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ENVIRONMENTAL POTENTIAL IDENTIFICATION ON THE EXAMPLE OF THE NÍZKÝ JESENÍK HIGHLANDS

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Abstract

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Human activities have a variety of impacts on the environment and local communities as well. Many adverse impacts on landscape have appeared for example in context of tourism development which was considered as an environmentally friendly industry for a long time. That is why it is necessary to find out limits to maintain the environment as well as tourism, because as it turns out in status quo it does not work as it should do. Regions with damaged environment lose its value for the quality of living and the landscape is under the uncontrolled load which burdens the environment. On the level of municipality planning it is important to have precise information for decision making. In the scope of this a specific environmental area value (SEAV) was proposed in selected municipalities in the Nízký Jeseník Highlands as an evidence of landscape fragility, were the increasing interest of tourism has risen up. SEAV calculation is based on scoring municipalities within defined criteria reflecting partial landscape attributes. Proposed data set was evaluated according to ranking decision making method.

Keywords: spatial decision making, environmental value specification, GIS

INTRODUCTION

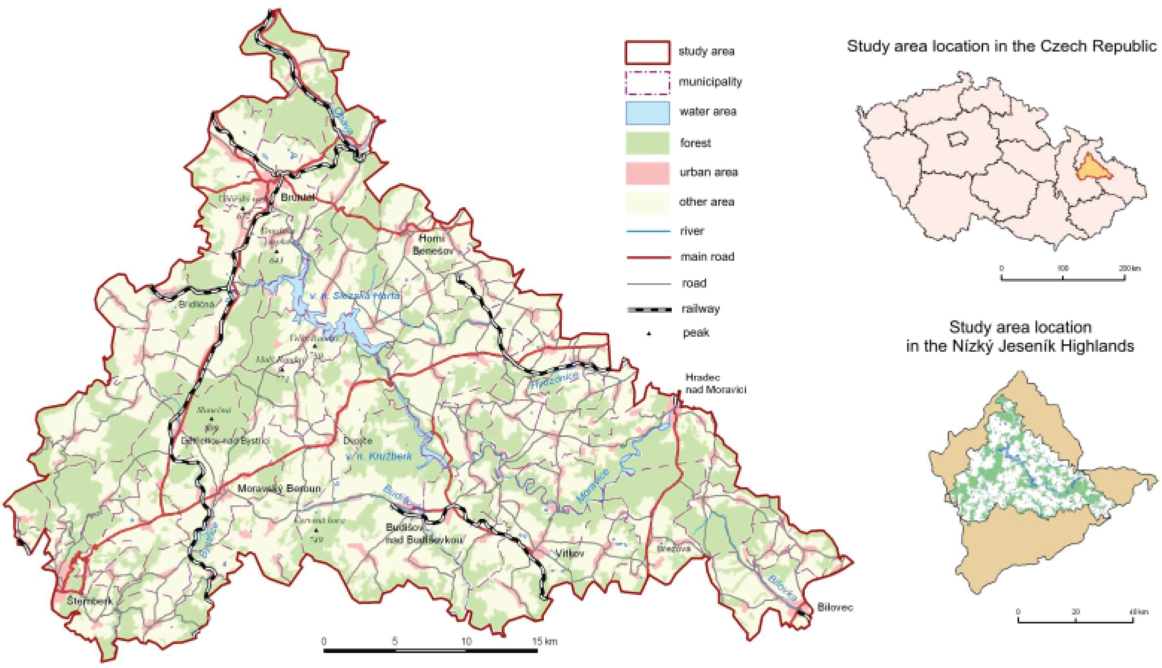
According to Forman and Gordon (1993) landscape represents part of the Earth's surface consisted of interacting ecosystems. If there is a need to study or assess landscape it is very difficult to choose the right point of view, because we can study landscape borders, anthropogenic and natural components, relations, inner structure etc. Landscape and its environment is very complex and difficult object to study. Landscape can be characterized by a number of specific physiognomic, structural and functional attributes. According to Kolejka *et al.* (2010) we can distinguish four main structures of landscape. In the natural (primary) structure we can see complexity of elements caused by the change of topoclimate (originally actively created heat island), changes in runoff (artificial surfaces, drainage area, artificial water bodies), removing or covering of soil, human made changes in terrain, changes in the contact with the geological environment (removal of the weathered objects when setting foundations), biodiversity and etc. The economic (secondary) structure is characterized by the dominant economically important areas with typical objects (buildings, chimneys), large abandoned or intensively used communication areas and equipment (handling areas, dock, parking lots, dense network of roads and railways, etc.), passive or active mining areas (quarries, dumps), abandoned or still used water management facilities (dams, swimming pools, ponds), residential and service buildings etc. In the human (social, tertiary) structure we can see the importance of social benefits of applied sustainability because of the changes of interest within post-industrial areas there are devastated areas, abandoned areas without maintenance, decline and loss of original functionality of cultural, educational, healthcare, catering, sports, leisure, entertainment and other buildings, facilities associated with the former industry and industrial society. The opposite case is in contrary an introduction of different degrees of protection over certain objects. The spiritual structure depicts the human perception of the landscape. This part is also related to the change of political conditions, both economic and social, and openness in knowledge concerned with environmental conditions, but also with different accessibility to power and the power authorities. To some places, we cannot deny the formation of strong genius loci, whether positive or negative. That is why, it is necessary to find out limits to maintain the environment with respect to using its potential. This paper is focused on specific environmental area value identification using spatial decision making on the example of study area situated in selected municipalities in the Nízký Jeseník Highlands, where another consequences concerning tourism impact were studied.

MATERIALS AND METHODS

If there is a need to study or evaluate landscape a difficult assignment must be solved. It depends on the point of view. It is possible to study landscape borders, elements, relations, inner structure, processes and time horizon. Two research approaches in landscape ecology, ecosystem and geosystem appears. Ecosystem studies occur in works of Tansley (1935), Forman and Gordon (1993), Zlatník (1976), Buček (1984) and others. It aims at linkage of partial aspects of biology of population. Geosystem approach works with factors with the same weight, although Moss (2000) says it is not the most suitable solution. Several methods have been designed for landscape evaluation purpose. LANDEP (LANDscape Ecologiocal Planning) method proposes the most suitable way how to use land in the scope of keeping environmentally friendly (Růžička, 2000). Löw and Míchal (2003) investigated the landscape as a complex of functional, sensitive and visual appearance of landscape elements. Landscape typology connecting natural and following cultural and spiritual features as a base for landscape management was proposed by Dower and Spiegler (Ruda, 2010). Besides that, there are well known methods such as Environment Impact Assessment (EIA) and Strategic Environmental Assessment (SEA). Skokanová (2006) deals with anthropogenic landscape assessment, landscape structure analysis or spatial geographic analysis.

For many cases studying landscape raster data prevails. In this case the main object was to suggest a procedure evaluating natural conditions within municipalities in relation to tourism potential and tourism infrastructure load assessment. That is why all partials criteria are considered within polygons representing municipalities' areas in selected municipalities in the Nízký Jeseník Highlands (Fig. 1) and thus using vector data format is more useful. Taking administrative regions as key areas (polygons) also brings powerful results for municipalities' assessment and especially decision making in the frame of regions clustering. Data processing used primarily Data200 geodatabase, CORINE land cover 2006 and data collected in the field.

Due to the presence of a number of criteria (factors and constraints) it is suitable to use appropriate multi-criteria evaluation approaches enabling the selection. Effat and Hegazy (2009) states, that Multi-Criteria Decision Making (MCDM) includes



1: *Study area delineation, own processing using Data200 database* both Multiple Attribute Decision Making (MADM) and Multiple Objective Decision Making (MODM). In the case of MCDM applications the term Multi-Criteria Analysis (MCA) or Multi-Criteria Evaluation (MCE) is often used. In contrast to conventional approaches of MCDM spatially oriented MCDM includes individual criteria as well as their location in space. In essence, the spatial multi-criteria decision making takes into account both the geographic data (data with spatial localization) with decision-making preferences and their final summarization according to specified decision rules (Malczewski, 1999; Malczewski, 2006a; Malczewski, 2006b; Voogd, 1983). In general, MCDM decision-making process can be divided into four basic steps (Yager and Kelman, 1999):

a) criteria and alternatives selection (preselecting),
b) data normalization and weights setting,
c) specific decision making method implementation,
d) result aggregation and interpretation.

The proposed assessing procedure uses aggregation method based on criteria scoring and weights setting and concerns following partial steps resulting into final output. The overall procedure can be seen in flowchart (Fig. 1).

Data Preparation (Calculation)

Step 1: calculation of proportion of a feature in municipality area.

Each of considered criteria was calculated as a proportion of a feature to municipality area. It enabled to distinguish the power of area.

Features Weight Setting

Step 2: qualified expert estimation of features weight.

Estimated weights were given according to Tlapáková (2006).

Data Aggregation

Step 3: multiplying of features values and estimated weight.

Step 4: values summarizing for each alternative.

Data Classification

Step 5: classification using natural breaks method.

Value Scoring

Step 6: points assignment (scoring 1–5) for each attribute values of studied criterion to each municipality according to position in intervals mentioned above.

Categories, Themes or Task Group Calculation

Step 7: pairwise preferences setting and WGM (weighted geometric mean) calculation for partial categories, themes or task group according to Saaty's method.

Step 8: summarizing of calculated weights and assigned points multiplying.

Step 9: natural breaks of SEAV classification into 5 classes.

The Nízký Jesník Highlands represents the region with insufficient database therefore primary data collecting was very difficult and their selection depended on required indicators and their presence (Ruda, 2010). Data of particular task groups and themes within the frame of data sets were applied to municipalities (basic urban areas) as a proportion in municipality area. It enabled to get valid results usable for data classification and point classification system used for evaluating each municipality. Each municipality gets its final value on the basis of combined calculation of proportion, statistical classification with following point distribution and pairwise comparison expressed by task groups, themes and attributes. For better understanding it is needed to explain developed and used terms.

Necessary terms:

- **Task group** (for instance protected areas, landscape lines dealing with specific environmental value assessment) is expressed by number value gained as a sum of weighted values coming from individual themes (natural parks, roads etc.) and categories which are weighted using qualified estimation according to their level of importance in study area;
- **Theme** is represented by a studied features which are applied to each municipality as a proportion in area, it is expressed using indicators in km. 10 km^{-2} (line feature), % (polygon feature) or index value coming from sum calculation;
- **Category** is represented by individual characteristics necessary for calculation theme value (for example: forest areas in Land use theme).

Specific environmental area value (SEAV) was considered as appropriate solution for identification of environmental area potential. The proposal and name of this data set comes from used data and basic areas represented by municipality. Concept content of environmental value was used with regard to quantification and data set character. Concept specific means application of factual and preselect environmental criteria as well as the term area reflecting application elementary urban areas (municipalities) as a feature into which mentioned data were applied. Two task groups and three themes whose values were calculated on the basis of themes or categories were specified for particular environmental area value assessment (Tab. I).

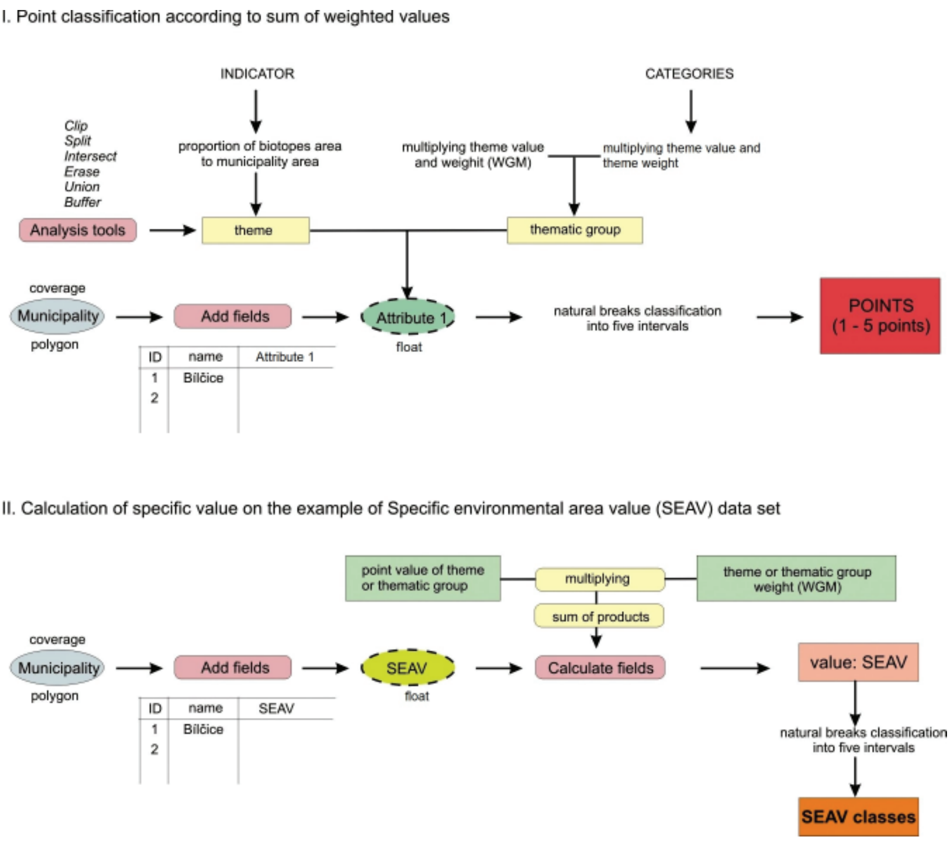
Data of particular task groups and themes were applied to municipalities as a proportion in municipality area (step 1, Tab. II). It enabled to get valid image for each municipality expressed by a numeric value. But it was necessary to set the final calculation up according to the level of importance. Qualified estimation of features weight was used in this part of research. Qualified expert estimation (step 2) was proposed in the case of setting features

I: *Overview of task groups, themes and categories for SEAV assessment, own processing*

1. Protected areas	2. Coefficient of ecological stability	3. Land use	4. Habitat Catalogue Natura 2000	5. Landscape lines
• small protected areas (SPA) • natural parks (NP) • territorial system of ecological stability (TSES) • bird's areas in Natura 2000 (BA) • protected deposit areas (PDA)	• forest areas • water areas • grasslands • meadows and pastures • arable land • built up and other areas	• forest areas • water areas • orchards • grasslands • gardens • arable land • built up areas	• naturally forest biotopes • vegetations of water bodies and streams • springs and mires • secondary grasslands and heath lands • scrub • cliffs and scree • mosaic of biotopes	• direct water stream • winding stream • roads • cycle tracks • railways

II: *Proportion of specific areas (Protected areas task group) in municipality (SPA – small protected areas, NP – natural parks, TSES – territorial system of ecological stability, BA – birds' areas of Nature 2000, PDA – protected deposit areas)*

	SPA	NP	TSES	BA	PDA
Bílčice	0	0	0.160971	0	0
Bratříkovice	0	0	0	0	0
Bruntál	0.0028	0	0.191093	0	0
Břidličná	0	0	0.464645	0	0
Budišov nad Budišovkou	0	0	0.210657	0.196	0.010191

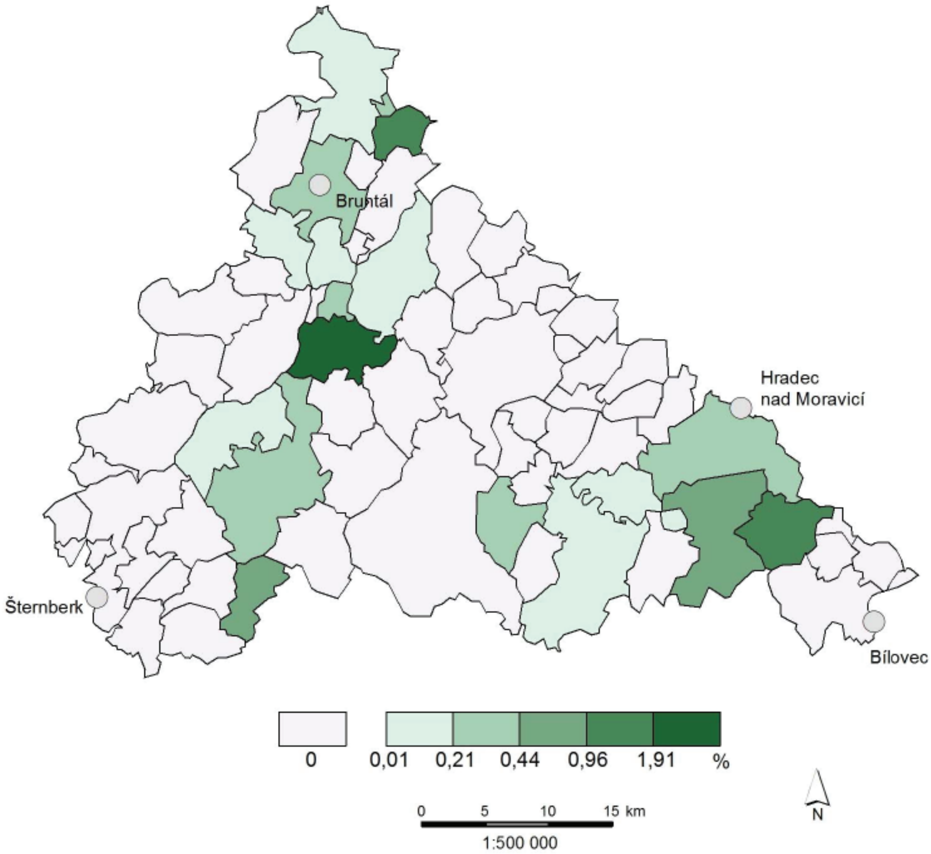


2: *Procedure flowchart, own proposal*

hierarchy for themes in the task group according to Tlapáková (2006) – for example protected areas consist of individual themes (example weights: small protected areas – 3, natural parks – 2, territorial system of ecological stability – 2, bird's areas in Natura 2000 – 3, protected deposit areas – 1). Calculated values were multiplied and summed (steps 3, 4; Tab. III). Better comprehension gives us choropleth map showing proportion of protected areas in municipalities (Fig. 3).

III: *Proportion of specific area multiplied by estimated weight within protected areas task group*

Municipality	Proportion x qualified estimation of weight					SUM
	SPA	NP	TSES	BA	PDA	
Bílčice	0	0	0.321942	0	0	**0.321942**
Bratříkovice	0	0	0	0	0	**0**
Bruntál	0.0084	0	0.382186	0	0	**0.390586**
Břidličná	0	0	0.92929	0	0	**0.92929**
Budišov nad Budišovkou	0	0	0.421314	0.588	0.010191	**1.019505**



3: *Proportion of protected areas in municipalities, own processing*

IV: *Point scoring using Natural breaks on the example of SEAV calculating showing first five municipalities according to alphabetical order.*

Municipality	Point scoring				
	prot. areas	coeff. of ec. stab.	land use	biotopes	landscape lines
Bílčice	1	3	4	2	3
Bratříkovice	0	1	0	1	1
Bruntál	1	2	3	2	3
Břidličná	2	3	4	3	4
Budišov nad Budišovkou	2	3	4	3	4

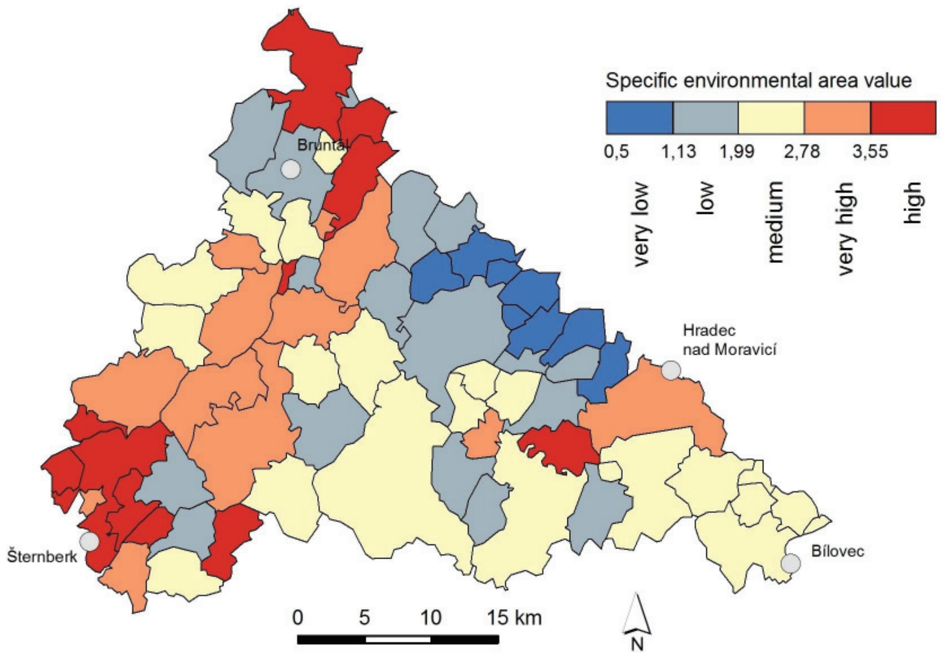
Next steps (5, 6) are focused on data classification and point scoring of each studied municipalities in mentioned task groups or themes. Five point scoring were suggested as a tool for municipality classification and serves as the best linguistic expression of five categories – (1) very low – (2) low – (3) medium – (4) high – (5) – very high value. Using statistic method natural breaks helped to classify sums of task groups and themes in municipalities into five intervals and thus enabled to assign points from 1 to 5 where 1 means the lowest and 5 the highest point score. In the case of absent feature there was given zero value (Tab. IV). Saaty's method (Saaty, 1980) using analytic hierarchy process enables to estimate pairwise preferences expressed on a ratio scale (step 7). The Analytic Hierarchy Process (AHP) is a systematic procedure for representing the elements of a multicriteria decision maker problem, hierarchically. A decision problem is broken by means of AHP into smaller parts and then decision makers lead through a series of pairwise comparison judgements to express the relative intensity of the impact of the elements in the hierarchy. It means criteria were compared to each other using 1–9 point scale. If a criterion A is more significant than B, A will get according to the level of significance value 1–9 and B will be expressed in ratio 1:A value (Tab. V). Finally weighted geometric mean was calculated to each of studied elements that enable to provide a field for other valid mathematical operation. In the pairwise comparison method, Saaty's consistency test is performed to ensure that the decision maker is being neither random nor illogical in his or her pairwise comparisons. Saaty suggested that the consistency ratio should be less than or equal to 0.1. Apparently the biggest weight was given in context of natural worth to protected areas the lowest level of importance is evident at landscape lines.

V: *Pairwise preferences and WGM calculation using Saaty's method on the example of SEAV*

Thematic elements	protected areas	biotopes	coefficient of eco. stab.	land use	landscape lines	GM	WGM
protected areas	1	2	3	3	4	2.352158	**0.385**
biotopes	1/2	1	2	3	4	1.643752	**0.269**
coefficient of eco. stab.	1/3	1/2	1	2	4	1.059224	**0.174**
land use	1/3	1/3	1/2	1	3	0.698827	**0.114**
landscape lines	1/4	1/4	1/4	1/3	1	0.349414	**0.057**
						Σ 6.1033	Σ 1.000

VI: *Final assessment of SEAV (PA – protected areas, KES – coefficient of ecological stability)*

Municipality	Point scores multiplied by weight					SEAV value	Interval description
	PA	KES	LANDUSE	BIOTOPES	LINES		
Bílčice	0.385	0.522	0.456	0.538	0.171	**2.072**	high
Bratříkovice	0	0.174	0	0.269	0.057	**0.5**	very low
Bruntál	0.385	0.348	0.342	0.538	0.171	**1.784**	low
Břidličná	0.77	0.522	0.456	0.807	0.228	**2.783**	high
Budišov nad Budišovkou	0.77	0.522	0.456	0.807	0.228	**2.783**	high



4: *Specific environmental area value, own processing*

Values given in the 6th step were within each thematic element (task groups and themes) in municipalities multiplied with calculated weight (WGM) and subsequently summed. Now each municipality is represented by a number reflecting its specific environmental area value (step 8, Tab. VI). Considering greater clarity municipalities were following SEAV classified into five intervals with using natural breaks classification method (step 9). Determined classes were according to other data sets given mentioned following description: (1) very low – (2) low – (3) medium – (4) high – (5) – very high value (Fig. 4).

RESULTS AND DISCUSSION

Very high value is noticeable in the northern and southwestern part of the studied area mainly in Řídeč village (4.47), Lipina village (4.09) and Mutkov village (4.03) but then villages situated in the middle part of the join running from the north to the southeast reach the lowest value, especially in Mladecko village (0.5), Bratříkovice village (0.5), Svobodné Heřmanice village (0.61) and Hlavnice village (0.61). The most valuable environmental parts can be seen more likely in the northern and southwestern part where significant features of the nature protection are localized. Opposite municipalities with lower or the lowest SEAV are mostly agricultural regions with higher proportion of arable land. Ascertained values are ready to compare with other data sets (e.g. tourism potential, tourism infrastructure load) values mainly using data correlation and regression. Thoughtful thematic elements were suggested according to landscape pattern and data availability. In other cases if it is needed thematic elements selection could be extended because of data accuracy with further thematic elements such as soil quality, lithology, underground water quality etc. Possible inaccuracy can be seen in pairwise comparison judgments. It depends on experiences and skills of trier of fact and it is recommended to assess the elements according to rules of procedure. Finally we have data for further analysis including for instance negative tourism impacts detecting, defining possible sustainable types of tourism, infrastructure planning etc. Researched municipalities can be gathered using cluster analysis into typological regions and then they can share the same thought in environmental protection considering sustainable tourism planning and writing projects asking for European funds subvention. Regional tourism potential disparities assessment within municipalities is other way how to use final results mainly during the process of strategic planning. They can make agreement on the field of tourist attractions supporting or tourism infrastructure improving. In relation to regional disparities assessment authorities can use partial results mainly those dealing with tourist tracks to increase building information centres and boards which are still missing.

SUMMARY

Environmental issues are still important at every level of planning and decision making. The paper is focused on partial case study dealing with special environmental area value proposal. This was considered as the important value calculated for each municipality in selected administrative regions. Firstly, the aspect of special environmental area value was proposed. SEAV was considered on the basis of existing data set and known criteria for environmental issues assessment. Two task groups (protected areas, landscape lines) and three themes (coefficient of ecological stability, land use, habitat catalogue Nature 2000) whose values were calculated on the basis of themes or categories were specified for particular environmental area value assessment. Data were taken from Data200 set and own data collection. According to Yager and Kelman (1999) partial steps and analyses using spatial decision making methods and GIS tools were proposed. The procedure involves calculation of proportion of a feature in municipality area following with multiplying of proportional feature values and calculated weight and resulting in points (1–5) assignment using natural breaks classification method. The ranking method using scores was applied. This was realized on the level of task groups and themes. Finally, further weight assessment using Saaty's method of pairwise comparison was considered among task groups and themes. Calculated weights and assigned points were calculated and the results are the final SEAV. Choropleth map was used for data visualization. In the map we can see actual distribution of different environmental situation expressed as a relative value in the whole municipality region. Map also indicates that SEAV is heterogonous in study area. Further comparison with partial results reveals that lower values can be seen especially in regions with higher proportion of arable land. The SEAV proposal is beneficial in case of environmental aspects evaluation which may result in finding common characteristics or indicating the level of dependence in human activities planning.

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