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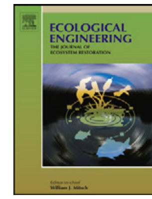

Visual preferences for physical attributes of mining and post-mining landscapes with respect to the sociodemographic characteristics of respondents

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ABSTRACT

Our study presents a method for assessing the visual quality of post-mining landscapes, empowering the residents of these areas, or a wider range of experts, to take part in the design of new landscapes. The goal of this study was to evaluate respondents' visual perception of selected relevant physical attributes of mining and post-mining landscapes and to determine the influence of certain sociodemographic characteristics of the respondents on their visual preferences. Based on a spatial image analysis of ground photographs of landscapes included in a questionnaire determining the respondents' visual preferences, we found that active, non-reclaimed mines contributed fundamentally to a negative evaluation of whole landscape scenes. Built-up areas, another form of human impact on the landscape, did not significantly lower the respondents' ratings for the scenes. The study confirmed a major positive influence of reclamations in post-mining areas, including those in early successional stages. This effect was increased in reclamations containing mature woody communities. The most important sociodemographic factor proved to be the professional field or study focus of the respondents, which significantly influenced their evaluation of most of the selected physical attributes of the landscape. Visual preferences were also significantly affected by the respondents' gender and education.

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1. Introduction

Surface coal mining does not only affect the landscape in which it takes place. Because of its large scale, this industry also leaves traces in adjacent landscapes. Apart from dust and noise pollution, the adjacent landscapes also suffer from negative visual impacts of surface mining and related activities (Simpson, 1979; Ramos and Panagopoulos, 2004).

After the termination of mining activities, it is necessary to mitigate their impacts and to restore the post-mining landscape and all its functions. Reclamation, as a tool for restoring these landscapes, aims not only to restore the geomorphological, hydric and ecological balance of the landscape (Hancock et al., 2003; Hendrychová, 2008), but also to restore or create its aesthetic value (Simpson, 1979; Sklenicka and Kasparova, 2008).

In the Czech Republic, as in most European countries, mining companies are legally required to create a remediation and reclamation plan before they start mining activities. This plan addresses the landscaping of the area, taking into account its future use. With regard to the multi-functionality of post-mining landscapes, the reclamation project should contain both a land use plan and the requirements for the appearance of the future landscape, based on the needs of the government, the mining companies and the public (Kaplan, 1979a; Dentoni and Massacci, 2007). Accordingly, a survey of the visual preferences of the landscape's inhabitants should be a significant part of the process of creating a project for the reclamation of a post-mining landscape.

1.1. Landscape perception

Humans are better adapted for perceiving visual stimuli than for absorbing other types of information. Visual stimuli are also effective in conjuring associated information (Kaplan and Kaplan, 1989). Landscape scenic beauty can therefore be seen as a significant natural resource, indispensable for a full human life (Denker, 2004).

The mental resources of each individual include an aesthetic stance, i.e. the ability to perceive the environment aesthetically (Zuska, 2001). Just as there are psychological, physical and socio-economic differences between people, there are differences in their visual preferences in landscape perception (Fujita, 2001; Sevenant

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and Antrop, 2010). On the other hand, landscape contains visual values and elements which are generally accepted as aesthetic by the public (Angileri and Toccolini, 1993; Vorel, 1999). This suggests a dual approach to the aesthetic perception of landscape – the sensory approach and the psychological approach (Newby, 1971; Valenta, 2008). The sensory approach is based on the current state of the landscape and of the observer, and is determined by conscious psychological processes. The cognitive approach is affected by the previous cultural and personal experience of the observer, and is based largely on unconscious, phylogenetically determined chains of thought (Jung, 1997; Löw and Míchal, 2003). It is because of the effect of these cognitive motives that the visual preferences of people coming from very different environments often prove to coincide (e.g. Webster and Kruglanski, 1994). On the other hand, previous studies have shown that the personal characteristics of the observer or of a whole social group (e.g. their age, education, place of residence and profession) significantly influence visual preferences and the perception of landscape in general (see e.g. Misgav, 2000; Sklenicka and Molnarova, 2010).

1.2. Evaluating the visual quality of landscapes

Approaches to evaluating the visual quality of landscapes vary in their attitude to public participation. The expert approach, where the visual quality of a landscape is assessed by one or more experts, does not take into account the opinion of the public in the evaluation process (Brown and Itami, 1982). On the other hand, the participative approach evaluates the visual qualities of the landscape by means of a study of the visual preferences of the public (Bulut and Yilmaz, 2007; Conrad et al., 2011).

Studies focusing on the visual preferences of the population usually use questionnaires to assess landscape perception (e.g. Simonič, 2003; Roth, 2006). However, they vary in the goal of the research, the sample tested, and the form of the research. Two main types of studies can be differentiated according to the means of determining visual preferences: those that use verbal questions, and those based on visual stimuli. Tahvanainen et al. (2001), who compared these methods, point out a higher impact of prejudice and other background characteristics in studies using verbal questioning. By contrast, assessment through visual stimuli was found to be more accurate.

There are also a range of perceptional visual stimuli. The visual quality of a landscape can be assessed directly on site or it can be assessed indirectly, using static or dynamic presentations of the landscape (Stewart et al., 1984). Visual presentation of landscapes was utilized, e.g. by Oh (1994), who studied preferences on the basis of an evaluation of pictures of virtual landscapes presented on a computer screen. Morgan and Williams (1999) evaluate perceptions on the basis of video panoramas of landscapes, and Van den Berg and Koole (2006) and Simonič (2003) use photographs of landscapes in digital or printed form. Photographs of landscape are the most frequently used perceptional stimulus, and many studies have shown that photographs are a valid and adequate stimulus for aesthetic evaluation of a landscape (e.g. Shuttleworth, 1980; Palmer and Hoffman, 2001). On the other hand, some authors consider the use of landscape photographs to be inadequate (e.g. Zube et al., 1974; Kroh and Gimblett, 1992).

Since the end of the 20th century, the use of the Internet has been on the increase, both in experimental research and in research on the visual quality of the landscape. Bishop (1997) has shown that the Internet can provide a convenient medium for undertaking experiments in perception studies. Wherett (1999) notes that use of the Internet in perception studies causes significant difficulties, especially by limiting the sample of respondents to people who can access the Internet. The sample composition also often becomes less predictable and balanced. On the other hand, use of the Internet brings many advantages, e.g. accessibility of the research to the broader public, connected with a higher level of research transparency, as well as a wide sample of respondents with a broad span of demographic characteristics (Reips, 2002; Roth, 2006). Moreover, Lindhjem and Navrud (2011), who compared Internet-based surveys with face-to-face interviews, found that the preferences established by these two methods were similar. Roth (2006) concludes that the scenic quality categories of visual beauty, naturalness and also overall scenic quality can be validly recorded on the Internet.

A number of studies using photographs to evaluate visual preferences undertake an analysis of selected elements directly in the landscape, or on maps or aerial photographs. These studies use photographs only as a representation of a previously analyzed landscape (e.g. De la Fuente De Val et al., 2006). Only a few studies have evaluated landscape elements directly in photographs (e.g. Arriaza et al., 2004).

Evaluations of visual preferences in mining and post-mining landscapes with the aid of photographs are rarely found in the literature – so far, this approach has only been utilized by Sklenicka and Molnarova (2010) in a study of habitat types used in reclamation.

1.3. Attributes affecting visual landscape preferences

Landscape attributes that create the landscape scene can be identified and used in the assessment of visual landscape preferences (Strumse, 1994; Cañas et al., 2009). Although many studies have focused on preferences for various landscape attributes, it is not easy to decide which attributes affect landscape preferences and how significant each attribute is in determining the overall landscape perception (Williams et al., 2007). The character and the presence of landscape attributes in the landscape scene are to a high degree determined by the type of landscape in which the assessed landscape scene is situated (Bulut and Yilmaz, 2007).

Several studies have focused on physical elements and on their role in the assessment of visual qualities of the landscape. Ulrich (1986) and Misgav (2000) emphasize the positive influence of vegetation, especially of woody plants, on the visual perception of landscapes. The presence of a water feature has also been shown to have a positive influence (Bergen et al., 1995; Arriaza et al., 2004; Bulut and Yilmaz, 2007), as well as distinctive topography or the presence of mountains (Hammitt et al., 1994; Bulut and Yilmaz, 2007). According to Van den Berg and Koole (2006), natural settings are preferred to managed settings. The presence of wilderness features in the landscape is also valued, especially in agricultural landscapes (Arriaza et al., 2004). The important role of the degree of human influence on visual preferences was also confirmed by Van den Berg et al. (2006). Man-made elements such as objects of vernacular architecture, vistas, etc., are evaluated positively (Arriaza et al., 2004), while, e.g. urban and suburban development, industrial areas and roads tend to be perceived negatively (Strumse, 1994; Purcell et al., 1994).

Visual preferences are influenced not only by the presence of natural elements in the landscape, but also by their configuration, especially by the diversity and richness of these elements, by contrasts in their color and form, and by their spatial structure (De la Fuente De Val et al., 2006; Tveit et al., 2006). According to Hands and Brown (2002), respondents prefer higher color contrast, as well as higher contrast in the form and diversity of landscape elements (Cañas et al., 2009).

1.4. Objectives

The goal of this study is to evaluate the significance of seven variables (distinctiveness of topography, the presence of a mining element, proportion of trees in the photograph, the presence of a built-up area, of a water feature, of wilderness, of diversity of land use) in the perception of a landscape directly and indirectly affected by surface mining. Further, the study aims to determine the extent to which differences in the visual preferences of the respondents are related to their sociodemographic characteristics, e.g. sex, age, education and profession. Another goal of the study is to determine whether the visual preferences of respondents living in regions affected by surface mining are different from the visual preferences of respondents living in other areas, especially concerning preferences for elements typical for mining and post-mining areas (quarries, dumps).

2. Methodology

2.1. Study area

The study area, the Chomutov – Teplice basin (594 km^2), is a part of the North-Bohemian brown coal basin in the Czech Republic, at the foot of the Krušné Mountains, along the Czech-German border (Fig. 1). The North-Bohemian Basin is the most productive brown coal basin in the Czech Republic (approx. 1400 km^2), belonging to the so-called Black Triangle, one of the largest mining areas in Europe. Within the study area, the total area of landscape affected by mining (including reclaimed areas) is 231 km^2. Of this area, 79 km^2 have been reclaimed, and 152 km^2 still await reclamation.

In the second half of the 20th century, surface coal mining in the study area became large scale, thereby affecting significant parts of the landscape. In the same period, large-scale reclamation projects began to be systematically developed. These reclamations were mostly of agricultural and forest type, focusing on restoring the productive functions of the landscape (Štýs et al., 1981). However, in the last decade, a conceptual, pro-landscape approach to reclamations has been adopted, which takes into account ecological, aesthetic and social aspects of the landscape as well as productive aspects.

The study area is relatively densely populated. Approximately 400,000 inhabitants live there and the average population density is 160 inhabitants per square kilometer (which is more than the average density in the Czech Republic–130 inhabitants per km^2). There are 64 municipalities in the study area, the largest of which are Ústí nad Labem (97,000 inhabitants), Most (68,000 inhabitants), Chomutov (52,000 inhabitants) and Litvínov (29,000 inhabitants).

2.2. Analysis of photographs, landscape elements

630 photographs were taken in the study area in 50 different places, at the end of June 2009, using a Panasonic DMC-FZ18 digital camera (EVF SLR type, basic focal length 28 mm). A portable tripod was used to take the photographs at a height of 170 cm, i.e. from the average adult's view. The scenery was photographed preferably from footpaths and roads, places commonly used for observing the landscape. The goal was to depict all present landscape types (forest, forest-agricultural, urban and mining), focusing on pre-selected landscape elements: topography, mining elements, mature woody vegetation, built-up areas, water features, wilderness and diversity of land use. These seven elements were selected from three sources: a preliminary field study, focusing on typical and frequently repeating features of the landscape in the study area; the findings of studies focused on the perception of individual landscape elements (section 1.3); and consultations with specialists in the fields of reclamation, landscape planning and master planning from the Czech University of Life Sciences Prague and the Czech Technical University in Prague.

We also aimed to depict landscapes with various impacts of surface mining: landscapes unaffected by surface mining, landscapes directly affected by mining, and landscapes affected only visually. Eighty-four of the 630 photographs were selected for the study. After removing photographs of poor technical quality, we created a balanced set of photographs which represented all the analyzed attributes. Each attribute was depicted in its presence, in its absence and in various proportions on the photographs. The selected photographs were divided into seven thematic "baskets", according to the landscape feature that was dominant in each photograph (Fig. 2). The selected photographs were not modified in any way for the purposes of the evaluation.

The photographs were analyzed in two steps: the selected landscape elements (see Table 1) were identified and specified in the photographs, and the proportion of these elements in each photograph was calculated using the Adobe Photoshop CS3 Extended application.

Table 1
Evaluated variables: results of an analysis of photographs from the standpoint of landscape elements and sociodemographic characteristics of the respondents.

Landscape elements	Categories (scoring scheme) = number of photographs with the element
Mining features	No mining features (0) = 65; mine (1) = 7; newly reclaimed dump (2) = 12
Morphology	Flat (0) = 54; hilly (1) = 30
Water feature (water body, watercourse)	No water features (0) = 68; the presence of a water feature (1) = 16
Proportion of forest and non-forest mature tree vegetation (without shrubs)	0% (0) = 9; 0.01–9.99% (1) = 36; 10.00–19.99% (2) = 25; 20.00–29.99% (3) = 9; 30.00% and more (4) = 5
Built-up area[a]	No built-up area (0) = 47; the presence of built-up area (1) = 37
Wilderness[b]	No wilderness (0) = 44; the presence of wilderness (1) = 40
Land-use diversity[c]	One land-use type (1) = 3; two land-use types (2) = 5; three land-use types (3) = 29; four land-use types (4) = 19; five land-use types (5) = 6; six land-use types (6) = 2
Sociodemographic characteristics of the respondent	**Categories (scoring scheme) = number of respondents (%)**
Gender	Man (0) = 455 (43%); woman (1) = 595 (57%)
Age	Under 14 years (1) = 20 (2%); 15–25 years (2) = 256 (24%); 26–35 years (3) = 551 (53%); 36–45 years (4) = 99 (9%); 46–65 years (5) = 111 (11%); 66 years and over (6) = 13 (1%)
Level of education	Lower than university level (0) = 416 (40%); university degree (1) = 634 (60%)
Professional field or study focus	Other professions (0) = 650 (62%); professions related to landscape management, e.g. ecology, nature conservation, architecture, urban planning and master planning (1) = 400 (38%)
Current place of residence	Municipality (within Czech Republic); abroad in the study area = 106 (10%); elsewhere = 944 (90%)
Place of birth	Municipality (within Czech Republic); abroad in the study area = 32 (3%); elsewhere = 1018 (97%)

[a] Built-up area consists of buildings and fences, does not include paved areas, e.g. roads.
[b] Wilderness is defined as an "area of unmodified or slightly modified land ... significantly free from direct human intervention" (Höchtl et al., 2005)
[c] Land-use diversity is determined by the number of land-use types in the photograph: grassland, arable land, forest, continuous stand of shrubs, orchard/garden, water body, barren land (scree, rock, paved area), surface mine, built-up area.

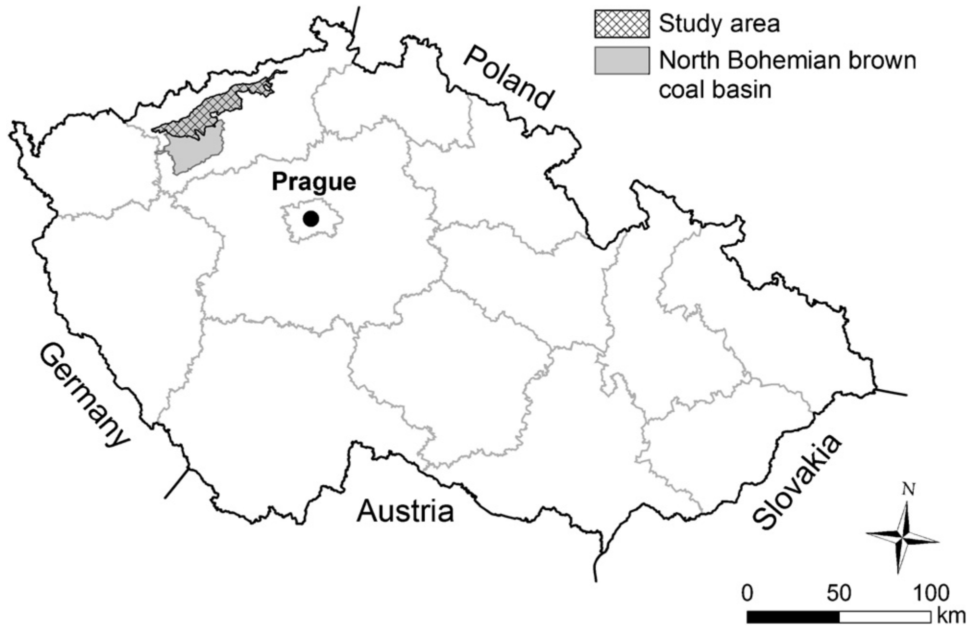

Fig. 1. Location of the study area: Chomutov – Teplice basin.

2.3. Questionnaire survey

A web-based anonymous questionnaire was used to evaluate the visual preferences of the population. The questionnaire was developed according to standards for Internet-based experiments (Reips, 2002). A publicly accessible web page was used, and PHP, MySQL, JavaScript and HTML with CSS were applied. The transferred data was saved to a MySQL database and further analyzed. No special software was needed on the computers of the participants. The goal of the web questionnaire was to find out the sociodemographic characteristics of the respondents (Table 1) and their assessment of the digital photographs. To ensure maximum diversity in the sample evaluated by each respondent, one photograph was randomly selected from each thematic “basket”. Each photograph was presented to the respondent whole and in maximum size on the screen. This was implemented using the JavaScript framework jQuery to identify the size of the respondent’s screen and to choose a suitable photograph size.

The participants rated the perceived beauty of each photograph on a 7-point evaluation scale from −3 to +3 points (−3 = not beautiful at all; 0 = neutral; +3 = very beautiful). The span of seven response categories was chosen according to a theoretical analysis of the human information-processing capacity defined by Miller (1956). Miller suggested that the human mind has a span of absolute judgment and the span of immediate memory that can distinguish about seven categories. The seven-point scale has also been recommended by other authors (e.g. Matell and Jacoby, 1971; Preston and Colman, 2000). Similarly, the possibility to make either a negative or a positive evaluation was chosen on the basis of the general assumption that mining landscapes (especially mines) are considered ugly (Simpson, 1979).

For the purposes of this study, a combination of two types of selection of respondents was chosen: stratified random selection and selection by inherence. For stratified random selection, two target groups were selected: inhabitants of the study area and people living outside the study area (in other parts of the Czech Republic). 540 randomly selected respondents from these groups were sent an e-mail invitation to fill in the questionnaire, containing a request to complete the survey, a brief introduction to the research, the approximate time needed to fill in the questionnaire, the link to the URL address of the on-line questionnaire, and the authors’ contact information. The subsequent selection by inference was carried out by the respondents, who had the option of sending the invitations to other people.

The survey was carried out in February 2010. 1050 respondents with various sociodemographic characteristics (see Table 1) took part in it, taking an average time of approximately 10 min to fill in the questionnaire.

2.4. Statistical analysis

The statistical distribution of the semi-quantitative respondent responses gathered on a scale of seven categories (from −3 to +3) characterizing the perceived beauty of the landscape scene was strongly skewed from normal, although a logarithmic, square root or arcsine transformation of the data was applied. We therefore associated the three positive categories (1, 2, 3) versus the three negative categories (−1, −2, −3) and, by excluding all indecisive answers (zero values), we obtained an unambiguous binomial distribution (positive versus negative) pattern of the respondent decisions that were finally adopted as a response variable in our models. To examine particular and associate effects of various factors on the respondents’ answers, we built generalized linear mixed-effect models with fixed effects of all predictors and their first-order interactions. The individual photographs were repeatedly evaluated by many respondents. To avoid pseudoreplication, the identity of the photograph was therefore included as a random factor. All non-significant variables ($P > 0.05$) were then eliminated step-by-step, using the backward selection procedure to achieve minimum adequate models (Crawley, 2007). Because the overdispersion of the response variable was low (0.76), χ^2 testing was applied to assess the contributions of particular terms to the model deviances and to the calculation of their statistical significances. All procedures were performed using *R*.

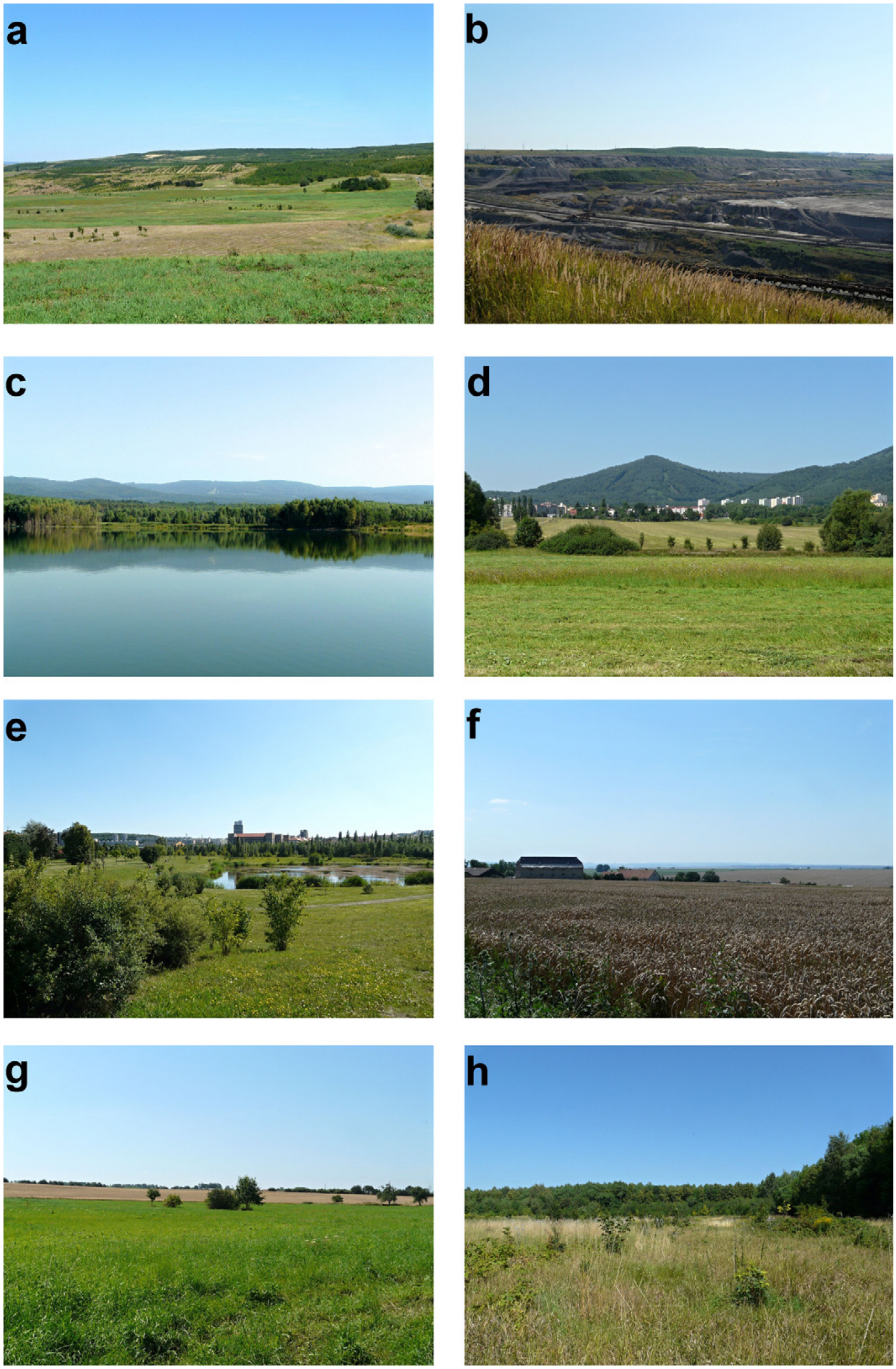

Fig. 2. Examples of selected photographs showing the evaluated landscape variables used in the study on landscape preferences (a – a newly reclaimed dump in a post-mining landscape; b – a surface brown coal mine as an element of a mining landscape; c – a water feature as an element of a post-mining landscape; the woody vegetation in the background is an element of the forest landscape; d – a built-up area and distinct topography in a forest-agricultural landscape; e – a built-up area and a water feature in an urbanized landscape; f – indistinct topography of an agricultural landscape with a low proportion of built-up area; g – indistinct topography of an agricultural landscape with a minimal proportion of mature woody vegetation; h – wilderness on the border of forest-agricultural and forest landscapes).

Table 2
Significant single predictors of visual preferences ($P < 0.05$).

Predictors and their categories	Average evaluation	df	χ^2	P
Mining feature		2	32.32	<0.0001
No mining feature	1.35			
Mine	−1.15			
Newly reclaimed dump	1.00			
Proportion of forest and non-forest mature tree vegetation (without shrubs)		1	7.75	0.0054
0%	−0.50			
0.01–9.99%	1.5			
10.00–19.99%	1.30			
20.00–29.99%	1.67			
30.00% and more	2.16			
Built-up area		1	7.55	0.0060
No built-up area	1.34			
The presence of built-up area	0.77			
Professional/study focus		1	17.56	<0.0001
Other fields	1.19			
Landscape management fields	0.93			
Gender		1	6.26	0.0124
Men	0.99			
Women	1.17			
Level of education		1	4.97	0.0258
Lower than university level	1.21			
University degree	1.1			

3. Results

The visual preferences expressed by the respondents vary according to the landscape elements and the sociodemographic characteristics of the respondents. These differences in preferences are significant for the predictors listed in Table 2. The visual preferences are also significantly affected by some interactions between the predictors listed in Table 3. Landscape elements with a non-significant influence on the visual preferences are water features, morphology, wilderness and land-use diversity. Sociodemographic characteristics that were not found to be significant predictors of differences in visual preferences were age, place of birth and place of residence of the respondent. The values of the non-significant predictors are not specified in this study.

3.1. Visual preferences for landscape elements

The variability in the visual preferences of the respondents evaluating photographs of landscapes affected by surface mining was significantly influenced by the presence of a mining element and by the presence of a built-up area in the depicted landscape scene, as well as mature woody vegetation, both forest and non-forest. The most significant impact on visual perception of the landscape depicted in a photograph was found in the case of surface mines, which are the main active mining elements in the study area (see average evaluation in Table 2).

3.1.1. Mining elements

The tested categories of mining elements (no mining element, surface mine, newly reclaimed dump) have a significant influence on the visual preferences (Table 2; Fig. 3a). The least attractive element was a surface mine (mean = −1.15). Only 4% of respondents expressed the highest preference (+3) for photographs containing a mine, whereas the largest group of respondents (26%) gave mines the lowest score (−3). The case of newly reclaimed dumps (mean = +1.00) was different. The presence of this feature in a photograph was given the maximum score by 11% of respondents, and only 1% of respondents gave it the lowest score. Landscape scenes containing neither a mine nor a dump were rated positively in 75% of cases (mean = +1.35).

3.1.2. Proportion of forest and non-forest mature woody vegetation

The proportion of forest and non-forest mature woody vegetation in a photograph proved to be a significant predictor of visual preferences. Average preferences for a photograph grew along with the growing proportion of this type of vegetation in the photograph (Fig. 3b). Whereas landscape scenes without forest or non-forest mature woody vegetation tended to receive a negative score (mean = −0.5), the photograph with the highest proportion of this type of vegetation (over 30%) achieved the highest scores of all evaluated landscape elements (mean = +2.16; Table 2). 95% of the respondents gave this photograph a positive score (43% gave it the highest score). Only 2% rated this landscape negatively, and no respondent gave it the lowest score.

3.1.3. Built-up areas

Visual preferences for the presence or absence of built-up areas in the photographs varied significantly (Table 2, $P < 0.01$). On an average, respondents preferred landscape scenes without built-up areas (mean = +1.34; Fig. 3c), 27% of respondents gave this type of landscape scene the highest rating. Landscape scenes which included built-up areas were given the highest rating by only 15% of the respondents (mean = +0.77; Fig. 3c).

3.2. Influence of the sociodemographic characteristics of the respondents on their visual preferences

Among the sociodemographic characteristics that were studied, the respondent's professional field or field of studies, his/her gender and education were found to have a significant influence on his/her visual preferences (Table 2).

3.2.1. Professional/study focus

The evaluation of the visual quality of the post-mining landscapes depicted in the photographs varied significantly according to the respondent's professional field or study focus ($P < 0.0001$). Respondents whose profession or studies focused on creative landscape management (e.g. professionals from the fields of ecology, nature protection, architecture, urban or master planning) were more critical in their landscape preferences (mean = +0.93; Table 2; Fig. 3d) than respondents from other professions (mean = +1.19; Table 2; Fig. 3d).

The professional field and study focus of the respondents also had a significant influence on the variability in their preferences in interaction with most analyzed landscape elements: the proportion of forest and non-forest mature woody vegetation, water features, morphology, mining elements and built-up area (see Table 3).

3.2.2. Gender

There were significant differences in the visual preferences of the respondents according to their gender (Table 2; $P < 0.02$). On an average, men were more critical of the visual qualities of the depicted landscapes (mean = +0.99; Table 2; Fig. 3e) than women (mean = +1.17; Table 2; Fig. 3e). The influence of gender in interaction with the analyzed landscape elements was not significant.

3.2.3. Education

The visual preferences of the respondents varied significantly according to their level of education (Table 2; $P < 0.03$). On an average, the preferences of respondents with a completed university education were lower (mean = +1.01; Table 2; Fig. 3f) than those of

Table 3
Significant interactions between the predictors of visual preferences ($P < 0.05$).

Interaction between predictors	Average evaluation		df	χ^2	P
Proportion of forest and non-forest mature tree vegetation × professional/study focus	Other fields[a]	Landscape management fields[b]	1	26	<0.0001
0%	−0.46	−0.56			
0.01–9.99%	1.22	0.85			
10.00–19.99%	1.37	1.19			
20.00–29.99%	1.72	1.46			
30.00% and more	1.45	1.96			
Water feature × professional/study focus	Other fields[a]	Landscape management fields[b]	1	12.32	0.0004
No water features	1.12	0.82			
The presence of a water feature	1.49	1.41			
Morphology × professional/study focus	Other fields[a]	Landscape management fields[b]	1	9.99	0.0016
Flat	1.37	0.98			
hilly	0.87	0.85			
Mining features × professional/study focus	Other fields[a]	Landscape management fields[b]	2	10.29	0.0058
No mining features	1.45	1.17			
Mine	−1.14	−1.00			
Newly reclaimed dump	1.20	0.79			
Built-up area × professional/study focus	Other fields[a]	Landscape management fields[b]	1	5.61	0.0179
No built-up area	1.44	1.19			
The presence of built-up area	0.88	0.60			

[a] Professions not related to landscape management.
[b] Professions related to landscape management, e.g. ecology, nature conservation, architecture, urban planning and master planning.

respondents with a lower level of education (mean = +1.21; Table 2; Fig. 3f). The influence of level of education in interaction with analyzed landscape elements on landscape preferences was not significant.

4. Discussion

The results of this study show that the visual preferences of respondents evaluating photographs of mining and post-mining landscapes vary according to the presence, the absence or the proportion of some of the evaluated landscape elements in the landscape scene. The results also confirm the significance of certain sociodemographic characteristics of the respondents in determining their visual preferences.

4.1. Landscape elements

The most important elements from the standpoint of a visual evaluation of mining and post-mining landscapes were active (unreclaimed) mines and completed (newly reclaimed) dumps. The presence of active, unreclaimed mines had a significant impact on the attractiveness of the whole landscape. In our study, the presence of unreclaimed mines moved the average perceived beauty value to the lowest level (mean = −1.15), receiving negative scores from almost 80% of respondents. Large-scale surface mining is generally perceived as an activity which destroys the landscape and causes long-term destabilization of all its functions (e.g. Majumder and Sarkar, 1994). From the visual standpoint, some of the main negative impacts of surface mining are the destruction of a harmonic scale and harmonic relationships in the landscape, significant changes in its morphology, and the destruction of ecosystems and cultural values in the landscape (e.g. Sklenicka et al., 2004). The negative effect on the observer is strengthened by the absence of vegetation in large areas, which furthermore evokes increased dust pollution, erosion and other indicators of unsustainable development (Vizayakumar and Mohapatra, 1992). These factors may, in terms of cognitive reasoning (Newby, 1971), contribute to the negative visual perception of mining elements in the landscape scene.

In contrast, newly reclaimed dumps are evaluated much more positively by respondents, only 20% of whom saw these elements as negative. The mean perceived beauty value was +1.00. The visual attractiveness of these landscape features is decreased mainly by the early successional stage of vegetation, as shown by Sklenicka and Molnarova (2010), and in some cases also by an artificial topography, which is in contrast to naturalness (Van den Berg and Koole, 2006). On the other hand, positively evaluated attributes of newly reclaimed dumps are the presence of vegetation and especially of mature woody vegetation. This is consistent with the findings of many authors (e.g. Lien and Buhyoff, 1986; Schroeder, 1989; Han, 2007; Sklenicka and Molnarova, 2010). The presence of vegetation generally increases the success of the integration of new, mostly man-made elements into the landscape, and thus increases the overall visual preferences for these elements (Sklenicka et al., 2004).

A comparison between the visual preferences for a newly reclaimed dump and for landscapes without a mining feature (a mine, a dump) showed that there was very little difference in the evaluation of these landscapes (only 0.35 points). This demonstrates the positive effect of reclamation of post-mining landscapes, even just a few years after completion. Overall, landscapes without mining features received the highest perceived beauty scores (mean = +1.35), and these landscapes were evaluated positively by more than 85% of the respondents. In situations of this type, respondents mainly appreciate the visual manifestation of a low degree of human influence (Kaplan and Herbert, 1987; Van den Berg et al., 2006) in comparison with landscapes containing dumps or mines.

In contrast to landscapes with active mines (mean = −1.15), built-up landscapes, a different type of anthropogenic landscape, are evaluated much more positively (mean = +0.77). The perceived beauty of landscapes containing built-up areas and landscapes without these features varied only slightly (0.57 points), which demonstrates a relatively high level of acceptance of this form

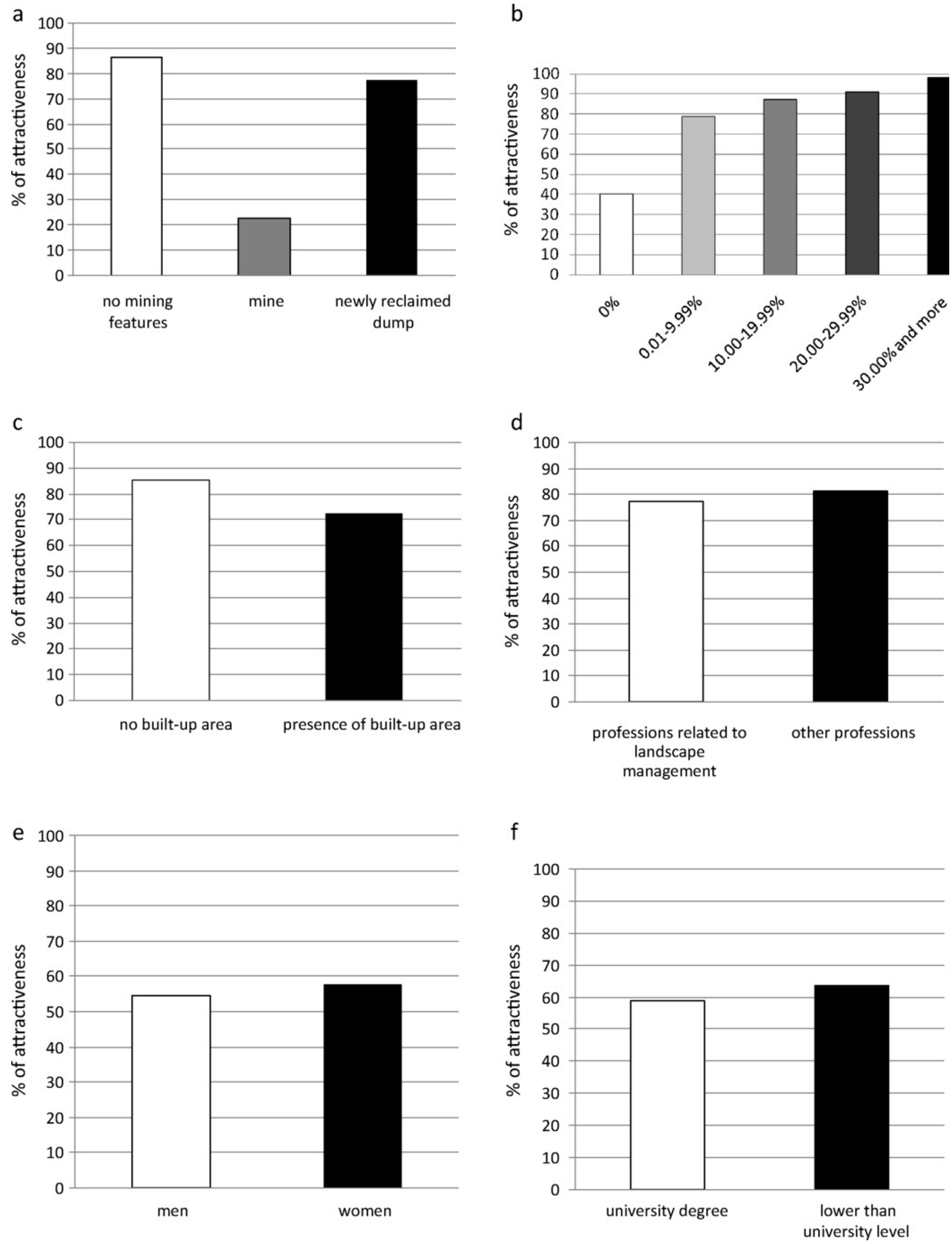

Fig. 3. Visual preferences for significant predictors (the columns show the proportion of positive evaluation of the landscape scene). (a) The presence of a mining feature. (b) Proportion of forest and non-forest mature woody vegetation. (c) The presence of a built-up area. (d) Professional field/study focus. (e) Gender. (f) Education.

of landscape transformation. However, visual preferences are significantly influenced by the quality of the built forms, by their aesthetic value and also e.g. by their historic value (e.g. Strumse, 1994; Arriaza et al., 2004). Photographs with built-up areas with a distinctly negative or positive aesthetic or historic value that could significantly influence the respondent's evaluations were therefore deliberately omitted from this study. Regarding the impact of perceived beauty in the evaluated landscape photographs on the score awarded by the respondents, the presence of built-up areas in the landscape (mean = +0.77) had a much less negative influence than the absence of woody vegetation (mean = −0.50).

Our results further indicate that visual preferences for landscape photographs grow with the growing proportion of forest and non-forest mature woody vegetation, which has also been confirmed by the results of other authors (e.g. Arriaza et al., 2004). The difference in preference for photographs with no woody vegetation and for those with over 30% of woody vegetation was as high as 2.66 points. This difference is even greater than the difference between preferences for photographs with and without a mine. This clearly shows the importance of mature woody vegetation in landscape perception, and shows its essential role and high potential in the reclamation of post-mining landscapes. The results also show that even the presence of a very small proportion of woody vegetation in a landscape significantly increases visual preferences for this landscape, with the mean perceived beauty always achieving positive scores. On the other hand, landscapes completely lacking woody vegetation were on an average evaluated negatively (mean = −0.5), with 60% of respondents perceiving them as negative.

These results indicate that there are significant differences in the perception of various visual elements which form the post-mining landscape (perception of their presence, their absence and their proportion). Because people need beauty in their environment, it is necessary to fulfill the requirements for aesthetic qualities of the reclaimed landscape. Reclamation plans should consider not only land use (which is the current practice), but also landscape elements. The results of our study show that the most important element in a reclamation plan is woody vegetation. It should be planted mainly in relation to significant viewpoints, along the transportation network, etc. Woody vegetation can also have a significant influence on the aesthetic value of a landscape by preventing visual contact with mines, which are, according to our results, always perceived as a negative element.

4.2. Effect of the sociodemographic characteristics of the respondents

Respondents whose profession is related to landscape management, including reclamation, tended to be more critical (see average evaluation in Table 3). These respondents expressed lower preferences for landscapes with a lack of woody vegetation, or with a low proportion of woody vegetation, for landscapes without water features, for landscapes with built-up areas, and for homogeneous (flat) morphology. Preferences for landscapes containing water features and for topographically diverse (hilly) landscapes were approximately the same for this group of respondents as for the respondents with other professions. The preferences of the landscape professionals for landscapes with the greatest proportions of woody vegetation (above 30%) were significantly higher.

These results can be explained by the tendency of landscape professionals to prefer naturalness, biodiversity and sustainability, and by the projection of their professional knowledge into their visual preferences (Virden, 1990; Van den Berg et al., 1998). However, respondents of other professions showed on an average significantly greater differences than landscape professionals (2.17) in their preference for landscapes with an active mine and for landscapes without a mining feature (2.59). The higher tolerance of landscape professionals for landscapes containing active mines may be connected with the fact that members of this group often project their knowledge of the field (process) of surface mining into their visual preferences and, at the same time, these respondents see surface mining as an opportunity to apply their profession in the subsequent reclamation.

Men tended to be slightly more critical than women in their evaluation of landscape photographs. These findings are consistent with the results of studies by Lyons (1983), Strumse (1996) and Lindemann-Matthies et al. (2010). Arguments for the more favourable visual preferences of women are generally founded on gender differences in evolutionary terms, and the resulting calmer attitude of women toward nature (Strumse, 1996). On the other hand, many studies have reported gender as a sociodemographic characteristic which does not indicate the respondents' landscape preferences (e.g. Penning-Rowsell, 1982; Dearden, 1984; Tips and Savasdisara, 1986).

Respondents with a university education were more critical in their evaluation of perceived beauty than respondents with less education, though the difference in the average evaluation between these two groups was only 0.2. Respondents with higher education gave lower perceived beauty scores mainly to photographs lacking woody vegetation or containing a newly reclaimed dump. On the other hand, respondents with a higher education awarded almost the same rating as respondents with less education when there was a mine present (the difference was 0.3). This can be attributed to a tendency of people with university education to prefer naturalness and sustainability and to the projection of their knowledge into their visual preferences, in this case as a result of accentuating these values in the course of their education (Virden, 1990; Van den Berg et al., 1998).

One of the three main goals of this study was to evaluate the differences between the visual preferences of residents of mining areas and residents of other areas. This goal could not be met, as the influence of this predictor on the dependent variable, perceived beauty, was not significant ($P > 0.05$).

4.3. The method

Other studies have focused on the relationship between physical attributes of the landscape and visual preferences of the public, and have evaluated these physical attributes by analyzing landscape structures on the basis of aerial photographs or maps (Ode et al., 2009; De la Fuente De Val et al., 2006; Dramstad et al., 2006). Our study, by contrast, investigates this relationship on the basis of an analysis of ground photographs, which are used as a part of a questionnaire. A quantitative and qualitative analysis of ground photographs included in a questionnaire for evaluating visual preferences offers a more direct and accurate comparison. When the respondents' visual preferences, determined from an analysis of ground photographs of the landscape, are confronted with the physical attributes seen from a bird's eye view, the results inevitably become distorted. In such cases, due to perspective, topography or land cover, the landscape seen by the observer can offer or accentuate only certain features, especially those that are in the foreground of the ground photograph. On the other hand, landscape features in the background of the ground photograph are visually suppressed. They appear to take up a smaller proportion of the photograph or do not appear in the photograph at all, although they are present in the evaluated landscape.

The method used in this study only analyses those features which are visible on ground photographs. It reflects their roles (e.g. dominance) in the evaluated landscape scene and takes into account the circumstance that certain features, although physically present in the photographed landscape, are not visible in ground photographs. Results obtained in this way can therefore be considered more reliable for defining the visual preferences of the public, which should subsequently be used in defining the design of new, reclaimed landscapes.

Some studies have indicated that photographs showing the landscape scene in the dormancy period are rated lower in visual preferences than photographs of landscapes in the vegetation period (e.g. Misgav, 2000). Only photographs showing landscapes in the growing season were therefore used in the questionnaire. This decision was also supported by the fact that, under Czech conditions, people come into visual contact with the landscape in the vegetation season especially in summer, more than at any other time of the year. Visual preferences concerning landscapes in this season are therefore also particularly significant for the design of reclaimed landscapes.

The use of the Internet as a means of communication with the respondents in our study was in accordance with the recommendations of Bishop (1997), as the study was carried out on a relatively small scale and did not require a specific, pre-determined sample of respondents. According to Wherett, 1999, while the limiting aspects of the Internet-based survey must be kept in mind, there is substantial merit in using the Internet as a medium for executing visual preference research.

5. Conclusions

The results have shown, on the one hand, that open non-reclaimed mines are the feature with the most significant negative influence on visual preferences. On the other hand, reclaimed areas, including those in early successional stages are shown to have a significant positive impact. The study has also confirmed the key role of mature woody vegetation in the landscape. It significantly increases visual preferences, even when it is only marginally present in the landscape scene, while landscape scenes without this type of vegetation are perceived negatively. Unlike mining features, built-up areas – another form of human impact on the landscape – have not been found to have a significant negative impact on visual preferences. The results also confirm the significance of some sociodemographic characteristics of the respondents. The most significant driver was the relationship with reclamations of the respondent's professional field or study focus. This sociodemographic factor has a significant influence on the evaluation of most physical attributes of the landscape. Visual preferences were also significantly affected by the respondents' gender and education. However, these two factors were not proved to have a significant impact on the variability of the perceived attractiveness of the studied landscape elements. The results support the use of spatial image analysis of ground photographs of landscapes along with a questionnaire containing these photographs as methods for public participation in the design of new post-mining landscapes. This method also helps to characterize the stimuli for visual attractiveness of the landscape and the use of these stimuli in the design of post-mining landscapes. To improve the public evaluation of post-mining landscapes, the results of this study support rapid reclamation of areas where mining has been terminated, using a high proportion of mature woody vegetation.

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