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LANDSCAPE DISRUPTION OR JUST A LACK OF ECONOMIC BENEFITS? EXPLORING FACTORS BEHIND THE NEGATIVE PERCEPTIONS OF WIND TURBINES

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Abstract: This paper provides new empirical evidence on the hypothesis that the perception of landscape disruption by wind turbines is a substantially subjective and relative matter. It is based on a survey involving nearly five hundred residents living in six different locations with operational wind turbines in the Czech Republic. Geographical and socioeconomic factors and sociodemographic characteristics that affect local community perceptions of landscape disruption are explored using correlations and a regression analysis model. The results suggest that the expressed perception of landscape disruption is not determined by the number of existing wind turbines, the proximity of residences to them and their visibility from the home but is significantly affected by the perception of the economic favourability of projects (benefits to local communities), perception of other negative impacts of wind turbines (particularly the noise annoyance) and the socio-cultural background of people (particularly the level of education).

Introduction

Thirty years have just passed since the release of probably the first article dealing with public perceptions of emerging wind energy landscapes (Thayer and Freeman 1987). After three decades of our coexistence with wind turbines, public perceptions and acceptability of wind turbines is still a topic of debate and conflict (Rand and Hoen 2017).

It has been widely emphasized in the literature that aesthetic concerns about landscape impacts feature prominently in the narratives of opposition to wind turbines; "It's the landscape, stupid!" (Wolsink 2007: 2695). Following this 'hypothesis', several studies have attempted to quantify landscape impacts by assessing landscape´s physical characteristics or surveying visual preferences (concerning the number of turbines, different distances, and types of landscape) using photographs or visualisations of wind turbines in specific landscapes (Sibille et al. 2009, Běťáková et al. 2015, Molnárová et al. 2012, Maehr et al. 2015, Ribe et al. 2018, Skleničkа and Zouhar 2018). There is also a growing body of evidence, however, showing that the actual *ex-post* perception of landscapes with wind turbines might not be as negative as one might conclude from research employing surrogates of landscape (e.g. see Warren et al. 2005, Eltham et al. 2008, Swofford and Slattery 2010, Frantál and Kunc 2011).

The studies also show a gap between 'laboratory' methods using photographs or audio-visual simulations and those employing actual landscape experiences (places in situ). It has been proven that perception of the landscape is a result of the interactions of all senses (Jallouli and Moreau 2009, Pedersen and Larsman 2008); and is a product of cognitive processes, where the physical setting is assessed through individuals' cultural and personal backgrounds (Bidwell 2013). Furthermore, the visual impact of wind turbines on acceptance is not linked just to the physical landscape context but also to socio-economic parameters which shape the way in which landscape is perceived and experienced (Slattery et al. 2012, Kontogianni 2014). It seems that the imagery of wind turbines itself does not have to be the

key negative impact, but more of a proxy, through which dissatisfaction with the distribution of benefits and damages of a wind project is expressed.

The findings from recent surveys of residents living with and without wind farms in Canada (Baxter et al. 2013) detected the perceptions of health risks, appraisal of community benefits, general community enhancement, and preferences for wind-generated electricity as the key predictors of wind turbines support. While the adaptation to changed landscape character turned out to be a common phenomenon, negative perceptions concerning increasing electricity prices due to the renewable energy subsidies, noise from the turbine rotation, and uncertainties surrounding the long term effects of wind turbines seem to persist years after construction was completed (Groth and Vogt 2014).

While the disruption or visual contamination of landscape remain the most common stated negative impact of wind energy developments (Swofford and Slattery 2010, Frantál 2015, and others), already long ago Bosley and Bosley (1988) pointed out that opponents often make use of environmental arguments (such as the negative impacts of wind turbines on the landscape or birds), to justify their opposition to local developments. The landscape impacts may be more persuasive in the battle against developers, but underlying concerns may be more diverse, e.g. of socioeconomic or political nature.

The aim of this paper is to provide new empirical evidence on the hypothesis that the perception of landscape disruption by wind turbines is a substantially subjective and relative phenomenon. Using the methods of correlation and logistic regression analysis on data from survey of local communities living several years near wind farms, we examine the strength of influence of geographical and socioeconomic factors and sociodemographic characteristics on perceptions of landscape disruption by local people.

Material and methods

The paper is based on research recently conducted in the Czech Republic. The country's current energy policy is still based predominantly on traditional sources, where the overall electricity production is prevailingly (51%) by thermal power plants fired mostly by domestic coal and by nuclear power plants (37 %), with renewable energy sources at a mere 12% (Energostat 2017). The development of wind energy has been significantly delayed compared to most EU countries due to specific political, cultural and socioeconomic conditions, a complicated decision making process and the political-institutional practices (Ceňa et al. 2010, Frantál 2015). The country´s realizable wind potential that has been at a moderate scenario estimated at 2,500 MW (Hanslian et al. 2008) is far from being effectively utilized. The total installed capacity of wind energy reached only 280 MW in 2016. The largest realized wind farm in the country consists of 21 wind turbines, while the average number of turbines per project is two and half, and the most common (40) are projects with only one turbine.

In 2016, we carried out a questionnaire survey of local communities living in the vicinity of six wind farms which were implemented during the past 15 years (Table 1, Figure 1). The sample included inhabitants of municipalities on whose cadastral area wind turbines are actually constructed (six municipalities included in Table 1) as well as inhabitants from other twelve municipalities in the surrounding area that have not received any direct economic compensation. For the purpose of analysis, a distance from the centre of each municipality to the nearest wind turbine was measured using Google Maps application. The distance of wind turbines from the nearest settlement in the studied municipalities ranged from 0.5 km (Pavlov municipality) to 9 km (Vílanec municipality). The sample included 474 respondents older than 18 years (the age for giving the vote in local plebiscites on project implementation). Considering that the objective of research was not to generalize results to the entire

population but to formulate representative relative indicators and relations, the selection of respondents was carried out to ensure equal gender representation, the entire age and education spectrum, and municipalities of different locations based on distance from wind turbines.

Table 1. Basic characteristics of surveyed wind energy projects
1. táblázat A felmért szélerőmű projektek alapvető ismérvei

Location (municipality)	Number of turbines	Type	Size rotor/ tower (m)	Capacity (MW)	Year of installation
Anenská Studánka	6	2 x Fuhrlander FL250	29/42	5.5	2006
		4 x DeWind D6	64/68		2008
Bantice	1	1 x Vestas V90	90/105	2	2008
Pavlov	4	2 x Vestas V52	52/65	5.7	2006
		2 x Vestas V90	90/105		2006
Protivanov	3	1 x FL-100	21/35	3.1	2003
		2 x Repower MD77	77/85		2005
Věžnice	2	2 x Repower MM92	80/92	4.1	2009
Vítězná	1	1 x Vestas V112	112/119	3.0	2014

Source: Czech Association for Wind Energy (2017)

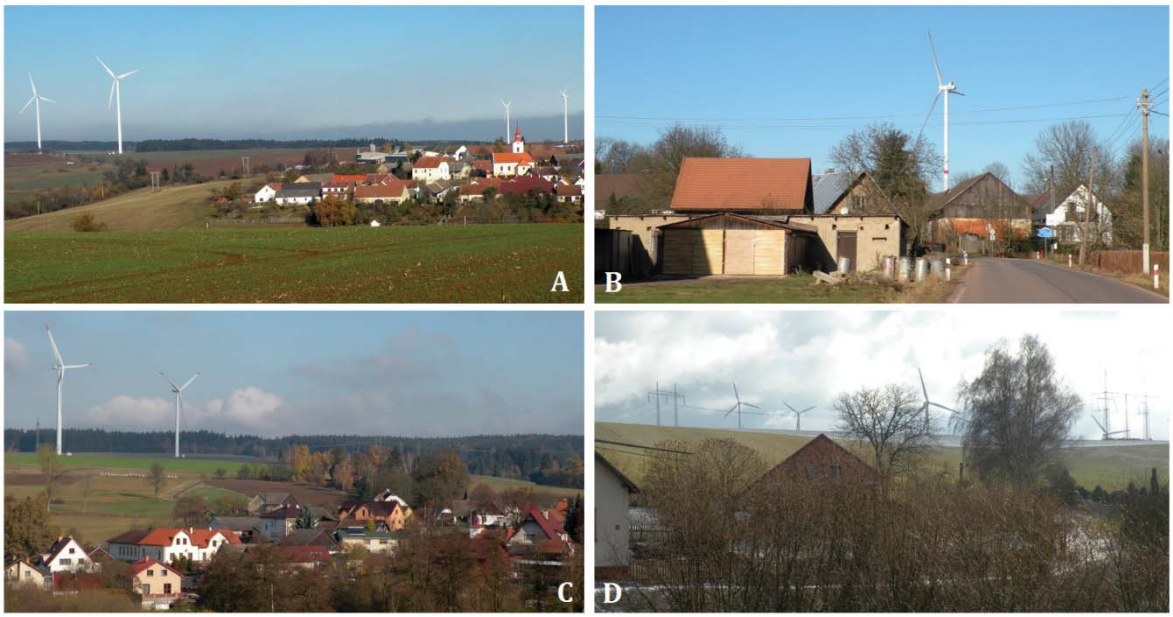

Figure 1 Wind farms in municipalities (A) Pavlov, (B) Vítězná, (C) Věžnice, (D) Anenská Studánka (Photos ©Bohumil Frantál)
1. ábra Szélerőműparkok (A) Pavlov, (B) Vítězná, (C) Věžnice, (D) Anenská Studánka településeken (Fotók: ©Bohumil Frantál)

The questionnaire included items on perceptions of positive and negative impacts of wind turbines, a question about the attitude to the project at the time of planning and the current attitude, about the main reason for such attitudes, attitudes to the possible construction of other wind turbines in the locality or region, preferences concerning the current energy policy of the state, and socio-demographic data of the respondents. The data from questionnaires were digitalized and analysed using SPSS version 21.0 software, applying descriptive statistics, correlations and regression analyses.

Results and discussion

Generally, our survey confirmed some findings from previous studies from other countries concerning the time–space dynamics of perceptions and attitudes. Similar to reports by

Braunholtz (2003), Eltham et al (2008), Kontogianni et al. (2014) and others, the acceptance of wind turbines by Czech people after several years of operation is higher than it was during the planning and decision-making stage (as reported retrospectively). Similarly, the expectations for negative impacts from wind turbines (e.g., noise, decrease in property values, decline of tourism etc.) were reported as higher before the construction than how actual negative impacts are perceived today.

The most noticeable negative impact reported today (by 56% of respondents) is the visual disruption of landscape, followed by beliefs about the negative impact of turbines on birds and other animals (40%), noise annoyance (34%), and some other negative aspects (Table 2). The attitude to landscape disruption shows the highest variance, which means that there are the biggest differences in perceptions among people in this respect.

Table 2. Perceived negative impacts of wind turbines
2. táblázat A szélerőművek által okozott érzékelt negatív hatások

Wind turbines…	**Relative frequency (%)**				
	Agree	Neither	Disagree	Mean	Variance
visually disrupt local landscapes	56	19	25	3.6	1.9
threaten birds and other animals	40	21	39	3.1	1.8
annoy people with noise and infrasound	34	26	40	3.0	1.8
cause social conflicts among the local population	29	34	37	2.9	1.7
reduce property values and marketability of real estates	24	38	38	2.8	1.5
do not bring sufficient economic profit to communities	24	34	42	2.7	1.5
are economically unprofitable without subsidies	22	43	35	2.8	1.3
degrade the quality of TV and radio signals	18	44	38	2.7	1.4
discourage tourists from visiting the locality	12	26	62	2.2	1.3

Note: The attitudes were measured on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree), and then merged into three categories. *Source: Authors 'survey*

The expressed perception of landscape disruption proved to be the strongest predictor of opposition to projects. According to the results of binary logistic regression, the perception of landscape impact explains nearly 70% of the variance in the attitudes to projects. Perceived landscape disruption is, however, not a decisive factor of opposition. There is still about one third of those perceiving landscape disruption who would even accept projects again if returned back in time (Table 3). The key positive factor that outweighs negative perceptions of landscape impacts is the perception of adequate economic benefits to local community.

Table 3. Relationship between the perception of landscape disruption and current project acceptance
3. táblázat A tájváltozás érzékelése és a jelenlegi project elfogadása közötti kapcsolat

Perceived landscape disruption	**Acceptance of projects (%)**			
	Yes	Neither	No	Total
No	70	23	7	44
Yes	34	18	48	56
Total	50	20	30	100

Note: Perceived landscape disruption is the percentage of people who either agree or strongly agree on that wind turbines disrupted local landscape (measured on a five-point Likert scale). The value of correlation between variables $r_s = 0.53$ ($p < 0.001$). *Source: Authors 'survey*

The further analysis of data revealed that the perception of landscape disruption is a relative matter, which is significantly affected by sociodemographic characteristics, the place of residence and the distance from wind turbines, and the perception of other pros and cons of projects (Table 4).

Table 4. Factors affecting perception of landscape disruption
4. táblázat A tájváltozás érzékelését befolyásoló tényezők

Factor	Category	Perceived landscape disruption [%]	Correlation value (r_s)
Height	< 100 metres	55	n.s.
	> 100 metres	55	
Number of turbines	1	52	n.s.
	2	65	
	3	36	
	4 or more	58	
Place of residence	Central municipality	45	0.22**
	Neighbouring municipalities	66	
Distance of residence	< 1 km	45	0.19**
	2 – 3 km	56	
	4 – 5 km	70	
	> 5 km	50	
Visibility of turbines	Not visible from home place	55	n.s.
	Visible from home place	55	
Noise annoyance	Not annoyed by noise	43	0.37**
	Annoyed by noise	81	
Local economic profit	Perceived as sufficient	49	0.24**
	Perceived as insufficient	76	
Climate change mitigation	Considered important	53	n.s.
	Considered not important	57	
Education	Basic	38	
	Secondary	55	0.20**
	Tertiary	78	
Age	less than 30 years	56	
	30 – 39 years	58	
	40 – 49 years	64	0.10*
	50 – 59 years	53	
	60 and more years	29	

Note: Central municipality is a municipality on which cadastral area wind turbines are located; Perceived landscape disruption is the percentage of people who either agree or strongly agree on that wind turbines disrupted local landscape. Correlations are significant at: *p < 0,05 ; **p < 0,01; n.s. means non-significant correlation. *Source: Authors 'survey*

The negative impact on landscape is more likely to be reported by people living in neighbouring municipalities located at a relatively greater distance from wind turbines. This finding seems to rebut the so called ´proximity hypothesis´ assuming that those living nearer to energy facilities are likely to have more negative attitudes in comparison to those living further away (Dear 1992, Jones and Eiser 2010). This kind of paradox (that people living closer to wind turbines do not mind so much their landscape impact) may have, however, quite a simple explanation in this case study. The people living in neighbouring municipalities can see wind turbines every day, but they (or their municipalities) do not usually have any economic benefits from them; financial profit from energy production usually goes only to municipalities in whose cadastre the wind turbines are constructed. A similar ´reverse proximity effect´ for existing wind farms was reported by Warren et al. (2005), Ladenburg and Krause (2011), and others. This finding illustrate that in many operational wind projects the perceived landscape impacts are of a wider spatial scale than the financial compensation provided. Consequently the opposition in neighbouring municipalities is often higher if they are not included in any benefit package (perceived distributional injustice). In this regard, developers carrying out new projects need to calculate and distribute economic compensation much more broadly and evenly among concerned communities.

Landscape disruption is more likely reported by people who feel annoyed by noise and who consider local economic benefits as insufficient. It is interesting (yet actually quite logical) that the perception of noise annoyance – in contrast to the perception of landscape disruption – is positively correlated with the proximity to wind turbines (the closer the more noise perceived). On the other hand, there was no significant difference in perceptions of negative impacts according to the physical parameters of wind turbines (number, height). Even the fact whether wind turbines are visible directly from the respondents' home (or not), does not matter.

A somewhat surprising finding is that perceptions of the negative landscape impact are not directly influenced by personal attitude towards the need to mitigate climate change and the positive role of wind energy development in this respect. The consideration of climate change mitigation, however, significantly affects the overall attitude to the projects (its acceptance).

Finally, the perceived landscape disruption is reported more likely by people with higher education and less likely by the elderly over the age of 60. The differences according to gender are not statistically significant. These results are in line with the study of Molnárová et al. (2012) who found that respondents with a university degree are more critical toward wind turbines in attractive and average landscapes than respondents with a lower level education.

The final logistic regression model for predicting the perception of landscape disruption is presented in Table 5. The model explains 72% of the variability in the dependent variable. Based on this model, the profile of people perceiving landscape disruption can be exemplified as those who have university education, live in neighbouring municipalities, consider wind turbines noisy, and do not see an adequate economic benefit for their community.

Table 5 Logistic regression model for the perception of landscape disruption
5. táblázat Logisztikus regressziós modell a tájváltozás érzékelésére

Predictors	**Sig.**	**Exp(B)**
Number of turbines	0.511	0.941
Size of turbines	0.139	1.417
Place of residence	**0.022**	**0.344**
Distance of residence from wind farm	0.752	1.082
Visibility of turbines from home	0.842	1.047
Noise annoyance	**0.000**	**5.912**
Local economic profit	**0.000**	**3.064**
Climate change mitigation	0.488	0.853
Education	**0.006**	**2.330**
Age	**0.007**	**0.367**
Constant	0.911	0.907
- 2 LL	512.424	
Nagelkerke R^2	0.337	
PCE	72 %	
N (cases)	474	

Note: The significant predictors are in bold. *Source: Authors 'survey*

We are, however, aware of some methodological limitations of this study. First, our survey covered only projects with quite small number of wind turbines (in comparison with developments in other European countries). Second, most investigated projects are located in a relatively similar type of landscape (forestry-agricultural landscape). It would be appropriate to repeat the same research in locations where there are larger concentrations of wind turbines and in different types of (more attractive) landscapes.

Conclusions

The results of this study supports the hypothesis that landscape disruption – as the most commonly reported negative impact of wind turbines and stated argument to oppose projects – is a highly relative and subjective matter. Our survey found that the perception of landscape disruption is not determined by the number of existing wind turbines, the proximity of residences to them and their visibility from the home but is significantly affected by the perception of the economic favourability of projects (benefits to local communities), perception of other negative impacts of wind turbines (particularly the noise annoyance) and the socio-cultural background of people (particularly the level of education).

These findings suggest that if people live close to wind turbines and see them from their home, this does not automatically mean they perceive the landscape to be negatively impacted. And even if they perceive the landscape as disrupted, it does not automatically mean that they disagree with the project implementation (even though the correlation between perceived landscape disruption and opposition is quite strong). The key positive factor that can outweigh negative perceptions of landscape impacts is the perception of adequate economic benefits to local community.

This study illustrates that the perception of visual landscape impact cannot be studied without considering the local environmental and socioeconomic context. In this sense, the photographs and audio-visual simulations of wind turbines often used in surveys of wind energy acceptance cannot be considered real landscapes, since people are not passive independent observers but actors in specific local environmental and socioeconomic contexts. Our study thus supports the suggestions of Toke (2005) and others that it is impossible to separate landscape factors from economic factors since economic factors play a major role in assessments of whether landscape or pollution reduction values are given greater prominence in planning and implementation decisions.

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TÁJROMBOLÁS VAGY CSUPÁN A GAZDASÁGI ELŐNYÖK HIÁNYA? A SZÉLTURBINÁK NEGATÍV MEGÍTÉLÉSE MÖGÖTTI TÉNYEZŐK FELTÁRÁSA

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Kulcsszavak: szélenergia, tájképi megítélés, társadalmi elfogadottság, Cseh Köztársaság

Tanulmányunk új empirikus adatokkal támasztja alá azt a hipotézist, amely szerint a szélturbinák, mint tájba nem illő elemek megítélése alapvetően szubjektív és relatív alapokon nyugszik. Tanulmányunk hátterét egy csaknem 500, aktívan működő szélturbina közelében, a Cseh Köztársaság hat különböző helyszínén élő lakos bevonásával készült felmérés adja. A tájrombolás helyi közösségi megítélését befolyásoló földrajzi és szocioökonómiai tényezőket korrelációk elemzésével és regresszióanalízis segítségével tártuk fel. A kapott eredmények tanúsága szerint a tájrombolás mértékének megítélése nem a meglévő szélturbinák számától, azok lakóhelyektől való távolságától és a lakóházakból történő láthatóságától függ, hanem sokkal inkább a projektek kedvező gazdasági megítélésétől (a helyi közösségekre gyakorolt pozitív gazdasági hatásától), a szélturbinák egyéb, negatívan értékelt hatásaitól (elsősorban a zajártalomtól), valamint a lakosság szociokulturális hátterétől (elsősorban az iskolai végzettségtől).

Appendix 1. Description of selected questions from survey
1. melléklet A kérdőívben szereplő, a regresszióanalízisben használt kérdések

Variable	Description	Coding
Perceived landscape disruption	Do you agree wind turbines disrupt local landscape?	1 = Strongly disagree 5 = Strongly agree
Local economic profit	Do you agree wind turbines bring sufficient profit for local community?	1 = Strongly disagree 5 = Strongly agree
Noise annoyance	Do you agree wind turbines annoy people with noise?	1 = Strongly disagree 5 = Strongly agree
Climate change mitigation	Do you agree wind turbines contribute to mitigating climate change?	1 = Strongly disagree 5 = Strongly agree
Visibility	Can you see wind turbines from your home place?	0 = Not at all 1 = Partly 2 = Completely
Current acceptance	Would you agree or disagree with the construction of wind turbines if you returned back in time?	1 = Strongly disagree 5 = Strongly agree
Residence	What is your place of residence?	1 = Central municipality 2 = Neighbouring
Education	What is your highest education level	1 = Elementary 2 = Secondary 3 = Tertiary

Note: The table contains only variables (questions) which were included in the regression model (Table 5).