target location or route, low costs, easy bicycle accessibility, respect towards the environment, combination of other recreational activities). On the contrary, walking is preferred chiefly because it can be combined with other recreational activities (27%). A surprising 42% of respondents could not choose from the offered options.

The questionnaire further included a free answer question, which could be used by the respondents to express their view of the cycle transport situation in Brno. One fifth of them made use of this possibility. The most frequent criticism was directed at the insufficient quantity of bicycle tracks, inadequate rate of their connectivity, and few available information regarding the Brno cycle tracks. Other issues raised by the respondents were lack (or complete absence) of parking racks with the possibility of locking and fear from the road traffic.

7. Conclusion

Cycle transport is a fully-fledged means of urban individual transport with economic, ecological, social and health benefits which clearly speak for efforts to be undertaken by the cities and other entities in the direction of improving the conditions for cyclists (Hesková et al., 2006; Vasconcelos, 2007; Pucher, Buehler, 2008; Zemanová, 2008).

In the wake of 1989, the issue of cycle transport has seen remarkable shift to the better, but then only the average of 1.9 km of bicycle tracks was built annually for the past 19 years of "official support" to this type of alternative urban means of transport and popular leisure activity. Compared to other cities of the CR (Olomouc, Uherské Hradiště, Pardubice, Hradec Králové) with regards to this, Brno is lagging behind. In order to form an integrated cycle network, the Brno bicycle tracks still need a conceptual blueprint and an established solution to their connectivity. Constructions are scheduled till 2013, but their implementation is very insecure and sluggish. As of early 2008, fewer than 45%, i.e. 36.5 km, were completed out of the planned 81.5 km.

We consider the improved use and practical application of possibilities specified in the revised Czech Standard ČSN 73 6110 and Technical Standards TP 179 (Designing of Cycling Infrastructure), i.e. primarily the alternative of narrowing the traffic lanes for cars providing space in the same profile for another lane designed for cyclists, as necessary steps towards redressing the current situation. Austria, for instance, moves in such a direction. Further recommendations concern the organization of tempo-30 zones which boost cycle transport by increased safety and which are very widespread in Germany and particularly in Austria, where entire towns have introduced its application. The speed variance between a car and a bicycle becomes fairly reduced and thus leads to considerable increase in safety.

Furthermore, the geographical location of Brno favours cycle transport and its two rivers could become charming green transit corridors. The city's relief is neither extremely divided, nor tediously flat. It is however true that the existing cycle infrastructure can discourage cyclists from other regions from a visit to the city. The hitherto city traffic policy enables common safe use of bicycle as a means of transport only to those inhabitants whose places of residence and workplaces are located close to the Svratka River.

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Authors´ addresses:

Mgr. Eva KALLABOVÁ, Ph.D.
Institute of Geonics, v.v.i, Branch Brno, Czech Academy of Science
Drobného 28, 602 00 Brno, Czech Republic
e-mail: kallabova@geonika.cz

Veronika ZEMANOVÁ,
Grammar School Terezy Novákové in Brno
Terezy Novákové 2, 621 00 Brno, Czech Republic

RNDr. Josef NAVRÁTIL, Ph.D.
Faculty of Economics, University of South Bohemia
Studentská 13, 370 05 České Budějovice, Czech Republic
e-mail: jnav@centrum.cz

ASSESSMENT OF THE IMPACT OF WIND TURBINES ON LANDSCAPE CHARACTER: IMPLICATIONS FOR LANDSCAPE PLANNING

Stanislav CETKOVSKÝ, Eva NOVÁKOVÁ

Abstract

Landscape character is a term widely used in connection with landscape conservation, the image of landscapes, and their aesthetic and natural values. Landscape character assessment stems from two approaches – an expert one (based on landscape ecology) and one based on perceptions, that is, in what ways are the given landscape or the construction perceived. Expert evaluation is an essential basis for decision making processes in landscape planning. The quality of landscape character is not only given by objective reality (i.e. biophysical elements of the landscape) but also by subjective perceptions on the part of any observer. Therefore it is almost impossible to separate these two approaches when making a complex assessment of the impact of wind turbines on landscape character.

Shrnutí

Hodnocení vlivu větrných elektráren na krajinný ráz a krajinné plánování

Krajinný ráz je pojem hojně používaný ve spojitosti s ochranou krajiny, jejího obrazu, estetických a přírodních hodnot. Jeho hodnocení vychází ze dvou přístupů – percepčního, tj. vnímání stavby v krajině a expertního (krajinně-ekologického), jež je nezbytnou základnou pro rozhodovací procesy v území. Ač není kvalita krajinného rázu exaktně měřitelná, je rozhodujícím faktorem při rozhodování o akceptaci projektů větrné elektrárny. Kvalita krajinného rázu je dána nejen objektivní realitou, tj. biofyzikálními prvky krajiny, ale také subjektivním vnímáním konkrétního pozorovatele. Proto lze jen těžko, při komplexním hodnocení vlivu větrných elektráren na krajinný ráz, oba přístupy oddělit.

Keywords: *landscape character, wind turbines, landscape planning, GIS, visualisation, Czech Republic*

1. Introduction

Landscape character is a term widely used in connection with landscape conservation, its image, aesthetic and natural values. Landscape character assessment stems from two approaches – an expert one (landscape-ecological) and a perceptional one, that is, in what way is the given landscape or the construction perceived. The expert evaluation is an essential basis for decision making processes in the landscape. As the quality of landscape character cannot be measured exactly, each such evaluation faces the problem of subjectivity. The present development of wind turbines in landscapes where these constructions are new and uncommon is connected with the developing technology of wind energy use and with the support of renewable energy sources. When determining the acceptance of wind energy projects, it is the landscape character that matters - not only from the expert (landscape-ecological) point of view, but also from the socio-political perspective. This proves that the quality of landscape character is not determined by the objective reality alone, i.e. biophysical landscape elements, but also by the subjective perception of concrete observers. Therefore it is rather impossible to separate these two approaches when making a complex assessment of the effect of wind turbines on the landscape character.

2. Impact of wind turbines on landscape character

The boom in wind energy development is a global trend and it also becomes evident in the Czech Republic. There are relatively few localities in the Czech Republic that are suitable for wind energy use and meet various restricting factors. However, hundreds of wind turbines or wind park plans are prepared, which brings along certain stress on the landscape. Sklenička (2006) even mentions that wind turbines decide about the fundamental change of landscape. Concern about unrestrained expansion of wind turbines in the Czech landscape has proved exaggerated, since it turned out that an array of upcoming projects is overstated and runs up against insurmountable problems such as connection limits to the distribution electrical network, disapproval of state administration and self-government on the local and regional level, and last but not least there are growing difficulties with funding such projects at the time of financial crisis. The pace of wind energy progress in the Czech Republic is slower than it was expected; still it remains one of phenomena currently changing the landscape.

Each branch of power industry, including wind energy, represents to some extent a load on the environment. The impact of wind turbines on the landscape character is considered one of the most significant ones. Wind turbines are constructions of considerable vertical size – present-day technology of wind turbines is built on the tower of 100 to 105 metres high and diameter rotor of 90 to 100 m. Total height of these modern machines usually reaches 150 m. Their visual effect in the landscape is intensified due to their localization on elevations, i.e. visually exposed positions, in order to maximize the wind energy use. Central European landscape is a small-scale landscape. It can thus be stated that its scale will be affected virtually in any case. A separately standing wind turbine or a small compact group can be regarded as a new landscape dominant. Larger or smaller groups of wind turbines spread in the landscape cannot be perceived as individual dominants but as a brand new characteristic presented both horizontally and spatially (Vorel, 2009). Some authors (e.g. Simon, 2006) employ a term of visual pollution in this connection. By using this term, Simon describes a specific phenomenon when the overall landscape image completely changes after placing wind parks of large size.

Impacted landscape character does not imply a priori a negative phenomenon. Vorel (2009) states for example that wind turbines may represent a positive aesthetic value in a specific landscape type, being a product of high-tech. A wind turbine of modern type represents undoubtedly a new landscape feature. Löw et al. (2007) notes however that it is natural that such feature is typical of suitable parts of our landscape as it happened in the past with historical windmills or other similar constructions introduced by man into nature. Wind turbine can thus become a typical feature of those parts of landscape that are not protected for their value of being national cultural-historical heritage (such as National Parks, Protected Landscape Areas, Natural Parks and Landscape Monument Zones).

Landscape character is an attribute of each landscape and results from the mutual interaction of natural and anthropogenic elements. According to the Czech effective legislation, the landscape character is protected from such an activity that might reduce its aesthetic and natural values.

The objective of nature and landscape conservation, part of which is the protection of landscape character, is to contribute to the preservation and restoration of balance in nature, to the protection of species diversity, natural values and beauties and to the thrifty management of natural resources. On the other hand, it is necessary to take into consideration economic, social and cultural needs of citizens along with regional and local conditions. Production and supply of electric power are definitely basic economic requirements of inhabitants, the more so if the electric power is produced from renewable resources.

Thus, there is a conflict between the interests of landscape character conservation on the one hand and the production of electric power (using renewable and non-exhaust emission resources) on the other hand. So it is obvious that on a scale of the Czech Republic's landscape, most wind turbines will be a conflict issue.

3. Possibilities for an objective assessment of the impact of wind turbines on the landscape character

Is there a true, objective beauty of the landscape character that is quantifiable or comparable in some way, or is it the value that can be simply described only subjectively? This is a fundamental issue; however, opinions and approaches of experts are quite dissimilar. Dearden (1985) differentiates a physico-geographical (or, more precisely, landscape ecological) and human geographical (sociological) approach. The physico-geographical approach suggests and subsequently employs quantifiable landscape parameters – these reflect visual quality. The human geographical approach examines individual and social attitudes towards the landscape and landscape character. Arthur (1977) summarised the methods of landscape character assessment creating two elementary groups:

- Descriptive methods (Description inventories). These are methods employed by experts who interpret the landscape character as an objective reality.
- Methods of visual preferences (Public preference models). Being psychological, phenomenological and sociological, these methods are most often based on questionnaire survey, guided interviews, etc. These methods inevitably involve the consensus among public.

Thus, expert descriptive methods are employed in the objectivization of the landscape character assessment, which assess the landscape character by describing its features. However we have to deal with problems of aesthetic assessment that partly changes in time, partly it is a consequence of the fact that for people of diverse taste the same object possesses diverse aesthetic value. Míchal (2000) nonetheless states that the essence of such changes may be identified and allows us to find objective aesthetic values of the landscape. On the other hand, he admits that none of the solution that tries hard to find objective aesthetic values is perfect. Löw, Míchal (2003) state that the aesthetic value of the landscape is subjected to identifiable natural relations; change of aesthetic taste and values is not random and has its rational – extra-aesthetical – causes, so it is available for rational argumentation.

Aesthetic value of the landscape character can thus have objective, rationally grounded criteria, nevertheless the evaluating process itself is always subjective to some degree. It is important to realize that each assessment of the landscape character is anthropocentric and time-conditioned. Thus, a time-conditioned aesthetic standard originates (Míchal, 2000). Another factor is that perceiving of the aesthetics of anthropogenic elements in the landscape is also conditioned by their possible benefit. It may seem inappropriate but we cannot separate the assessment of wind turbines construction impact on the landscape character from the assessment of the expected contribution of wind turbines to power engineering and prevention of global warming (Culek, 2007). Conclusions of the assessment are significantly influenced by the author's strong belief or disbelief in benefits of the given construction.

By its objective, the landscape character assessment can be divided into two groups:

1. Regional study assessing condition of the landscape character. Its objective is to determine condition, or more precisely, quality of the current condition of landscape character. These studies dwell on descriptive methods, which use scientifically grounded and regionally specific set of instruments designed to analyze the landscape character. A detailed analysis of landscape characteristics in the territory of interest – the concerned landscape area - is necessary. Natural, cultural, historical and aesthetic characteristics are analysed.
2. Impact assessment of a concrete plan or study defining suitable or unsuitable localities for the given type of the plan. These studies are most frequently used as technical groundworks in the process of environmental impact assessment (EIA) or in landscape planning. The objective is to assess the degree of impact on landscape characteristics.

Nevertheless, a certain degree of subjectivity cannot be avoided when assessing the degree of impact and whether the plan is in its suggested version acceptable from the viewpoint of impact on the landscape character. It is therefore not unusual that more assessment studies are worked out for the same plan based on the same methodology, whose conclusions are totally different. It seems that the dream about creation of an objective scientific methodology to assess landscape character that would tell us unambiguously whether the assessed plan is acceptable for the given locality, will remain what it is – a dream (Van der Horst, 2009). Therefore, the aim of the assessment should be creation of a technical groundwork for more complex processes such as environmental impact assessment and landscape planning. Only at this level it should be decided about the acceptance of the assessed project. An important factor in these processes is participative decision-making of public, and this is why it appears appropriate to use a combination of descriptive methods and methods of visual preferences for such types of studies (Wherrett, 2000).

Geographic information systems (GIS) play an important role in assessing the landscape character, which mingle with the descriptive methods and methods of visual preferences (Fig. 1).

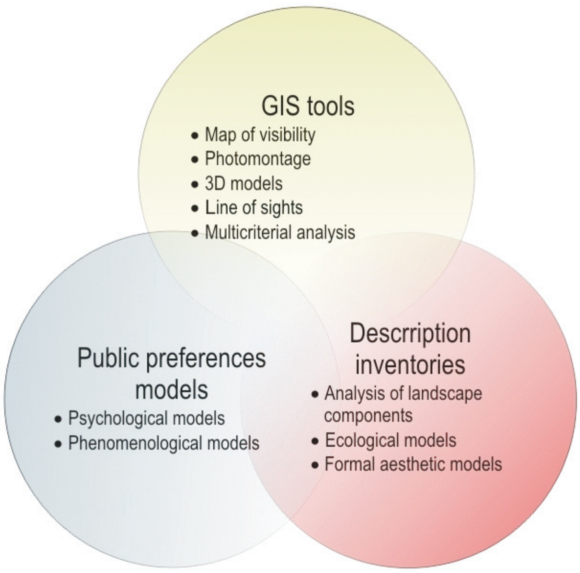

Fig. 1: A scheme of methods and instruments used for impact assessment of the plan of wind turbines on the landscape character
Source: Aspinall, 1990; Cetkovský, Nováková, 2008

4. The application of GIS tools

GIS plays an important role in the landscape character assessment since it allows us to process geo-data effectively, or more precisely, in three-dimensional variables defining typical landscape character features. Another advantage of GIS is that it allows us to apply the assessment onto a larger area (Bishop, Hulse, 1994). It is thus obvious that a complete assessment can hardly do without such tools. On the other hand, there are three reasons why the GIS application should be approached carefully: 1) with the geographical data input the real world is inevitably abstracted, which introduces questions of accuracy and truthfulness; 2) three-dimensional variables of impact onto the landscape cannot by no means be considered objective; and 3) model results should not be a predetermined basis for the decision-making, but merely a basis for public debate (Möller, 2008).

GIS tools are essential primarily for the following parts of the assessment:
- Creation of 3D terrain model with the wind turbines position, line of sights
- Creation of the maps of sights demonstrating from where the wind turbines will be visible
- Creation of exact photomontages
- Multicriterial analysis of areas suitable for the location of wind turbines

One of the most convincing arguments might be visualizations and visibility of the intended wind turbines. They are most often simulated using GIS or other specialized software and can provide us with an unbiased view of the future reality. A three-dimensional visualization is a powerful device in the decision-making process. It enables us to simulate the earth surface with other objects such as houses, terrain obstacles, forest or merely shrubbery. Such a terrain simulation, e.g. combined with a lapped aerial photograph supplemented with wind turbines, represents well a future situation.

The principal element of the assessment is the creation of a special map of sights that takes into account visibility of individual wind turbine elements. Such an adjusted map of sights is usually represented by a mosaic of coloured surface representing three levels of visibility – the bottom dead centre of the rotor (hence in fact the whole construction), the rotor itself with blades, or only the top dead centre of the rotor. The advantage of such an imaging is better proportionality, or more precisely, a possibility to break down the visibility information both into space and to height. In this mode of work, it is only the height of the earth's surface that is involved; a so-called active surface is normally not included, primarily because of its potential change and hence affected visibility. Actual visibility of the wind turbine is usually lower.

Nowadays another type of maps of sights is still widely applied, on which the locality is simply marked where the wind turbines are visible. Only one height is taken into account for calculation (in most cases the maximum height, i.e. the top dead centre of the rotor) and thus it is not taken into consideration which part of the wind turbine is visible. Such great simplification results in excessive growth of space affected or influenced by the view of the wind turbine. The maps of sights can be supplemented with the terrain profile in the direction of visual axes. Such profiles can help identify a possible visual conflict with existing valuable natural or cultural-historical dominant features.

Another visualization alternative is to create accurate photomontages using a specialized software. Such visual studies constitute a frequent supplement of all reports, nevertheless not always are they created according to appropriate criteria. The most important factor here is the size of the wind turbine, or more precisely, its height. It is often too complicated to estimate such a variable, and it consequently leads to degradation of the whole situation. Therefore it is essential to apply a specialized software for photomontages. Photomontages are suitable for local investigation, when possible collision vectors are selected defining where a conflict could occur between landscape character conservation and wind turbine construction.

When creating a conceptual regional study, a multicriterial spatial analysis is applicable, which enables us to delimit effectively localities suitable or unsuitable for the construction of wind turbines. It is based on the identification of limiting factors, which delimit localities unsuitable for the construction of wind turbines. Subsequently, we may create localities suitable or unsuitable for the placement of wind turbines in GIS interface, with the help of a so-called gap analysis. The advantage of such method is its transparency, and with explicitly defined rules, it is also relatively objective. It is problematic to define the input criteria, which then fundamentally affect the assessment result. Salašová et al. (2008) define for example the input criteria as objects or localities where the construction of wind turbines is unacceptable (e.g. protected areas, cultural dominants, sacral buildings, historical gardens, natural landscape, etc.), and further their certain distance from these localities (e.g. three kilometers from Protected Landscape Areas, five kilometers from sacral buildings, five kilometers from historical gardens etc.) where the construction of wind turbines is unacceptable too. There should be a discussion, both among the expert public and local people, to specify the certain distance as well as the localities unsuitable for the construction of wind turbines. Primary risk of the multicriterial analysis is abstraction, or more precisely, unacceptable simplification of actual world, and the risk of subjectivity.

5. Landscape planning

The objective of landscape planning is to harmonize trends of human society development with the principles of nature conservation and landscape protection. Landscape planning does not exclude from the landscape any activity useful for the society development, but searches for a harmony between ecological conditions and the given activity (Sklenička, 2003). Wind power development in the Czech Republic is a delicate, controversial and largely politicized topic.

Therefore, the landscape planning process should be highly transparent in the case of wind turbines. In localities that are not specially protected by law, the issue of project acceptance and tolerability with respect to the landscape character perspective should be discussed by local community in the first place. Möller (2008) mentions the following requirements that should be met by each landscape planning process in relation to wind turbines projects:

- Landscape planning should dwell on the principle of sustainable development, i.e. on balance among environmental – ecological, economic and social pillars. Concern in the conservation of nature and landscape is highly important; nevertheless, the same attention should be paid to another concern, for example creation of renewable sources of energy, development of tourism, farming, industry, housing development, etc. Individual interests might, but not necessarily have to conflict with the development of wind energy.
- The process of landscape planning is typical of public participation. Using a simple description of the „objective" criteria, either based on an „objective landscape feature" or on a simple criterion of „ the sphere of impact", it is only exceptionally non-subjective, without any assessment. Without the acceptance of specific wind turbine projects by the local community, all conclusions of expert studies are merely attempt to render decision that must be accepted at this level.
- The process of landscape planning stems not only from negative, but also from positive criteria (e.g. wind velocity, local distribution electrical network).
- The output should be more differentiated than just a binary map, dividing the area into suitable and unsuitable localities.

6. Case study – Assessment of the visual preference of wind turbines by people from municipalities Pavlov, Protivanov, Drahany, Odry (Czech Republic)

Visual preference research was carried out during June 2008 by the method of standardized questionnaire survey. As areas of research interest, the localities of Pavlov (Jihlava region), Drahany and Protivanov (Prostějov region) and Veselí u Oder (Nový Jičín region) were chosen – representing areas where modern large wind turbines have already been in operation for a certain time. The sample file includes not only inhabitants of the above mentioned municipalities on whose cadastres wind turbines are directly located, but also inhabitants from municipalities in their close neighbourhood who have visual contact with the turbines. Bantice (Znojmo region) was included as a control area, representing up-to-date attitudes in the period before wind turbine construction. The sample file included 351 respondents over 18 years of age, chosen proportionally on the basis of demographic quota features. The partial file of inhabitants from municipalities in which some experience with the operation of wind turbines already exists included 351 respondents, and the control file (Bantice) included 100 respondents.

The main research question was to find out how the constructions of wind turbines are perceived by respondents in the individual landscape types, and whether they are perceived more as heterogeneous elements or, on the contrary, whether they are perceived as a suitable part of the given landscape.

Results showed that in the period before the construction, 62.5% of the respondents had been concerned about their potential negative impact on the landscape character. The respondents regard as the most problematic thing the fact that wind turbines represent a heterogeneous element in the rural landscape. This is thus the most stressful aspect, beside fears of ice flying off the blades (58.9%), disturbed TV signal quality (57.8%), noisiness (57.4%) and concern that the investor would refuse at the end to pay money promised to the municipality (54.2%). The respondents were least concerned about the fact that the project of wind turbines might discourage potential tourists (21.4%).

It is interesting to find out in what way such concern changed more than a year after the construction right in the municipalities with wind turbines in their neighbourhood. The results prove that concern before construction was in most cases exaggerated. Right now, 42.8% of the respondents have agreed with the statement that wind turbines disturb the landscape character.

Further questions were focused on the aesthetic valuation of wind turbines in different landscape types. Photographs of the mountain Alpine landscape, highland landscape of the Nízký Jeseník Mts. and intensively cultivated lowland landscape of South Moravia, were presented to the respondents for evaluation, using grades from 1 to 5. It proved that the evaluations of individual landscape types did not differ in particular. The average grade was around 3, i.e. problematic intervention into the landscape. Another photomontage of wind turbine was inserted into a so-called harmonic landscape where human activities are in balance with nature. Fifty per cent of the respondents regard wind turbines in such type of the landscape (harmonic) as its acceptable part; on the contrary 35 per cent of respondents consider it an unacceptable or even inadmissible intervention.

Visual preference research in municipalities with a direct experience with the wind turbines showed that the impact of wind turbines on the landscape character is considered the most significant, regardless of the fact if it is lowland, highland or mountain landscape. Yet such a concern is much higher before the construction, about 20 per cent of inhabitants change their opinion for the better after the construction.

The truth that some inhabitants are exaggeratedly concerned before the construction is probably caused by the fact that 41 per cent of them have never seen any real wind turbine before. It is highly interesting that 55 per cent of those with the negative attitude towards wind turbines – mostly because of their impact on the landscape character – are wiling to agree with the construction on condition that they get some financial benefit, both individuals and households. It thus proves that the perception of wind turbines in the landscape is very much influenced by the fact whether the observer considers the construction useful.

Aesthetic valuation of wind turbines – visual impact assessment					
numerical	1	2	3	4	5
verbal	suitable	acceptable	problematic	unacceptable	inadmissible

Tab. 1: Aesthetic valuation of wind turbines - visual impact assessment
Source: authors

7. Conclusion

When assessing the landscape character, two principal approaches may be defined. The first one – objective approach– stems from the description of measurable parameters or landscape features. On the contrary, the second one – subjective approach – stems from the research of attitudes and public visual preferences.

The research by the method of standardized questionnaire surveys showed that the number of opponents and advocates of wind turbines projects belonging to local communities does not relate to landscape character quality. It is more or less a constant ratio, which can differ due to other factors. The level of knowledge about the given project is the factor that is the most significant (Frantál, Kučera, 2009). A nearly three times higher degree of opposition towards the construction of wind turbines was recorded in respondents who show insufficient knowledge of the problem (Frantál, Kunc, 2008).

Impact on the landscape character is definitely the main argument of those who disagree with the projects of wind turbines. Dominating factor of acceptation and support in the Czech Republic is the economic aspect (i.e. financial contribution to the municipality), unlike e.g. in Austria where the principal argument of chosen respondents is the fact that wind turbines represent ecological and clean form of energy.

The issue of subjectivity is a frequently discussed question when assessing the landscape character. The principle of objectivity stems from the fact that subjective characteristics, such as e.g. aesthetic quality, can be objectively described on the basis of measurable landscape features. Nevertheless, the problem of subjectivity cannot be eliminated completely, e.g. in case of the delimitation of protection zones and certain distances, in assessing the degree of acceptance, or more precisely, interpreting results. In such matters, public participation should be a characteristic feature of the decision making process. Local people are main users of their native landscape and they are fully competent to express their own opinions. An efficient process of landscape planning should get over discrepancies among individual subjects and interest groups – investors, local community, expert public, state administration and self-government. In landscapes that are not protected for their value of being national cultural-historical heritage, the decision about the acceptance of wind turbine project should be made principally by local people whereas the position of experts should rather be discreet – creating a certain professional basis for the next decision making process.

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Authors´ addresses:

Mgr. Stanislav CETKOVSKÝ, *e-mail: cetkovsky@geonika.cz*
Mgr. Eva NOVÁKOVÁ, *e-mail: novakova@geonika.cz*
Czech Academy of Sciences,
Institute of Geonics, v. v. i. – Branch Brno,
Drobného 22, 602 00 Brno, Czech Republic

IMPACTS OF THE OPERATION OF WIND TURBINES AS PERCEIVED BY RESIDENTS IN CONCERNED AREAS

Bohumil FRANTÁL, Petr KUČERA

Abstract

Wind power development is a global phenomenon that is in many countries still related to considerable social controversy. In context of the Czech Republic (or Central Europe) we are still short of a more complex study, which would examine potential impacts of wind turbines on the environment and the quality of life from the perspective of local actors (i.e. the residents in the concerned areas); therefore, speculations and unreasonable concerns prevail so far in this respect. The paper presents a deeper analysis of perception and attitudes of residents living in the areas with wind parks and withal it provides a partial international comparison of opinion levels of two neighboring countries (Czech Republic and Austria).

Shrnutí

Vlivy provozu větrných elektráren z hlediska percepce rezidentů dotčených oblastí

Rozvoj větrné energetiky je globální fenomén, který v mnoha zemích vzbuzuje stále značné sociální kontroverze. V kontextu České republiky (potažmo střední Evropy) přitom prozatím chybí komplexněji zaměřená studie, která by zkoumala otázku potenciálních vlivů větrných elektráren na životní prostředí a kvalitu života lidí z perspektivy lokálních aktérů (tj. obyvatel dotčených oblastí), proto v tomto směru převažují dosud spíše spekulace a často přehnané obavy. Článek prezentuje výsledky hlubší analýzy percepce a postojů obyvatel žijících v lokalitách s větrnými parky, přičemž nabízí dílčí srovnání názorových hladin obyvatel dvou sousedních států (ČR a Rakouska).

Keywords: *wind turbines; risk perception; social acceptance; Czech Republic; Austria*

1. Introduction: wind power development as a social-spatial dilemma

In connection with the increasing respect of academic and political discussions and with regard to conclusions of studies relating to potential catastrophic consequences of the global climate change, most European countries have ratified plans for gradual increase in the proportion of the energetic production from renewable sources. In this respect, the wind energetics seems to be the most dynamically developing sector. However, the development is not as fast as has been expected in many countries and the projects of wind turbines (hereafter WT) are both at local and regional levels related to considerable social controversy. Whereas not only objective factors but to a large extent also subjective views and preferences of various pressure groups (developers, investors, local and regional political authorities, residents, landscape ecologists, etc.) come into the decision-making process game about the WT projects. The exact question of WT image and social acceptance by key stakeholders and by the involved public is the crucial aspect in the process of spatial planning and prospective realization of building-up projects.

Empirical studies focused on the issues of social acceptance of WT are getting accomplished in foreign countries for a longer time (i.e. in countries where massive development of wind energy has been in progress since the beginning of 1990´s). Krohn and Damborg (1999), Devine-Wright (2005) and others draw up appraising survey of studies dealing with the issue of attitudes of residents to different aspects and impacts of wind energy exploitation, which were carried out in the countries of Europe and the USA. The implemented polls and surveys are to a different extent comparative, some are international, others are merely local case studies and even their findings are not fully compatible, which follows from a controversial essence of this issue. The most frequently examined issues concern the validity of a so called NIMBY theory in relation to the oppositional behavior to local construction projects (Wolsink, 1994, 2006), the question of spatial determinants (location and distance from the wind farm) in the process of shaping the attitudes (Van der Horst, 2007), changes of opinion level in the course of time (Warren et al., 2005; Eltham et al., 2008), the influence of social and political-institutional factors (social networks, the role of opinion leaders, institutional capacity, public participation in the decision making process, etc.) on the increase of project acceptance (Agterbosch et al., 2007), etc. The interest also heads towards the perception of WT from the point of view of tourists, towards the popularity of localities in tourists´ destination choice and the potential impacts of constructions on tourism and economic potential of the locality (Hauer, 2003; Puhe, 2005).

Within the Czech Republic the WT construction is being dealt with on the professional level from the point of view of wind potential of the area (Štekl, 1995, 2006), noisiness of turbines and effects of infrasound (Jiráska, 2008), influence on the electricity supply system (Kraus, 2005) or other more or less technological problems. The most discussed issue is the relation of WT to nature protection and landscape character impacts (Cetkovský, Nováková, 2009). In this respect the opposing opinions emphasize as the dominant aspect the disruption of landscape character (Sklenička, 2006; Culek, 2008), referring to insufficient natural potential of the Czech Republic for expansion of wind energy (Buček, 2007) or to potential biotope degradation and interference in the natural environment of some animals (Gaisler, 2007).

Some studies were elaborated recently on a regional level (e.g. RCEIA 2007; IRI 2008, etc.) that attempted at a spatial delimitation of localities unsuitable for the placement of WT methodically on the basis of "objective" criteria and distance limits (from the point of view of nature protection, impact on the landscape character or conflict with a so called "harmonic landscape"). In most cases, they resulted in a proposal to restrict almost absolutely the construction in the concerned area. Many professionals challenge such studies and draw our attention to the fact that significance of landscape factors cannot be abstracted from real life, or more precisely from the socio-economic reality (Wolsink, 2007). Local identity is not only the attribute of landscape but it is also identity of the community that feels to be more or less tied to the place. Use of wind energy is a political and social subject and the issue of the placement of wind-power installations, i.e. if a locality is or is not suitable for the construction, cannot be solved merely on the basis of "neutral scientific effort", or more precisely by the method of top-down expert or political decision. It should be rather solved in a decision making process with the participation of key public (developers, residents, local administration, regional authority) where the opinions of residents in the given locality should be of conclusive weight (cf. Van der Horst, 2009).

As to the public opinion across the countries, a significant divergence exists between the broadly high rate of support for a larger-scale utilization of renewable sources including the expansion of wind energy as a general idea and the rate of acceptance of WT as real constructions structuring a landscape. This discrepancy in attitudes used to be explained mostly by the NIMBY theory assuming that people do not want to construct the WT in their backyard just by reason of their own interests but they do not mind to place them anywhere else.

NIMBY syndrome can be related to a wide spectrum of potential projects (power plants, dumping grounds, incinerators, airports, highways, tunnels, mines, but also buildings of social asylums, prisons, hospitals, etc.), which may somehow (visually, by noise, pollution, or psychologically) impact inhabitants living in the area and subjectively outweigh the meaning and benefit of construction (let it be the accepted public demand, general utility or direct local financial compensation being taken into account). NIMBY phenomenon occurs in cases when – to provide for a public or entrepreneurial interest – some facility must be constructed in the specific area, which is perceived by local people as beneficial to society as a whole or to a certain group of people only, while external negatives will be concentrated just in their own locality. Thus, the NIMBY attitude represents a negative answer to the social-spatial dilemma that is characterised by spatial separation of advantages and disadvantages of the project (Vlek, Keren, 1992, cit. in Wolsink, 1994).

The NIMBY phenomenon does hold mostly negative connotations in the eyes of politicians and developers (vide the attribute "syndrome") and has used to be perceived as expression of personal – provincial, short-sighted and egoistic – interests of inhabitants of the concerned localities. The enforcement of development projects then mostly consists in the tactics of "defeating the opposition" by the strategy of buying support through financial or other compensations, eventually power-wise by total exclusion of opposition groups from the participation in the decision process (Wolsink, 1994). However, many studies – on the basis of more complex empirical surveys and multivariance analyses advise the NIMBY theory to be rather disputable and inadequate and they reveal a structural, contextual, political-institutional and social-psychological nature of public attitudes and oppositional behaviour (Johansson, Laike, 2007; Agterbosch et al., 2007; Wolsink, 2006, 2007, etc.).

A fundamental problem of the NIMBY theory supporters is that "they do not distinguish between the interests of the opponents and their motives" (Wolsink, 1994: 853). The interest of to have no wind power installation in own backyard may have actually many motives and hidden causes. Since the number of studies of risk perception and of potential impacts of WT on the environment, landscape and life quality of inhabitants grounded primarily on the opinion platform of local actors obtained from relevant empirical surveys is still very limited in the Czech Republic (Frantál, Cetkovský and Kunc, 2008; Frantál, Kunc, 2008), speculations, myths and often unreasonable concerns prevail.

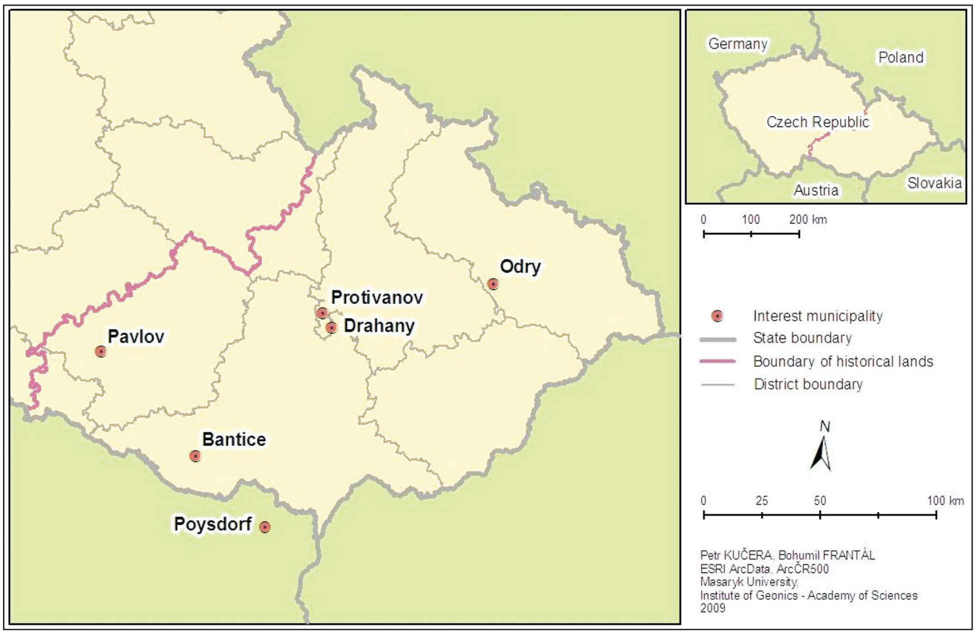

Fig. 1: The area under study

2. The survey: study area, methods and research questions

Standardized questionnaire surveys were realized from June to August 2008 and were focused on municipalities or more precisely on inhabitants living in the localities affected by WT construction. Experience of these people is regarded as the most valued and renders relatively most objective information that can be obtained about potential impacts of WT on the environment and human quality of life. We presume that nobody knows the daily reality with the "wind turbine in the backyard" better than those in whose neighborhoods are the WT sited.

Partial research questions were formulated as follows:

- How are WT perceived by residents in localities where such a construction has already been realized and is the perception spatially differentiated,
- To what extent the current perception and attitudes of people differ from previous apprehension and expectations,
- What negative environmental, social and economic consequences are most frequently associated with the operation of WT,
- What information sources and what other factors participate in the formation of attitudes in the wind energy dilemma,
- To what extent the opinion differences exist, concerning problems in domestic conditions as compared with other middle-European countries?

Localities selected as study areas (Fig. 1) were Pavlov in Jihlava district, Drahany (Fig. 2, 3 – see cover p. 2) and Protivanov in Prostějov district and Veselí u Oder in Nový Jičín district – representing locations where large modern wind-power plants (see Kučera, 2008) have been already in operation for a certain time. Within the sample not only inhabitants were included of the above mentioned municipalities on which cadastral area the WT are rightly located but also inhabitants from neighbouring municipalities that do not have any direct economic (financial) profit from the wind parks. Control or comparative localities were municipalities in the neighbourhood of Bantice in

Znojmo district (representing current attitudes right before the wind park construction), and the locality of Poysdorf in Upper Austria – with the objective to identify disparities in the opinion level of two neighbouring countries.

The sample included 551 respondents older than 18 years that were chosen via quota sampling proportionally on the basis of socio-demographic data. Partial file of inhabitants of municipalities which have already experience with WT operation included 351 respondents, control sub-sample (Bantice) and comparative sub-sample (Poysdorf) numbered identically 100 respondents each. Considering that the research was not focused on absolute numbers and its objective was not to generalize results upon total population but that the effort was to formulate representative relative indicators, relations and development tendencies, the respondents were chosen to equally include genders, the whole age spectrum and municipalities from different geographical location according to the distance of municipality from the wind farm. Practically, some age categories (younger than 19 and older than 60, or more precisely over 70) were rather undervalued in the sample as against the whole Czech population. The survey has a form of comparative case study with a purposely selected population segment (i.e. residents of the localities affected by the WT construction); results of which cannot be regarded as a representative opinion of the entire Czech population, yet we can draw some general conclusions and evaluations.

We used the questionnaire from a thematically similar study by Kučera (2008). Selected questions were methodically adjusted and supplemented with further aspects, scales and photographic visualizations. For the survey in Upper Austria, the questionnaire was translated into German language. The acquired quantitative data were compiled and analyzed via the statistical program SPSS (classification procedure of the first and second level including correlation and regression analyses). This contribution presents some basic results of these analyses.

3. Impacts of WT on the environment and the quality of life as perceived by residents

We learned that a relation exists between subjective perception of prospective (as prior expectation and concerns) and current (as actual experience) impacts of WT and general attitude of respondents to wind energy exploitation, or more precisely, their degree of opposition or support to a concrete construction project. At the same time, the degree of perception of negative impacts declines and subsequently the degree of project support increases in the course of time (see Figs. 4 and 5). In other words, current support (after 1–3 years of experience with equipment operation) is higher than it used to be at the time of planning and decision making of its construction. These results correspond to conclusions of similar researches from abroad (e.g. Wolsink, 2007), which prove a dynamic progression of attitudes following the so called U-curve further to stages of the proceeding WT project planning, their construction and subsequent operation.

The respondents had a choice from five answer options expressing their attitude towards WT construction (I absolutely agree, I rather agree, I cannot decide, I rather do not agree, and I absolutely do not agree). Affirmative answer options were synthesized later on for the purpose of evaluation and regarded as an expression of support, negative answers as an expression of opposition to the construction and undecided answers as a neutral attitude. Whereas at the time of project planning merely 37% of respondents agreed with the construction, today the construction is supported by as many as 59% of respondents due to their current experience with the WT operation (on average for the whole sample file). Higher percentage of opponents comes from municipalities more distant from places where WT are located (Fig. 5). This confirms the „proximity hypothesis" proposed by some studies (e.g. Van der Horst, 2007) according to which people living in the proximity of turbines (having a direct contact and experience with them) demonstrate a lower rate of actual perception of negative impacts and thus lower opposition toward operation. This can be partly caused by the fact that non-mediated personal experience with WT operation helps eliminate numerous myths, prejudices and idle fears (feared impacts had failed to materialize), partly by the factor of „adaptation" when people simply get used to the altered environment.

It can be confirmed that a significant factor is also the economic benefit, which is only acquired by municipalities on which cadastral area the WTs are located. In this context it is remarkable to notice that almost half of respondents in opposition to the construction of WTs declared that they would agree with the construction on a condition that they themselves or their household would have some economic benefit from the construction (financial benefit for residents, cheaper electricity for the municipality, and likewise). It can be stated that within all researched localities only about 10–15% of respondents are convinced or principled opponents of WTs.

In case we evaluate relative degree of actual negative impacts on the environment and subjective human

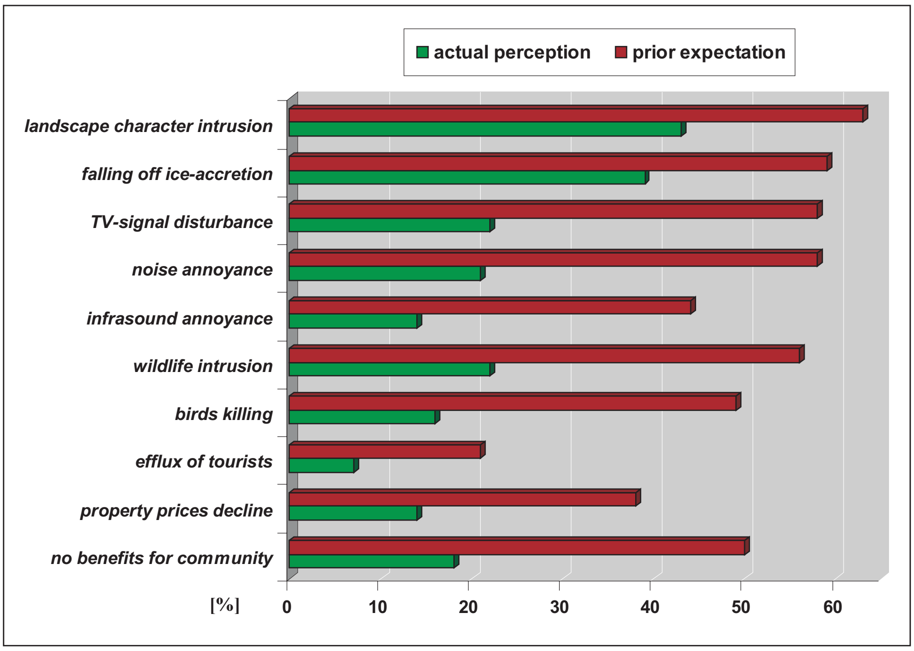

Fig. 4: Time changes in the perception of negative impacts of WT

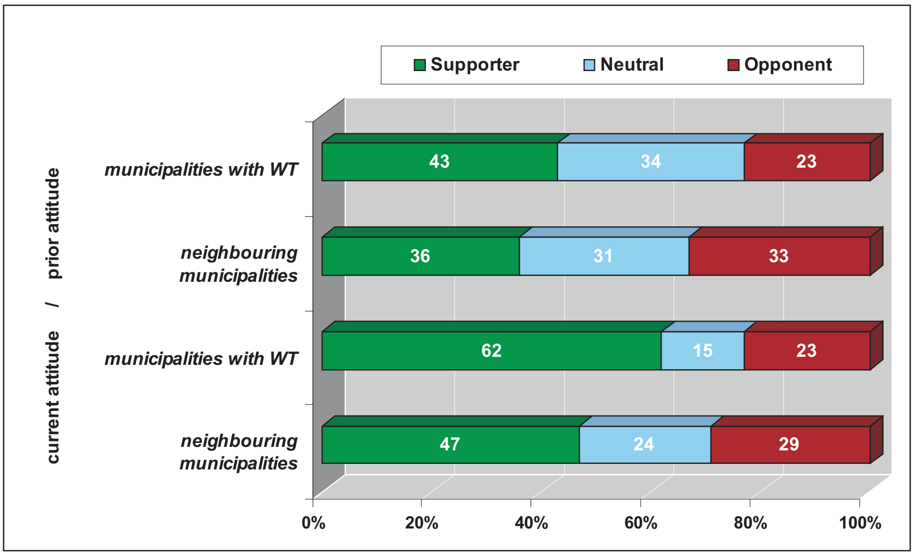

Fig. 5: Progression and spatial divergences of attitudes towards the WT projects

life quality from the point of view of residents it can be concluded that disruption of landscape character was perceived most noticeably – both before construction (63% respondents) and at present (43%). The second serious problem was ice-accretion falling off the turbines. However, it could rather be a matter of some neglected technical problem accelerated in the locality of Pavlov due to seasonal climate conditions and subsequently exaggerated in media, which caused general increase in the negative perception. At the time before construction, more than a half of respondents were slightly afraid of noisiness from the turbines, negative impact on TV signal, wildlife disturbance and the fact that the municipality would not benefit from the wind park operation in any way. It is important to emphasize that the degree of negative impacts perception found out in this study reaches higher relative values as against others implemented research works (Eltham et al., 2008; Kučera, 2008), the reason being a different questioning method applied. The above quoted surveys determined the absolute number of perceived impacts in such a way that respondents could choose random number of options on offer (e.g. to tick all ten options or just one or two, which represented impacts of operation perceived negatively.) By contrast, our questionnaire forced respondents to consider each aspect separately on the rating scale, and subsequently a relative rate of perception of partial negative impacts (or more precisely concerns or expectations) before construction (expected image) was compared to the existing perception after the construction and a certain operation period (actual image) (see Fig. 4). The aim was to identify primarily the rate of perception differences in the course of time.

Considering that previous expectations, concerns and attitudes from the time before construction were examined retrospectively, a control survey was made in the locality of Bantice in Znojmo district using the same questionnaire – approximately two months before the actual construction started in this place. The degree of actual concerns about all partial aspects in the control group almost agreed with the degree of concerns proved on the basis of the retrospective view of respondents in other researched localities (differences in percentage units with some items can be considered statistically insignificant). The only aspect where some noticeable dissimilarity occurred in respect of a higher actual degree of concern was the problem with ice flying-off the moving parts of windmills.

As to most partial impacts, we can say that concerns from negative impacts of WT did not come true by far (decline to a half up to a third of the former rate) and only a fifth of the respondents view them negatively at the present. The key factor of dispute is thus the impact on the landscape character. However, what is not expressed in the diagram is the relation between the facts whether a person perceives the specific impacts of WT operation and what is his/her general attitude to them. If we put these two pieces of information in a correlation, we find that not always when the respondent mentioned a specific problem, he or she had to be naturally a "WT opponent". For instance, although nearly 40% of respondents perceive a certain (be it noticeable or partial) impact on the landscape character, nearly one third of them would support WT construction again. A similar rule is true for other operation aspects, too. Thus, a question is the weight of problems illustrated in the diagram and their relevance for the decision-making process. The answer can be formulated as follows: maximum rate of importance of the given problem is as presented in percent in the diagram; however, we can assume that from the viewpoint of some residents the impacts are not serious enough to prevent their positive attitude to wind parks.

4. Socio-demographic and contextual divergences of opinion

With the aid of correlation analysis method, we tested if a relation exists among attitudes, rate of support or opposition towards projects and socio-demographic characteristics of respondents. It was demonstrated that there are no significant differences in perception and attitudes in connection with gender (except for a higher percentage of hesitant or neutral attitudes of females) and not even depending on respondents'education. Concerning the age factor it showed (somewhat surprisingly) that the most noticeable current acceptance of WT is among the oldest respondents over 60 years of age (almost 80%) and also among people of age below 29 years (75%) in

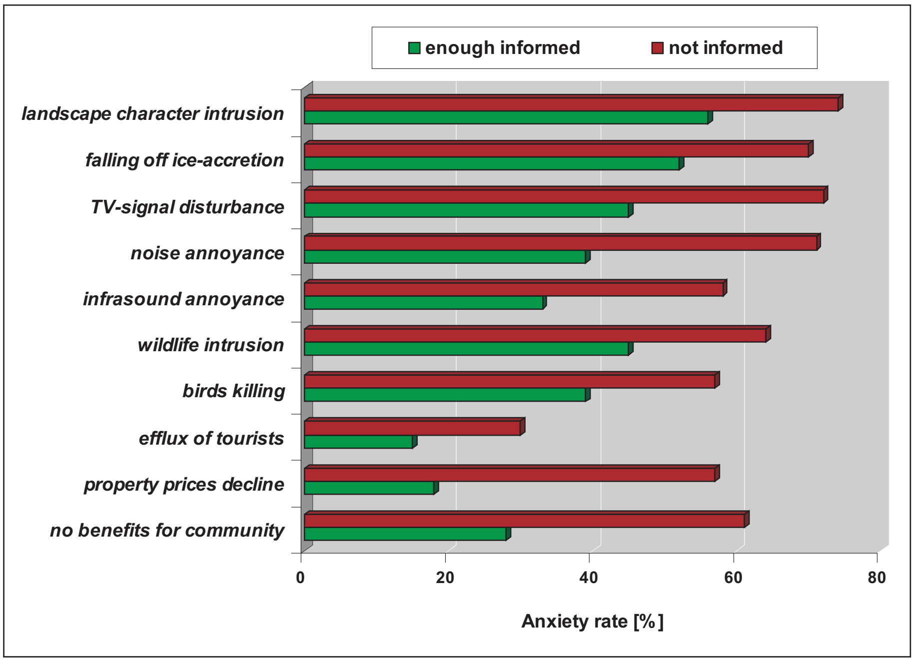

Fig. 6: Relationship between the foreknowledge of problems and the rate of anxiety about negative impacts of WT

comparison with 55% of acceptance among other age categories (differences among them are not statistically significant).

Important factors determining the rate of previous concerns about negative WT impacts (Fig. 6) and subsequently attitudes to construction include the degree of foreknowledge about the issue (acquaintance with the pros and cons of wind energy, personal experience with wind park in another locality) and namely awareness of the actual project (knowledge of exact localization and technical parameters of the equipment, photographic visualization of intended construction in the landscape, economic benefit for the municipality, etc.). Respondents mentioning insufficient knowledge of the issue had the degree of opposition to construction almost three times higher (see Figs. 7 and 8).

It was also found out that the degree of knowledge and subsequently the attitudes depend to some extent on the primary source of information (that is the source, which provided the person with most data concerning the wind power issue). Other studies indicate (e.g. Frantál, 2008) that in the process of opinion shaping the phenomenon of opinion leaders plays an important role. Most information about the issue of WT was acquired from family members, friends and neighbours (33%) and from the mass media (28%). For 17% of respondents the primary source was municipal council, for 17% the internet and for 10% the company developing or investing the project. The highest degree of opposition is usually with people primarily gaining information within their social network (family, neighbors, and fellows), while information obtained from the internet, municipal council authorities or directly from lectures or brochures of the developer company contribute to higher level of project acceptance (Fig. 9). From the point of view of the development companies the problem is, in connection with these findings, that their lecture attendance is rather low (there just 20% of the respondents living in municipalities where there was the possibility to attend the lecture actually participated).

5. International comparison of the opinion level

The analysis proved the existence of statistically significant differences in the degree of knowledge and in the attitudes towards wind energy as such in the Czech Republic and in Austria (within the examined localities), which has an impact on the lower degree of acceptance of wind parks in the Czech Republic. In the locality of Poysdorf, fewer local residents had at the time of the decision process personal experience

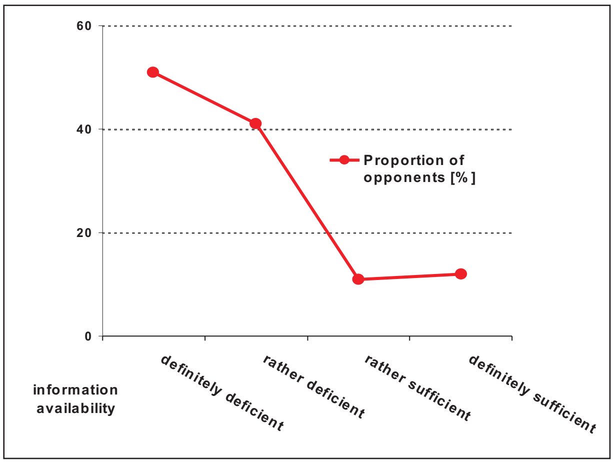

Fig. 7: Relationship between the rate of opposition and stated information availability

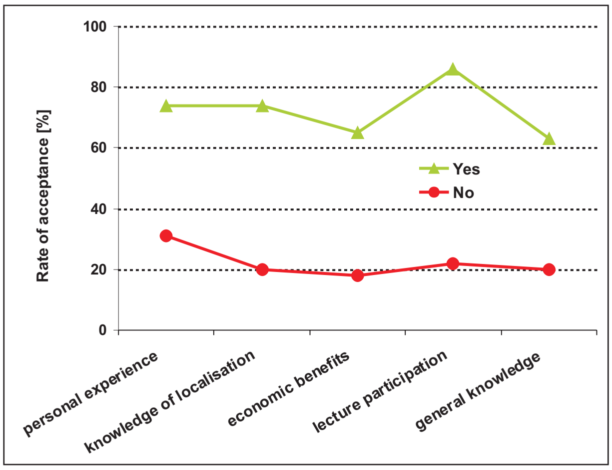

Fig. 8: Relationship between the rate of acceptance and stated awareness of the partial problems

with WT in another locality (in comparison with the localities in the Czech Republic) and they were less aware of the exact construction localization, technical parameters of the equipment and whether they fit into the surrounding landscape (they did not have any information such as photographic visualization). On the other hand, they proved to have a higher degree of general knowledge about the issue of wind energy and particularly they were more aware of the actual economic benefits of the wind park for the municipality (with roughly the same proportional attendance of inhabitants on the lectures of municipal council and company's lectures).

Further to this finding, it is important to refer to dissimilarities in the argumentation of wind power technology supporters and opponents. While the main negative attribute perceived in both countries is the disruption of the landscape character, arguments of supporters significantly differ. In Austria, the principal argument for wind energy support is the fact that it is alternative and clean energy, which should be preferred

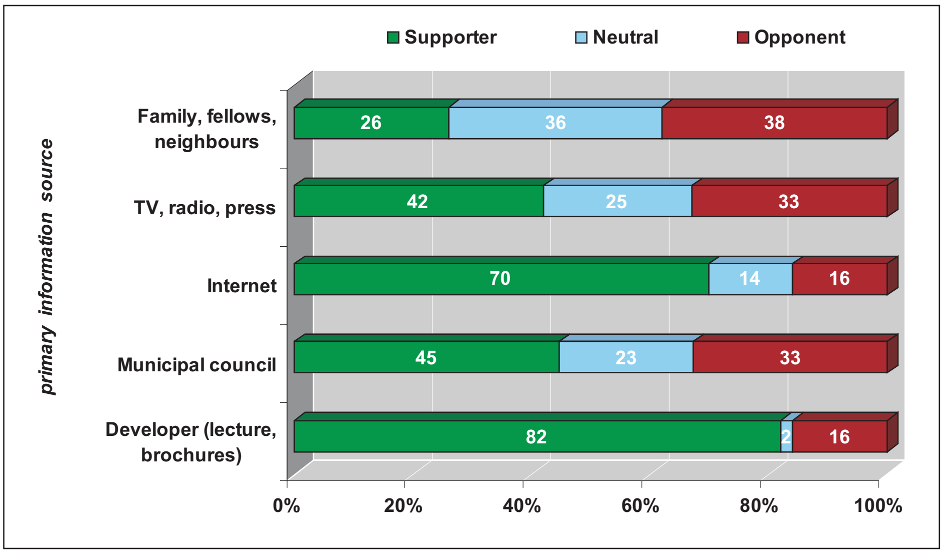

Fig. 9: Relationship between the attitude towards WT and the primary information source

CZECH REPUBLIC		AUSTRIA	
SUPPORTERS (in total)	**59%**	**SUPPORTERS (in total)**	**67%**
Arguments (relative frequencies)		Arguments (relative frequencies)	
Economic benefit for municipality	39%	Ecological (clean) energy	60%
Ecological (clean) energy	30%	Better than nuclear plants	22%
They do not mind (no visual contact)	15%	Cheaper energy	15%
Attraction - landscape supplement	8%	Economic benefit for municipality	2%
Better than nuclear plants	7%	Other reason	1%
Other reason	1%	—	
OPPONENTS (in total)	**26%**	**OPPONENTS (in total)**	**20%**
Arguments (relative frequencies)		Arguments (relative frequencies)	
Landscape intrusion	63%	Landscape intrusion	61%
Noise annoyance	18%	No cheaper energy	16%
No benefits for municipality	13%	No benefits for municipality	10%
Uneconomical technology	5%	Noise annoyance	8%
Other reason	1%	Other reason	5%

Tab. 1: Main arguments of supporters and opponents of wind power in the Czech Republic and Austria (relative frequencies represent valid percentage)
Source: own research, N = 551

to atomic power plants. To the contrary, in the Czech Republic, the dominating factor of acceptance of wind power projects is the economic aspect, i.e. financial benefit for municipalities.

6. Conclusion and discussion

The decision not to have a wind park on one's own locality can have various motivations and hidden reasons (to a large degree diverse): from concerns about noise or infrasound, depreciation of real estate value, over environmental aspects such as perception of disruption of landscape character or natural values of the area in general, to disagreement with the construction as a manifestation of opposition against groups involved in the projects (local politicians, developer company or foreign investor) (e.g. Přikryl, 2007). Little knowledge about the issue, myths and prejudices, local opinion leaders, but also real imperfections or faults in planning schemes and general local context of the project – all this can have an impact on attitudes and degree of concerns.

Factors increasing the degree of acceptance by residents are the level of knowledge about the given issue, including the so called "good practices" – positive functional models from other localities. Furthermore, transparent project planning, open communication from the municipality and the investor, and the participation of local people in the decision making process. During the planning stage, an attitude towards inhabitants is highly important and thus it is a necessity to give a lecture in the municipality about the construction plan. The inquiry revealed that almost 40% of respondents had neither approximate idea where the WTs were going to be built nor which specific economic benefits the municipalities would acquire. A very important aspect determining the ultimate attitude of people to construction is the economic benefit – both for municipalities (direct financial benefit and proportional profits for the municipal budget and for inhabitants) and for inhabitants (capital partnership of inhabitants as it works for example in Denmark). The form of wind park operation when also the residents are their shareholders has never been implemented in any locality of the Czech Republic, yet almost a fifth of respondents heard of such a system of financing and it is noteworthy that more than a third would be interested to invest in such an operation.

Similarly as other energy sectors, the development of wind energy brings some negative impacts on the environment and the rooted life of local residents. The main weak point of windmills is usually mentioned to be the impact on the landscape character (or more precisely on the visual aspect of the landscape). The visibility of WT itself is generally regarded as the most serious misconduct; therein an ideal area does not exist – there are only more or less suitable or acceptable areas. On the other hand, unlike traditional power engineering, the WTs exploit renewable sources, they do not produce any waste, and they are just temporary constructions - being relatively easy removable from the sites and recyclable after the end of their operating time. They have both strong and weak points, and it is difficult, maybe impossible, not to project his/her own subjective views and preferences into the assessment of local impacts on the landscape. General prediction factor concerning the support to local WT projects seems to be a general attitude of a person to wind energy as a renewable source and evaluation of positives and negatives connected with its exploitation in terms of ecology, global conservation of environment or local landscape (or in other words, those who consider wind turbines clean source of energy contributing globally to the environmental conservation do not regard local construction impacts on the landscape character or other impacts to be substantial).

Indigested construction of WT can mean a significant interference with the landscape; in this respect, it is not necessary to debate about justified restrictions of the construction (declared in most European countries by legislation) in strictly protected areas and in areas rare in the sense of their landscape character (National parks, protected landscape areas, biosphere reserves, Natura 2000). On the other hand, it is not possible to approach the construction of WT a priori negatively and yield to groundless speculations and myths about their negative impacts, which can prevent their constructions in suitable locations with no conflicts of interests. In this respect, there is a lot of work to be done by our public, media, political representation and academic community. Numerous data gained by research bring new issues for future study. The research team intends to conduct new examinations during the following year of grant project solution including further localities (within the Czech Republic and Slovakia) that will enlarge the sample file of respondents and data and will contribute to further extension of the acquired knowledge. In addition to quantitative surveys, there is also a need of more in-depth qualitative research to understand better the process of construction of individual attitudes and to explain the divergence between positive general attitudes and actual oppositional behavior.

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Authors´ addresses:

Mgr. Bohumil FRANTÁL,
Institute of Geonics, v.v.i, Branch Brno, Czech Academy of Science
Drobného 28, 602 00 Brno, Czech Republic
e-mail: frantal@geonika.cz

Bc. Petr KUČERA,
Masaryk University, Faculty of Science, Institute of Geography,
Kotlářská 2, 611 37 Brno, Czech Republic
e-mail: petr.kucera@mail.muni.cz

SPATIAL PLANNING OF WIND TURBINES AND THE LIMITS OF 'OBJECTIVE' SCIENCE

Dan van der HORST

Abstract

This is a review of the "Evaluation of possibilities of wind power plant location in the Moravian-Silesian region in aspect of wind potential and nature and landscape protection" (RCEIA, 2007) – a study which was commissioned by the Moravian-Silesian regional authorities. This review is critical of the RCEIA study for its top-down, one-sided and techno-centric approach, which implicitly answers only the question 'where are wind farms not acceptable?' The absence of positive planning criteria and the lack of justification for the use of a number of negative criteria undermine the potential policy relevance and political/societal legitimacy of this study.

Shrnutí

Prostorové plánování větrných elektráren a limity „objektivní" vědy

Příspěvek je recenzí na studii "Vyhodnocení možností umístění větrných elektráren na území Moravskoslezského kraje z hlediska větrného potenciálu a ochrany přírody a krajiny" (RCEIA, 2007), která byla zadána orgány Moravskoslezského kraje. Tato recenze je k dané studii kritická pro její direktivnost a jednostranný a technokratický přístup, který implicitně odpovídá pouze na otázku: kde jsou větrné elektrárny nepřijatelné? Absence pozitivních plánovacích kriterií a nedostatečné odůvodnění počtu negativních kriterií podrývá potenciální platnost této strategie i politickou a společenskou legitimnost této studie.

Introduction

In 2007, the Moravian-Silesian regional authorities commissioned a study titled "Evaluation of possibilities of wind power plant location in the Moravian-Silesian region in aspect of wind potential and nature and landscape protection"(RCEIA, 2007). The study was commissioned with a view to obtain data on the territory for territorial-analytical materials and for subsequent elaboration of the territorial planning documentation, especially the territorial development policy, provided by the Regional Authority. This study proved to be controversial, so that further research was commissioned. As part of this further research, I was invited to provide an independent review; reported here. I certainly found this study, and the issues it raised, very recognisable. Siting controversies regarding renewable energy facilities seem to occur more in some European countries than in others, but where they occur, there is a strong similarity in the issues raised, the key stakeholders involved and the approaches adopted (and then adapted) by policy makers. This review draws on the policy approaches I have seen and research findings I have examined since I first examined public concerns with biomass energy plants in the UK in 2001.

Wind energy is a political and societal issue and the siting of wind farms is not a question that can be fully answered through a neutral or value-free scientific endeavour. A more deliberative approach involving workshops or meetings with a range of key stakeholders would have been more appropriate, as it is the stakeholders who should be involved in defining the mapping criteria which concern them and then negotiate trade-offs in spatial planning. This process is unlikely to produce an agreed map with a simple suitable/unsuitable legend. Such a binary approach would leave little room for compromise. Experience in Scotland suggests that it would be more feasible to reach agreement on a range of intermediate categories, somehow combining at least the two main criteria with regards to wind farm siting; potential benefits (in terms of electricity generation) and potential costs (to various interest groups).

The approach in international context

The general approach taken by RCEIA is sometimes known as 'sieve mapping'. It is an approach in which different interests, which might be harmed by wind farm developments are mapped in GIS. These maps are overlaid in order to identify 'what's left over', i.e. areas where wind farms could not negatively affect any of the listed interests. This approach can be seen as a type of spatial multi-criteria analysis, which takes only negative criteria into account. It is a form of negative spatial planning, answering only the question 'where don't we want wind farms?'. A similar approach was used for the creation of regional Indicative Forestry Strategies in Scotland in the early 1990s, which were designed to reduce the environmental and socio-economic costs for planting non-native coniferous plantations.

This approach was criticised for its lack of economic reality from a forestry perspective, lack of effectiveness, and simplistic approach to socio-economic values (Warren, 2000; Van der Horst and Gimona, 2005). Yet the IFS approach at least did rule out areas where plantation forestry was technically not feasible, which can be conceptualised as areas where benefit is too low. Secondly it did communicate multiple levels of concerns by using a legend with 'traffic light' colour codes; areas that where 'preferred' (no/minor constraints; colour green), 'possible' (some constraints, colour orange), or had a 'presumption against' (major constraints; colour red) new afforestation. Last but not least, the IFS was the result of consultation with stakeholders. This gave the IFS much more legitimacy and societal acceptance.

The IFS has set a precedent for 'indicative planning' of wind farms in the UK, at least in terms of using GIS maps to discuss general siting criteria and broadly suitable locations, and in terms of the presentation of results. The approach detailed in the (Scottish) Highland Renewable Energy Strategy (2006) is communicated in maps with the same 'traffic light' legend of 'preferred'/'possible'/'presumption against'. Three different methods and maps are produced for small on-shore, large on-shore and (large) off-shore wind turbines. However the method by which these three categories have been identified, has evolved to include a much more appropriate assessment of positive siting aspects (benefits), including wind velocity and local grid connection. Project efficiency and productivity was explicitly assessed by (amongst others) taking account of resource optimisation and economies of scale[1].

Nadai and Labussiere (2008) reported that a more positive planning approach had been developed in a French region, whereby a range of positive and negative aspects were mapped and used in a deliberative process led by local authorities to discuss the key issues and to identify preferred areas for wind farm development – which are then advertised to invite bids from wind farm developers. Key to the success of this process was the avoidance of drawing new lines on the single interest maps. In other words, the key issues were presented as lines in the case of existing park boundaries, or as dots in the case of nesting sites or ancient monuments; no buffer zones were added.

Not all countries use explicit mapping approaches. In many cases, the guidelines are only textual. For example in Belgium, the two regional governments have their own but clearly related approaches. The government of Flanders (Vlaamse Overheid, 2006) states a preference

[1] It would not be useful to elaborate more on (what I think are) appropriate elements of spatial planning strategies developed in the UK – because I have limited familiarity with the political, social and biophysical conditions in the Moravian-Silesian region and I cannot assess the appropriateness of transplanting ready made solutions which have been (collaboratively) developed in a (very) different country context.

for the clustering of wind turbines, located in industrial areas or along infrastructural corridors (like major roads, canals) so as to balance economic efficiency and protection of open space between urban centres. Also, a distinction is made between the siting approach to small and large turbines. The government of Wallonia (Gouvernement Wallon, 2002) also stresses the protection of rural space, the importance of clustering and the concept of multifunctional use of the site. However, it also highlights the potential of wind turbines to improve the quality of degraded landscapes and give these a more positive and contemporary look. This idea is similar to findings in the UK that wind farms are likely to be viewed more positively in areas characterised by mining and heavy industry. In rural areas struck hard by economic restructuring, renewable energy is often seen as an opportunity for economic regeneration. There is a growing trend of building wind farms near ex-mining areas or more remote agricultural communities, whereby the community reaps some of the economic benefits (e.g. through direct payments, part-ownership, rent of the land etc). Wind farms are not universally popular anywhere, but these two approaches are generally successful in reducing the level of local opposition.

As a general point, it is important to note that none of the above planning approaches has been fully successful in avoiding or cancelling public or stakeholder opposition. The dream of devising an objective, scientific approach to planning is exactly that; a dream. The application of science in these matters is easily contested and, if not applied with the greatest care, rarely value free. The academic and practitioner literature on siting controversies is massive, simply because conflicts between development and conservation are rife in modern (post)industrial democratic society. Whilst it is clear that mechanisms of deliberation and benefit or cost sharing can be very important, they do not automatically guarantee a smooth way out of conflict. Gaps in underlying values and beliefs, the dominant governance culture, the level of public trust in NGOs, private sector and state institutions (and more personal issues of trust between these institutions) will all affect the willingness and ability of stakeholders to find compromise solutions. Many social scientists would argue that the social process of finding common ground, building trust between partners and developing an understanding for each-other's standpoints is key to conflict resolution, and that without attention for this process the provision of scientific inputs to planning has very limited effect.

More detailed comments about the study

Overall, the study shows a good technical competence and covers all major conceptual issues. As far as I can assess, it is factually correct. The list of criteria is particularly extensive and well documented, although the study is stronger on biophysical aspects than on socio-economic ones. For example, the notion of 'value' is discussed but it is never examined from an economic or an environmental-economic perspective; public attitudes are mentioned but not properly explored. There are three key problems I have with the study, and which I will discuss in turn:

1. The persistent and unquestioned approach to place expert perceptions of landscape value as a concern that is superior to the development of renewable energy.
2. The unsubstantiated choice of buffer zones.
3. The absence of positive siting criteria.

The first problem is really fundamental to the nature of this study. The report's conclusion that wind farms have a negative impact on landscape character, is correct. But what does that mean? It does not mean that wind farms have a negative impact on landscape! By using existing landscape character typologies as a benchmark against which the impact of this new development is measured, the result must by definition be negative because there is a change. The real key question remains where/when is the impact of wind turbines on the landscape acceptable or not? This question is not answered. The study uses landscape character as an implicit proxy for societal acceptance of the visual impact of wind farms. This is a highly debatable assumption, but the debate is largely missing from the report.

The study states that …more than a few examples of the 'wind industry' [..] that the tourists rather avoid… (page 6 of Design Part) – but no examples are given. The authors then say that impacts on tourism are neither positive nor negative. To my knowledge, this is a generic fear of people concerned with the tourism industry, but there is actually some evidence to suggest that most tourists don't mind wind turbines. This is an important point with regards to landscape value. I do not think it is appropriate in a pluralistic democratic society to leave the assessment of landscape beauty to a handful of 'experts', especially as the landscape is enjoyed by the majority of the population – who are perfectly capable of communicating their views. I am surprised at the one-sided approach in the report with regards to the views of the public.

There is a large body of literature about public views on the environment and on wind farms, on the role of lay/public/local knowledge. We have many established methods to assess public views, for example through photomontage questionnaires or surveys repeated before and after wind farm construction[2]. What the report effectively does, is to put an (unnamed) expert's value of the landscape above the value of low carbon energy sources or the value of action against climate change. These two different values are recognised in different government documents produced by different government departments, but the report is clearly based on the assumption that the oldest claim on an area (namely landscape protection) must be the strongest claim. There is no absolute right or wrong in this debate about (what are essentially) personal values and it is wholly inappropriate that the consultants chose side - which is what they unwittingly do. Climate change and energy security are recent policy issues, but just as the political landscape is always shifting and changing, the 'natural' landscape (and there is no landscape in Europe that has not been altered by man) has also never been 'stable' and 'harmonic' in the history of man. It could easily be argued that renewable energy is a means to 'rebalance' the relationship between man and nature (see page 25 of the Design part), so that the questions is; at what spatial and temporal scale are we seeking a rebalance? Is it local short-term landscape protection, or global long-term climate change mitigation? The list of 'sacred buildings' is a bizarre inclusion which underlines the highly normative and personal nature of this debate. I do not think it is appropriate for a report like this to be making such a potentially theological interpretation.

Secondly, I am baffled by the choice of the fixed buffer sizes of seemingly random sizes. Some zones seem exceptionally large, such as the 3km from all natural parks. This zone probably includes some villages and towns, industrial areas and motorways. In other words, built-up and disturbed landscapes may be excluded because of an incomprehensibly large and inflexible buffer. These landscapes are deemed in other countries as being good potential sites for wind farms (see Wallonia). Also, the separation of different projects by 3km seems strange to me, especially as in some other countries, clustering is actually encouraged (see Flanders and Wallonia).

As to the visibility analysis, I have no issue with the approach taken, except for noting that many other/different methods of view-shed analysis could have been used. Cut-off distances (assuming a clear or cloudy day), cumulative effects, scale of the analysis, inter-visibility analysis versus prioritisation of visibility from certain locations – these are all choices which cannot be justified from a strictly scientific perspective and which are likely to influence the outcomes of the analysis.

Concerning the use of the coefficient of ecological stability (KES), I again observe that it is not the only measure that could have been used. For example, measures of landscape connectivity

[2] In the past, the public trusted the 'expert' and he (very rarely a 'she') could get on with the job. But there is a growing gap between the professional aesthetics of experts (architects, planners) and the more diverse and dynamic public views reported in opinion polls or observed by social scientists. Maarten Wolsink, the most published author on the public perceptions of wind farms, has an illustrative case study in which a landscape architect designed a wind farm according to his professional aesthetics. The proposed project was then heavily resisted by members of the public, who said they did not oppose the wind farm per se but that they much rather preferred a different design (along the dike, rather than in the sea perpendicular to the dike). This was a clear failure of top-down planning; the 'experts' should have consulted first (Wolsink, 2007).

would have been relevant, especially for corridors that are known to be important for the migration of species potentially sensitive to disruption by the wind turbines or the access roads or the building work. However, the choice of KES is remarkable in one aspect, as there is an underlying assumption that wind farms are undermining landscape stability. This is clearly the case when they are being built – as roads have to be built, holes dug, machinery moving about. However in the subsequent decades of operation, the level of disturbance on the site is not necessarily higher than that in vineyards, productive forests etc. In fact, the presence of a wind turbine will restrict the number of possible co-activities on the site and thus may add to stability. As is often the case, the site may be used as a meadow (which increases KES) and is definitely not going to be built up (which decreases KES). In short, the use of KES prioritises short term thinking over longer term thinking.

Thirdly, I am really surprised about the absence of positive siting criteria. This is a wholly unacceptable omission. In fact, the title of the report talks about 'wind potential'! The consultants state that according to oral information, the wind speed in the height of 100m above the ground reaches the values sufficient for the effective electric power generation nearly everywhere.' That really is very weak. There are various modelling approaches which could be used to gain better estimates and in any case 'somebody told me' is not exactly a satisfactory input for this key planning aspect which clearly is scientific in scope. There are inconsistencies and contradictions with the subsequent paragraphs (on page 38 of the design part) where it is stated that the least windy places were eliminated by other assessment criteria and that 'on the contrary the windiest areas usually lay inside… areas of protection. I would not wish to guess why the wind capacity assessment has been so poor (or why other aspects such as access to grid, existing roads to site were not included) but this clearly is something that needs to be addressed if the study is to have any value as a planning tool for wind energy.

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Author´s address:
Dr. Dan van der HORST
School of Geography, Earth and Environmental Sciences (GEES)
University of Birmingham,
Edgbaston, Birmingham B15 2TT, United Kingdom
e-mail: d.vanderhorst@bham.ac.uk

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Fig. 2: Wind park in Horní Loděnice – Lipina (Photo: Martin Hanus)

Illustration related to the paper by S. Cetkovský and E. Nováková

Fig. 3: View on Čertovo jezero Lake (Photo: K. Kirchner)

Illustration related to the paper by K. Vočadlová and M. Křížek

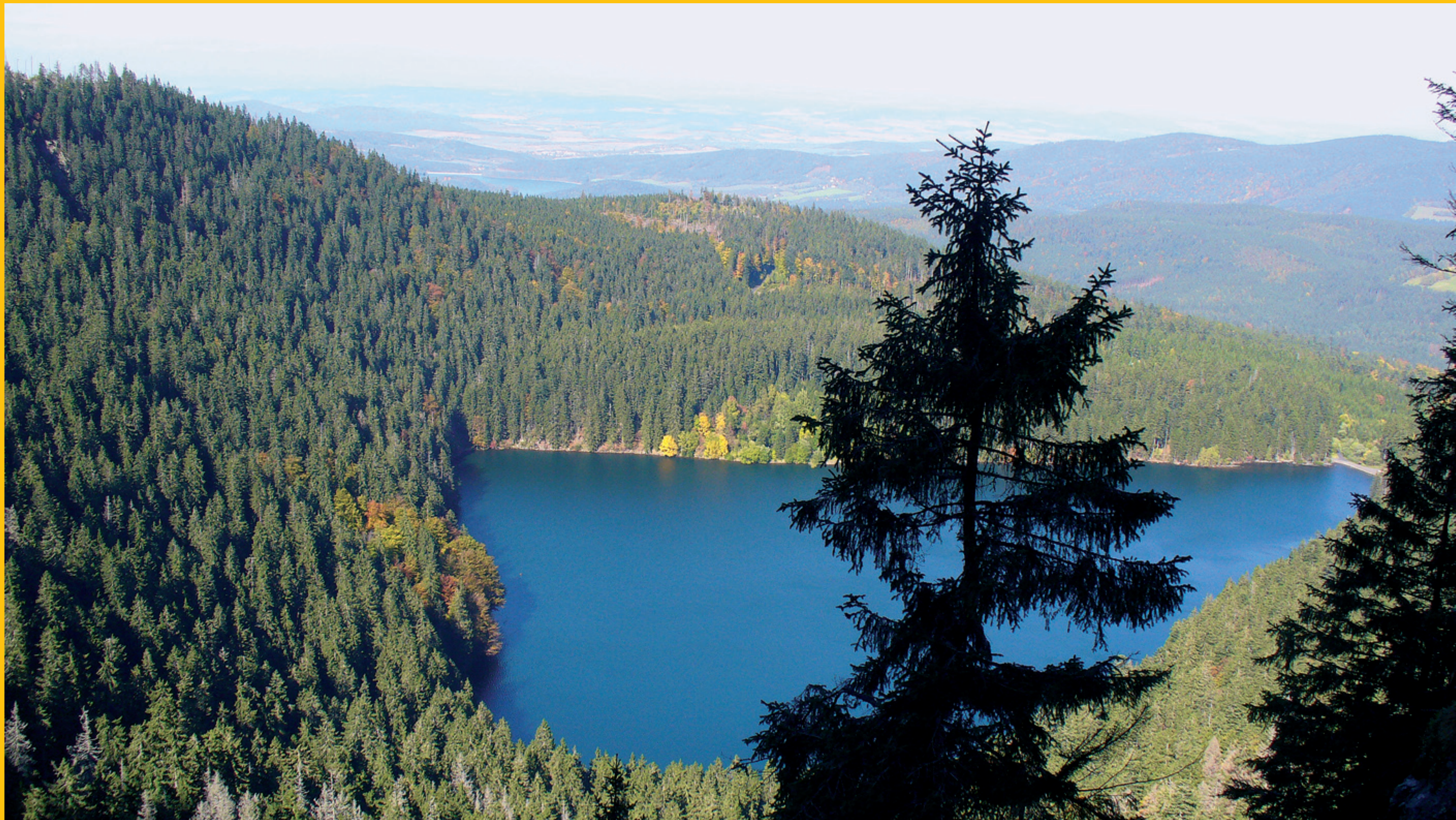

Fig. 2: View on Černé jezero Lake from edge of the cirque headwall (Photo K. Vočadlová)

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