FOLIA OECOLOGICA – vol. 34, no. 2 (2007). ISSN 1336-5266

On the possibility of usage of GIS for ecological damage evaluation, demonstrated on example of the wind calamity in the High Tatra National Park

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Abstract

Melicharová, A., Schneider, J., Mikita, T., Celer, S., Kupec, P., Vyskot, I. 2007. On the possibility of usage of GIS (Geographic Information System) for ecological damage evaluation, demonstrated on example of the wind calamity in the High Tatra National Park. *Folia oecol.*, 34: 125–145.

The article presents methodology and results of ecological damage evaluation carried out with using the Geographic Information System (GIS). The concerned ecological damage was caused by the wind calamity impacted the most part of the High Tatra National Park (TANAP) in November 2004. The ecological damage to mountain forests has been evaluated by the ecosystem method called Quantification and Evaluation of Forest Functions (Vyskot, 2003) as empowering (reduction) of the ecosystem functions resulting from the wind calamity having caused the damage. There have also been determined the damage categories and their presence in the forest stands. The GIS was used in the first step for the extensive data set processing; in the second step for some special analyses. The GIS software special analyses were applied in multi criteria evaluation of forest stands resistance to wind ecological damage, where different parameters of forest stand biotic and abiotic conditions were combined. The results presented in the article show evidence of powerful usage of GIS software for analyses connected with ecological damage evaluation.

Key words

GIS, functional analysis, damage to forest functions

Introduction

The modern science supplies us with different possible approaches to ecological damage evaluation. One of the leading scientific practices in this area is so called ecological evaluation. This approach evaluates the ecological damage as the empowering (reduction) of the ecosystem functions resulting from effect of the phenomenon causing the damage. The quantification and evaluation of ecosystem functions before and after the ecological damage provides the background for this approach to ecological damage evaluation.

The method Quantification and Evaluation of Forest Functions (Vyskot et al., 2003) is widely used for forest ecosystem evaluation in the Czech Republic. This method is based on determining ecological criteria and parameters of forest ecosystem functions for objective quantification of forest functions. Forest ecosystems are usually evaluated in frame of their spatial organization units.

In case when this method is used in evaluation of larger forest areas, there are usually present a lot of different forest units and the use of Geographic Information Systems (GIS) development provides us with new tools and possibilities for the method application.

Our article presents the methodology and results of ecological damage evaluation with using the Geographic Information System (GIS). There was examined the ecological damage caused by the wind calamity impacted the most part of the High Tatra National Park High Tatras (TANAP) in November 2004.

The method Quantification and Evaluation of Forest Functions (Vyskot et al., 2003) is used for evaluation of forest functions, and the ArcGIS software is used for the basic data processing and the presentation of the results.

The article deals with the extensive research and evaluation of the ecological damage resulting from the wind calamity in the TANAP. The research was concentrated to localities with the highest level of nature protection (Tichá and Kôprová valleys); localities with interesting recreational forests adjacent to the town of Vysoké Tatry (Štrbské pleso, Tatranská Lomnica, Starý Smokovec) and a locality with amenity forests around the health resort Vyšné Hágy. In this article we present the results obtained at the model locality Tatranská Lomnica.

The issues presented in this article (analyse of geomorphologic surveys regarding the influence of terrain segmentation on stability of forest stands and on their functional potential) was intended as preparation of theme for Area 6.1.3.2. – Vulnerability assessment and societal impacts (7th Framework Programme of the European Community for Research, Technological Development and Demonstration). The other parts were processed within a study of ecological detriment to the TANAP forests.

Materials and methods

Locality

The presented results are divided into two groups. The first ones (results of methodological character) are general results taken across the whole above mentioned area (Tichá and Kôprová valleys, forests adjacent to the town of Vysoké Tatry and forests around Vyšné Hágy). The second group (results of GIS application in ecological damage evaluation process) consists of the concrete results obtained at the model locality Tatranská Lomnica.

The High Tatra National Park (TANAP) is situated in the northern part of the Slovak Republic. It was established by the Act SNR No. 11/1948 Zb. Its area is nearly 73,800 ha, and it can be characterized as a mountain area consisting of the main ridge with a system of side peaks and valleys. The natural conditions in the area especially result from its geomorphology; the High Tatra Mts are the highest mountain group in the so called Carpathian Arc. The climate of the locality is cold and very cold with high humidity. The contemporary vegetation cover comprises different types of mountain forests, mountain meadows and so called forestless areas above the upper tree line.

The locality Tatranská Lomnica is situated in the central part of the TANAP. The average altitude is 850 m above sea level; average slope orientation is south and southwest. The prevailing tree species in forest stands is Norway spruce (*Picea abies* (L.) Karst). The area of the stands is nearly 800 ha.

Working procedure

As it has been mentioned above; the main goal of the research discussed in this article was evaluation of ecological damage caused by the wind calamity in forest stands in the TANAP, November 2004. For solving this problem, the method Quantification and Evaluation of Forest Functions (Vyskot et al., 2003) (in the following text only the Method) was used; the data processing was done using the ArcGis software.

The working process can be divided into five steps:

1. Transformation of typological units and their comparison with natural conditions in the Czech highland forests as a base for verification of correct usage of the chosen Method
2. Forest stands damage class evaluation realised through analysis of the ortho-photographs
3. Analysis of geomorphologic surveys regarding the influence of terrain segmentation on forest stands´ stability and their functional potential
4. Real functional potential and topical functional effect of forest stands estimated from the GIS-created layouts
5. Assessment of the degree of naturalness of the forest stands.

Application of the Method in Slovak (High Tatra) conditions

Because the Method has been created for conditions in forests of the Czech Republic, the first step was verification of its applicability in conditions of Slovakia, especially the High Tatra Mts. Conversion of the Slovak typological units – groups of forest types – to units used in Czech forest management planning was based on similarity in stand and biocenological conditions, adequate for specification of particular management groups of stands (MGS). MGS comprises associated groups of forest types based on similar site and production conditions. The map of the Tatra’s MGS was elaborated and compared with the analogous

Czech mountain forests conditions (Ještěd – Jeseníky Mts and Plešný – Šumava Mts) with respect to the differences between Hercynicum and Carpathians. This analysis confirmed the correctness of using the Method in Slovak conditions.

Damage class establishment and evaluation

The damage to the stands was first evaluated through analysis of the orthophotographs (made after the wind calamity in December 2004) and individual stand damage classes were established. The classification was then verified directly in field. Our evaluation is presented in Table 1 and Figs 1–4. The damage classes were determined on the base of the forest stand status immediately after the wind calamity in 2004.

Relationship between geomorphology and damage class of forest stands (Analysis of geomorphologic surveys with regard on influence of terrain segmentation on forest stand's stability and on its functional potential)

This problem was solved at the model locality – forest stands in wide surroundings of Tatranská Lomnica. The whole study area is a rectangle 5 × 6 km in size. The analyses were processed using the ArcGIS 9.2 software with the Spatial Analyser and 3D Analyser extensions. The input data for analysis were vector contours having a 10 m contour interval, vector forest stand maps, mapping server of the Slovak Agency for Nature Protection.

The initial data for geomorphological analysis consisted of a digital elevation model calculated from vector contours (received in shape file format) with using the TopoToRaster tool of ArcGIS Spatial Analyst extension with a final resolution of 10 × 10 m. In spite of the fact that the contour interval of 10 m did not enable a higher resolution in this DEM, there are visible some innaccuracies resulting from the relief curvature between the contours. On the basis of DEM, there were processed maps of Aspect, Slope and Curvature. The aspect map was reclassified into 8 categories according to the main orientations, Slope map was reclassified into 9 categories each consisting of 4 classes and Curvature map into 5 categories.

The initial data for forest naturalness evaluation were vector forest stand layers. Having compared the tree species composition and potential vegetation for every stand, we divided all forest stands into several categories expressing their naturalness. On the basis of these values were the whole layers converted from vector to raster format and the result was a map of forest stands naturalness.

Real functional potential and creation of GIS layouts for topical functional effect of forest stands (incl a brief description of the basic Method terms and definitions)

General functions of forest mean all effects of this natural ecosystem which are independent of human influence. The ecosystem method of quantification and evaluation of forest functions is, therefore, based on the quantification and evaluation of elements and parameters of forest ecosystems determining their functional effects.

The principle of indirect parameter quantification is used for all systemized implemented ecosystem functions of the forests. The elements and segments of the ecosystem are aggregated to so-called functional criteria specifying the functional effects under evaluation.

To quantify a forest ecosystem it is necessary to define its condition entering the evaluation procedure.

Each of the forest functions (effectiveness of the functional group) is quantified through quantities of functions of the determining parameters (determination criteria). The compatible (value) classification of parameters (criterion elements and segments) also expresses the extent of functional effectiveness of functional determination criteria through the hierarchy of value degrees (rate of quantity).

Table 1. Characteristics of damage classes

Class	Damage class characteristics
A	Forest stands or their parts totally damaged by the calamity. Area has got a character of a clear-cut area, or with solitary, predominantly extremely damaged trees (damage degree IV, IIIb).
B	Seriously damaged forest stands or their parts (stocking 2–4). Remaining trees are predominantly heavy or medium damaged (damage degree IIIa, II).
C	Forest stands or their parts influenced by wind calamity (stocking 5–7). Slightly or medium damaged trees (damage degree II, I) predominate.
D	Forest stands or their parts not affected or only slightly disturbed by the calamity. Stocking maintains without change or is slightly decreased (8 +). Health condition of stand is good (damage degree 0, 0/I, I).

The procedure is implemented at the following levels:

- o Real potential of forest functions RP_{FF} – quantified functional potential of forests (values of produced functions) under optimum ecosystem conditions
- o Real topical effect of forest functions RE_{FF} – topical quantified functional effects of forests (values of produced functions) under topical ecosystem conditions.

Method works with six groups of forest functions: bioproduction, ecological – stabilization, hydric – water management, edaphic – soil conservation, social – recreation, health – hygienic.

The real potential of forests functions is determined for certain forest ecosystem units corresponding to the so called stand types within the functional management groups. The stand type specification is described in the Method references (Vyskot et al, 2003) in detail; here we only specify the stand type coding in terms of tree species composition. Stand type is labelled with an Arabic number (coding the group of tree species) and a capital letter (coding its proportion in the evaluated forest ecosystem). Functional management groups summarise forest sites (forest habitats) with functionally similar conditions. Real potential of forest functions is graded according a 7 value scale (0–6), where 0 means functionally unsuitable real potential, 6 means extraordinary real potential of forest functions (see Table 2). There is also presented so called total real potential of functions, which is defined as the sum of potentials of the particular functions. The value of the total real potential of functions varies from 5 to 36, and it is classified in classes I–VI of total real potential of functions.

Table 2. Value classification of real potentials of forest functions

Degree	Classification of actual potential of forest functions (RP_{FF})
0	functionally unsuitable
1	very low
2	low
3	average
4	high
5	very high
6	extraordinary

The real effect represents the topical function effectiveness of a forest ecosystem resulting from its topical condition. It expresses the rate of a produced function with respect to its potential capacities in percentage values (value classification of real effect of forest functions – see Table 3). Real effect of forest functions is derived from real potential of forest function with using the parameters characterising the actual status of forest ecosystems – so called function-reducing criteria – age (forest ecosystem development phase), stocking and health conditions.

Table 3. Value classification of real effects of forest functions RE_{FF}

Degree	Classification of actual effect of forest functions (RE_{FF}) – % of RP_{FF}
0	≤ 10
1	11–30
2	31–45
3	46–55
4	56–70
5	71–90
6	≥ 91

The general formula for calculation of the real effect of forest functions is the following:

$$RE_{FF} = v_T * T + v_Z * Z + v_{ZS} * ZS \ (\%)$$

where:

T – value of the partial real effect of a given function in relation to *age* (stand development phase)

Z – value of the partial real effect of a given function in relation to *stocking* (stand development stage)

ZS – value of the partial real effect of a given function in relation to *health condition* (stand development stage)

v_T – weight of *age* for a given function in the stand development stage

v_Z – weight of *stocking* for a given function in the stand development stage

v_Z – weight of *health condition* for a given function in the stand development stage

Calculation of the value of real topical effects of functions is realised for the whole group of forest functions.

Evaluation of degree of naturalness of forest stands

The degree of naturalness according to Vyskot (Vyskot et al., 2003) is the parameter used for evaluation of the natural tree species composition of forest stands. It is closely associated with the tree species composition – it mainly reflects the tree composition of stands. The spatial structure of stands is reflected only marginally and tree diversity is not included. (See Table 4).

Degree of naturalness according to Vyskot (dependent only on tree species composition) gives somewhat overestimated results (higher degree). Therefore, there was created a new approach for individual naturalness evaluation. It is based on degrees of naturalness according to Vyskot, and it takes into account both vertical spatial structure of the stand and modifications to the tree biodiversity – simplification or "arborisation". Vertical spatial structure of the stand is presented on particular levels. In case of species composition, it shows a considerable simplification (thanks to the trees profitable for natural species composition) or on the contrary the extreme (unnatural) biodiversity. The modification of tree composition reduces the degree of naturalness. Characteristics of these degrees are summarised in Table 5.

Table 4. Degree of naturalness (Vyskot et al., 2003)

Code Degree specification	Degree of naturalness
0 unsuitable	paraclimax – ecotope change (e.g. locust forest), tree species representation of natural composition < 10%
1 very low	exotic species, tree species representation of natural composition 11–30%
2 low	monocultures endangered by air pollution and damaged by game, allochthonous tree species, substitute stands corresponding to air pollution stages A and B, genetically unsuitable stands, tree sp. representation of natural composition 11–30%
3 average	monocultures, cultivated biocoenoses, unsuitable species composition, tree species representation of natural composition < 50%
4 high	semi-cultivated forest, poor species composition, tree species representation of natural composition 51–70%
5 very high	close-to-nature forest differentiated from species and spatial aspects, tree species representation of natural composition 71–90%
6 exceptional	natural species composition corresponding to natural conditions, > 90%

Table 5. Characteristics of new modified degrees of naturalness

DOF 2	DOF 1	Characteristic
3	3	Monocultures, unsuitable species composition, tree species representation of natural composition < 50%. Simplified spatial stand structure
	4	Monocultures, unsuitable species composition, tree species representation of natural composition < 50%. Two- or three-storey spatial stand structure
4	3	Semi-cultivated forest, simplified or unnaturally adjusted composition, tree species representation of natural composition 51–70%. Simplified spatial stand structure.
	4	Semi-cultivated forest, tree species representation of natural composition 51–70%. Close-to-nature tree species diversity. One- or two-storey spatial structure
	5	Semi-cultivated forest, tree species representation of natural composition 51–70%. Close-to-nature tree species diversity. Two- or three-storey spatial structure
5	4	Close-to-nature forest differentiated in species and spatial aspects, tree species representation of natural composition 71– 90%. Partially simplified or unnaturally adjusted composition. Large-area stands with simplified spatial structure
	5	Close-to-nature forest differentiated in species composition, representation of natural composition 71–90%. Close-to-nature tree species diversity. One- or two-storey spatial structure
	6	Close-to-nature forest differentiated in species and spatial aspects, tree species representation of natural composition 71–90%. Close-to-nature tree species diversity. Two- or three-storey spatial structure
6	5	Natural species composition corresponding to natural conditions, > 90% but monocultures of autochtonous tree species. Wide area stands with simplified spatial structure
	6	Natural species composition corresponding to natural conditions, > 90%. Two- or three-storey spatial structure

DOF 1 – Degree of naturalness – (Vyskot et al., 2003); DOF 2 – Degree of naturalness – modified

Results

Comparison of the Czech and Slovak (High Tatra) mountain forests conditions (verification of correctness of usage of the chosen Method)

As it was mentioned above, the Method was elaborated for conditions in the Czech Republic. The first step was verification of its applicability for conditions in the Slovak Republic, especially the High Tatra Mts. Having compared the criteria determining particular forest function, we could conclude that ecosystem conditions in forest complexes in the forest zone at the foothill of the High Tatra Mts correspond to the conditions in the management group of stands (MGS) 71, 73, 75, 77, 79, 1, 2, 3. The Slovak typological units (SSLT – sets of forest types groups) were converted to the Czech MGS. Example of conversion of SSLT to MGS presents Table 6. Conversion of SSLT to MGS was accomplished on base of analogical stand and biocenological conditions according to the particular MGS characteristics. The forest type groups similar in site conditions and production were associated into corresponding management groups of similar stands.

Forest stands damage degrees determination

Figure 1 illustrates distribution of damage to selected forest stands surrounding the town of Tatranská Lomnica, according to particular damage classes.

Real functional potential and topical functional effect of forest stands (GIS records) – on example of social-recreational function

These maps (Figs 2, 3 and 4) present real potentials of forest functions in the model locality Tatranská Lomnica, and the differences in real functional effects of forests stands before and after the wind calamity. Decrease in functional capacity of the forests is evident.

Determination of close-to-nature degree

Confrontation of both types of close-to-nature degree is presented with diagram in Figure 5. This parameter was determined based on the original state of stands before the wind calamity in year 2004.

Relationship between topography (geomorphologic parameters) and damage classes of forest stands

Almost all forest stands in area with smooth topography (very shallow ragged hillside with a mild slope, south-east aspect with only a few gullies and small valleys were extensively damaged (only few small islands of trees have been preserved). All the stands situated under influence of the High Tatra´s peaks (especially Lomnický štít), located on a steep hillside below glacial moraine of Skalnaté pleso have been preserved. The GIS analysis was used to examine the relation between the degree of the stand damage and the damaged stand's location and topography. The following figures (Figs 6–8) present the GIS layers of geomorphological characteristics of the model locality.

The impact of the glacial moraine on the wind flowing was theoretically deduced based on viewshed analysis. A line perpendicular to the wind direction (oriented from south-west to north-east) was created through digitalization of maps in the location of the highest peak in the surroundings (Lomnický štít, 2,655 meters above sea level). The created DEM was converted to TIN (so called Triangulated Irregular Network) and the line representing mountain rocks was added to this TIN. Then this model was divided into 9 regular segments 1,000 meters wide in the windflow direction. In each segment, a central point representing the observation point was located at the middle of the line. The final Viewshed map was created with using viewshed analysis performed from each point to the

Table 6. Example of conversion of SSLT to MGS

SSLT	Nomenclature	MGS	
6111	Extrémna borovicová smrečina vst	1	extremely unfavorable sites
6112	Svieža borovicová smrečina vst	73	acidophilous sites of highlands
6113	Čučoriedková borovicová smrečina vst	73	acidophilous sites of highlands
6121	Sutinová rašelinlková smrečina s jedlou vst	71	exposed sites of highlands
6143	Smlzová smrekovcová smrečina nst	73	acidophilous sites of highlands
6144	Balvanovitá smrekovcová smrečina nst	73	acidophilous sites of highlands
6145	Živná smrekovcová smrečina nst	75	nutritive sites of highlands

SSLT – sets of forest types groups, MGS – management group of stands relevant partial segment and after that by combining of all these rasters together. (See Figs 9 and 10). All the preserved forest stands located on the steep slope below the glacial moraine were determined as hidden – in accordance with our suppositions.

In the next step, all the damaged and preserved forest stands had to be distinguished. The allocation of these stands was specified based on supervised classification of the colored airborne images from the year 2006 with a half-meter resolution. Firstly all pixels were divided into 10 spectral classes and then each class was classified according to its value determined from airborne images (using Iso Cluster and Maximum Likelihood Classification tools of ArcGIS Spatial Analyst extension) (see Fig. 11).

Thanks to classification of the airborne images, there was created binary raster expressing forest stand damage in two categories: 0 – damaged forest stands, 1 – preserved forest stands. Because the analysed area contained also some parts of the town Tatranská Lomnica, where all objects inside the town like buildings and roads were classified wrongly and outside our interest, finally it was necessary to convert all the final maps with a vector layer of forest stands to shapefile format, and then with the visibility layer to exclude the hidden parts. The final grid of the forest stand damage was adjusted into the resulting resolution 10 × 10 meters and all the subsequent analyses cover only this area.

Combining of all the created rasters (Aspect, Slope, Curvature and Forest Naturalness) to the final raster, each pixel received values from all layers. Selection by attribute enables us to explore the data and draw conclusions about the damaged and protected forests such as dominant aspect, dominant

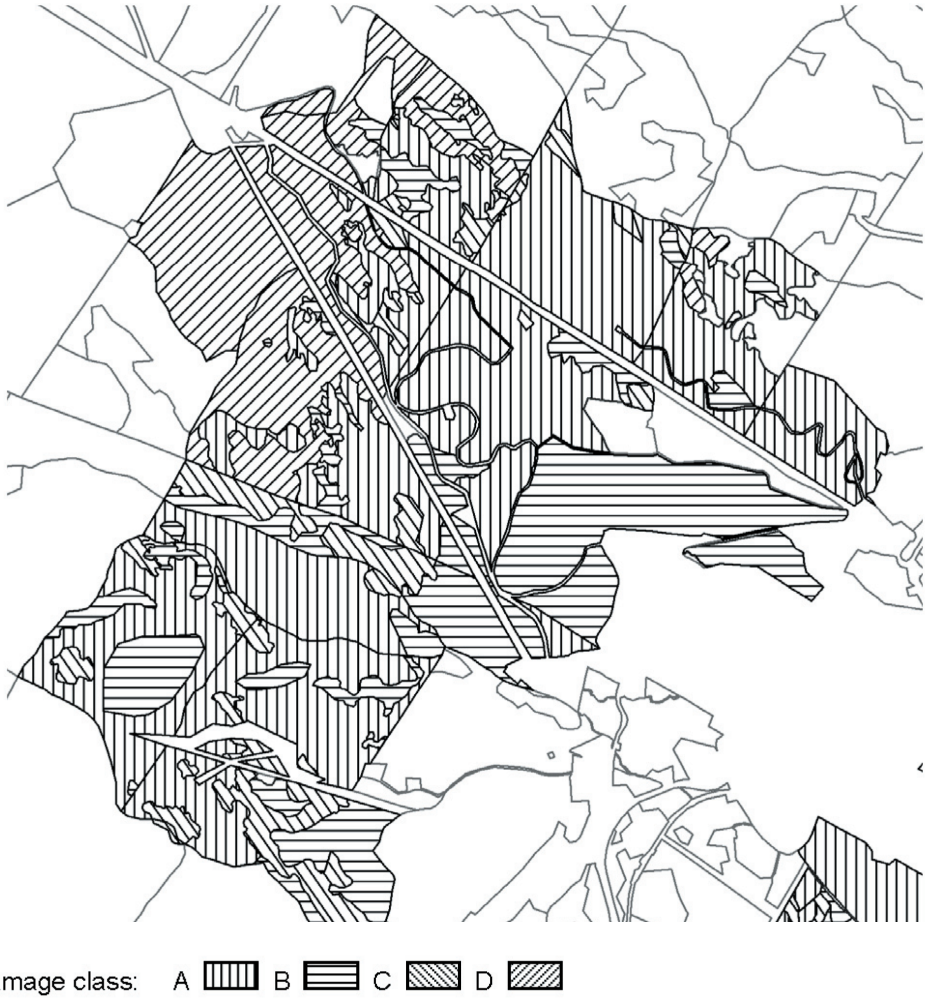


Fig. 1. Damage to selected stands surrounding Tatranská Lomnica (north-western part), according to particular damage classes

slope, curvature and close-to-nature status (see Figure 12 and 13).

The following graphs (Figs 14–17) illustrate terrain characteristics and close-to-nature degree, expressed from the analyzed raster maps in terms of pixel distribution.

Discussion

The GIS software provides with a wide range of possible use in functional evaluation and prediction of ecological detriment (caused by biotic or abiotic factors) to forest stands. However, accuracy of these tools primarily depends on precision of the research method used. The degree of naturalness is a typical example. This parameter is very different in dependence on the author and evaluated element. Another important aspect is the research locality. Final results of analysis are highly influenced by location and characteristics of the research area. Most intensive damage to forest stands was visible in pictures of flat places with south-east aspect, small slope and closest-to-nature forest. This is probably caused by the mentioned location and also with high naturalness of the forest.

Nevertheless, there was elaborated a good methodology for evaluation of forest sustainability. The visibility map shows quite precisely the influence of topography, but for obtaining more precise results it would be necessary to digitize all High Tatra peaks and to create real observation lines. For more precise results, it is necessary to test this method in assessment across a larger area with different geomorfological conditions.

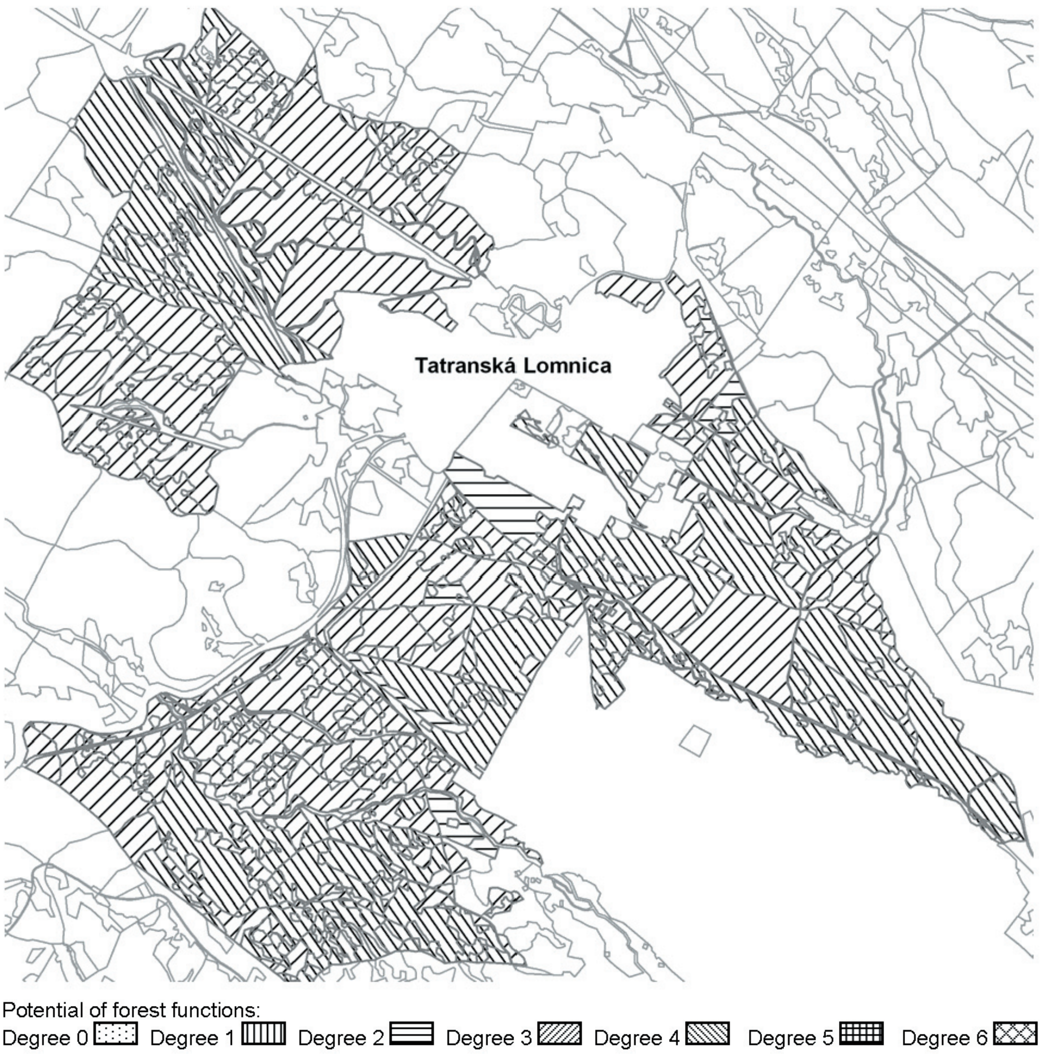


Fig. 2. Real potential of social-recreational function in the model locality Tatranská Lomnica

Acknowledgements

The authors would like to thank the Ministry of Environment of the Czech Republic and Dr. Ladislav Miko for supporting and coordinating this project aimed to helping the destroyed mountain forest ecosystems in the High Tatra Mts. This article writing was supported by the Ministry of Education, Youth and Sports, Project No. MSM6215648902 – "Forest and Wood: the support of functionally integrated forest management and use of wood as a renewable raw material". Research activities were realized within the research plan 04: "Management strategy of a region with the special statute of protection".

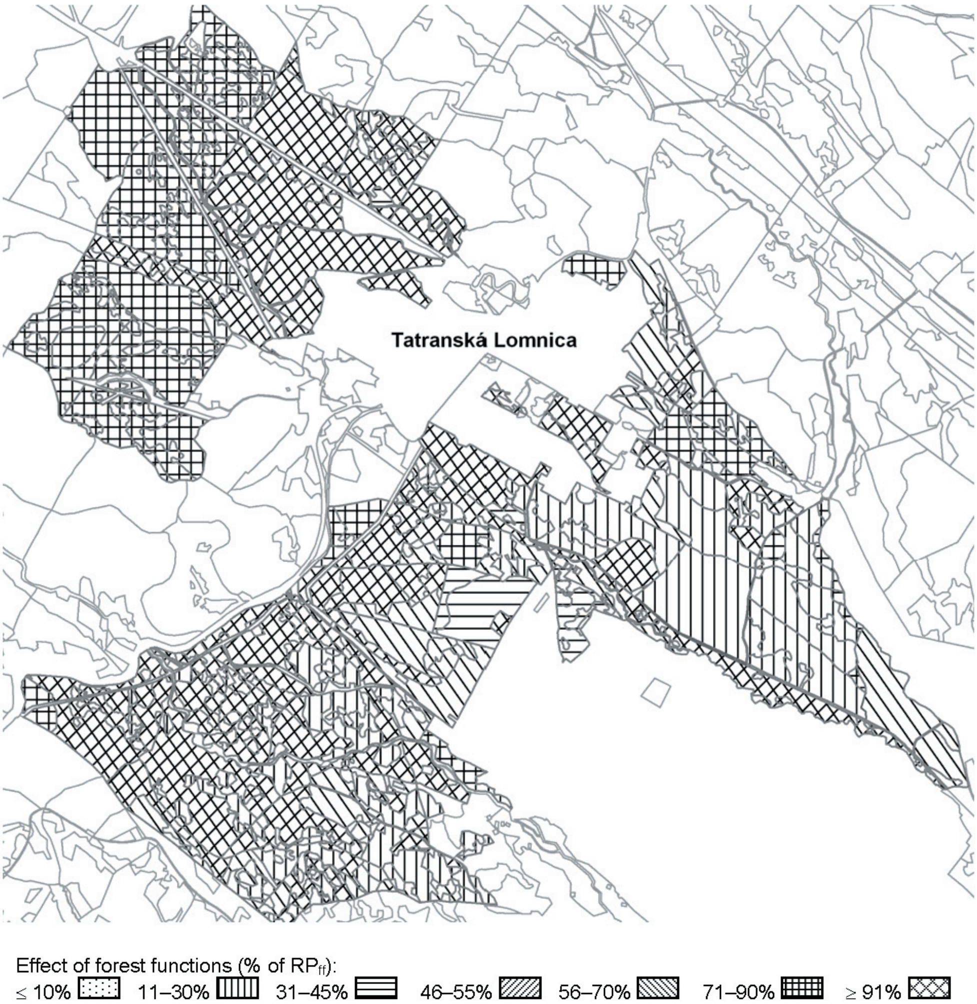


Fig. 3. Real effects of social-recreational function in the model locality Tatranská Lomnica before wind calamity

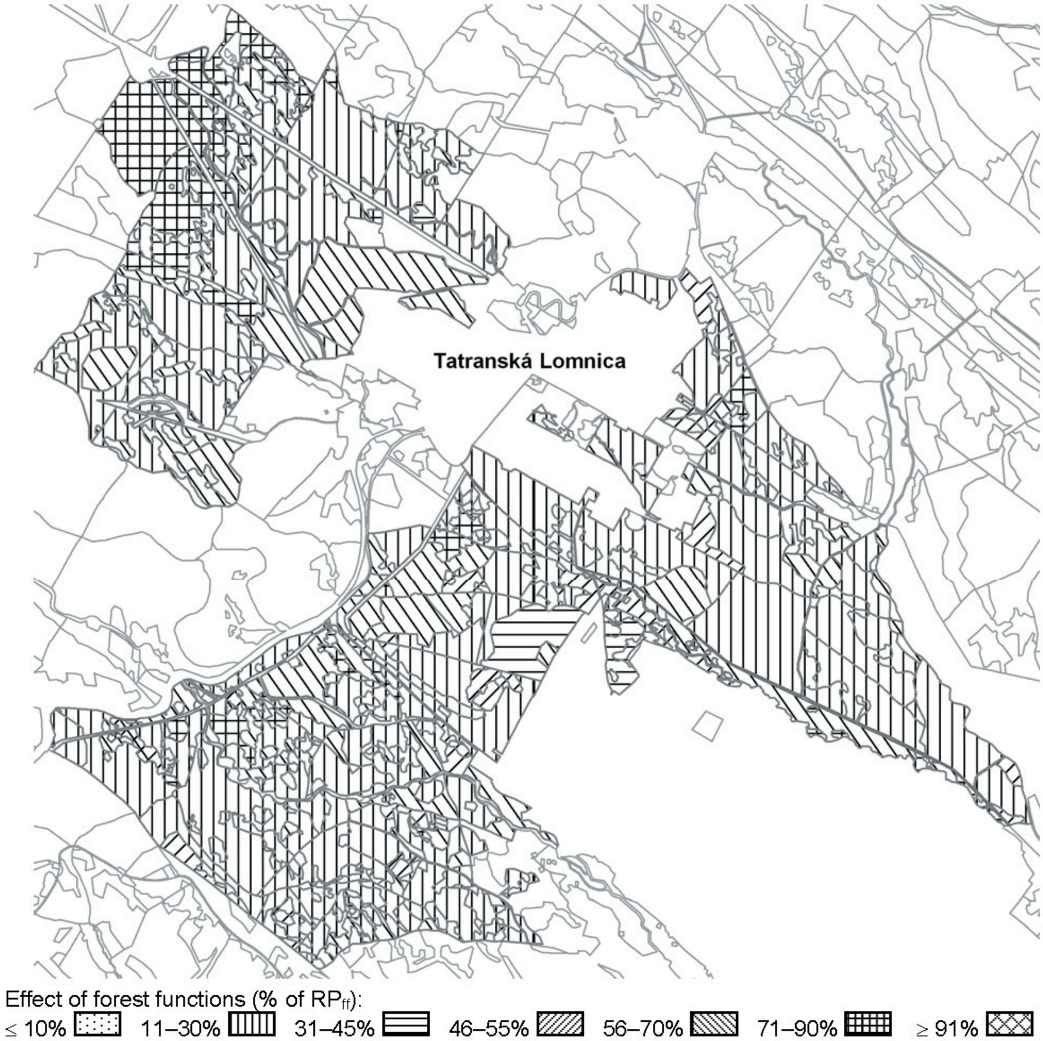


Fig. 4. Real effects of social-recreational function in the model locality Tatranská Lomnica after wind calamity

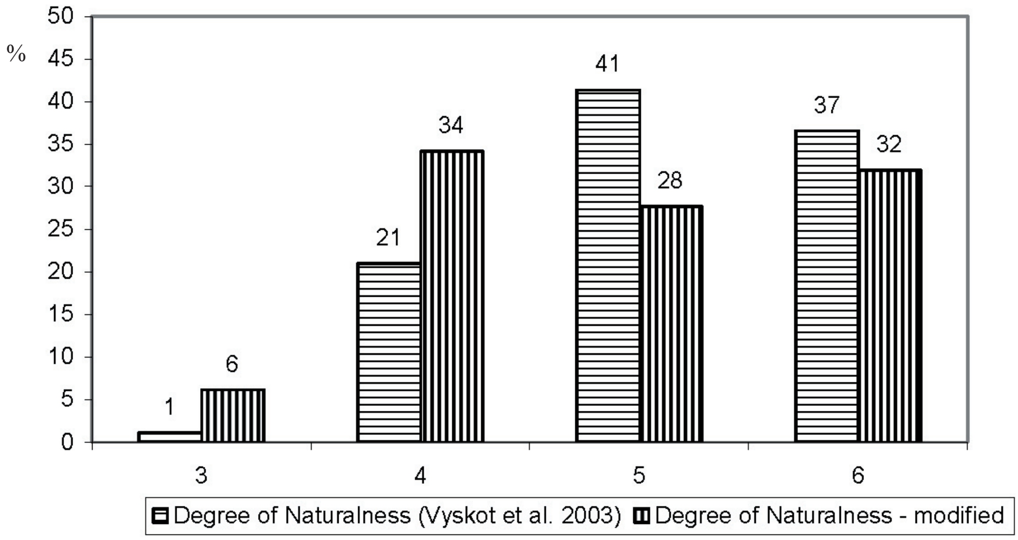


Fig. 5. Distribution of degrees of naturalness according to Vyskot and modified in %

Fig. 6. Aspect (exposition) map of the model locality Tatranská Lomnica

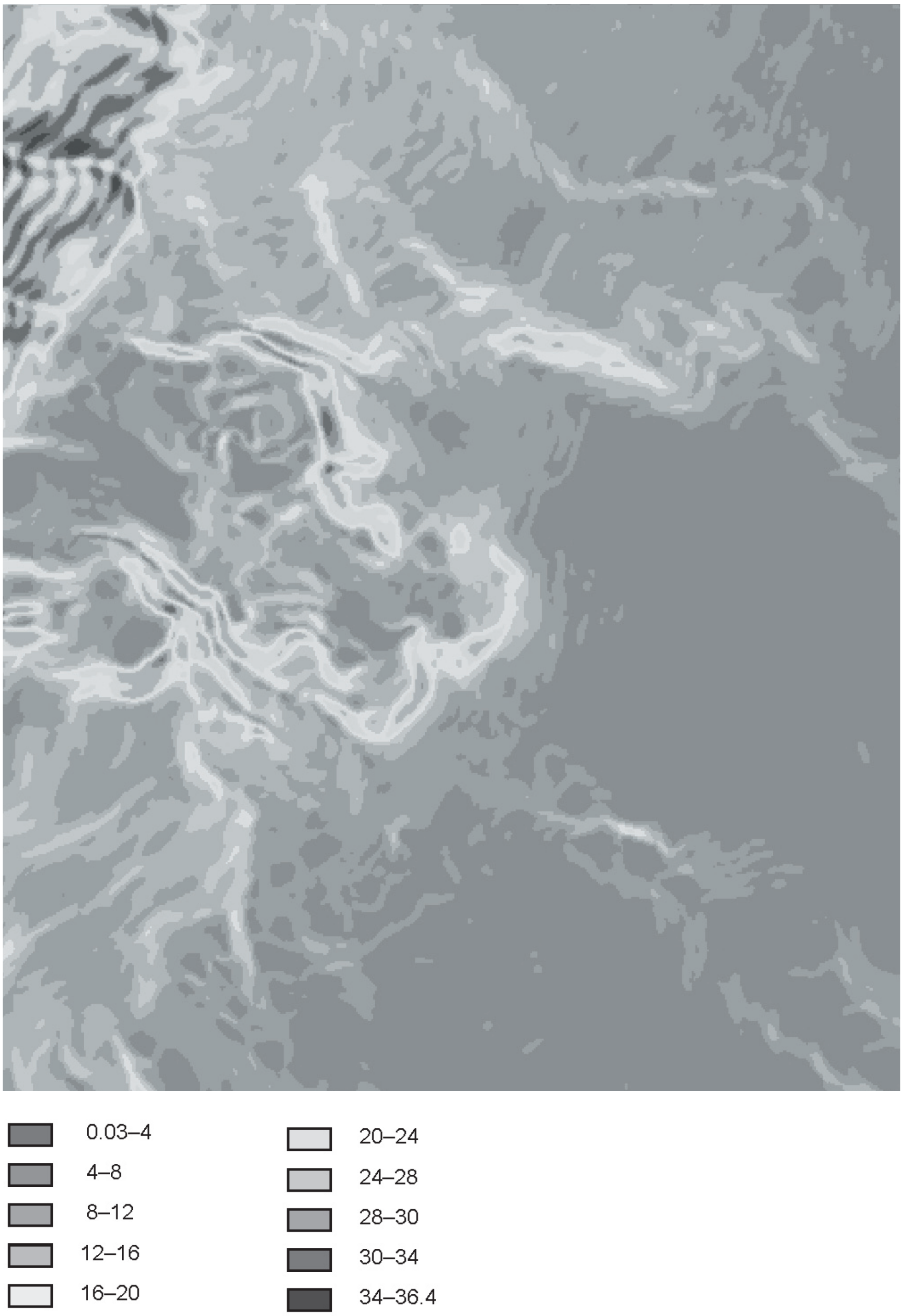


Fig. 7. Slope map in degrees of the model locality Tatranská Lomnica

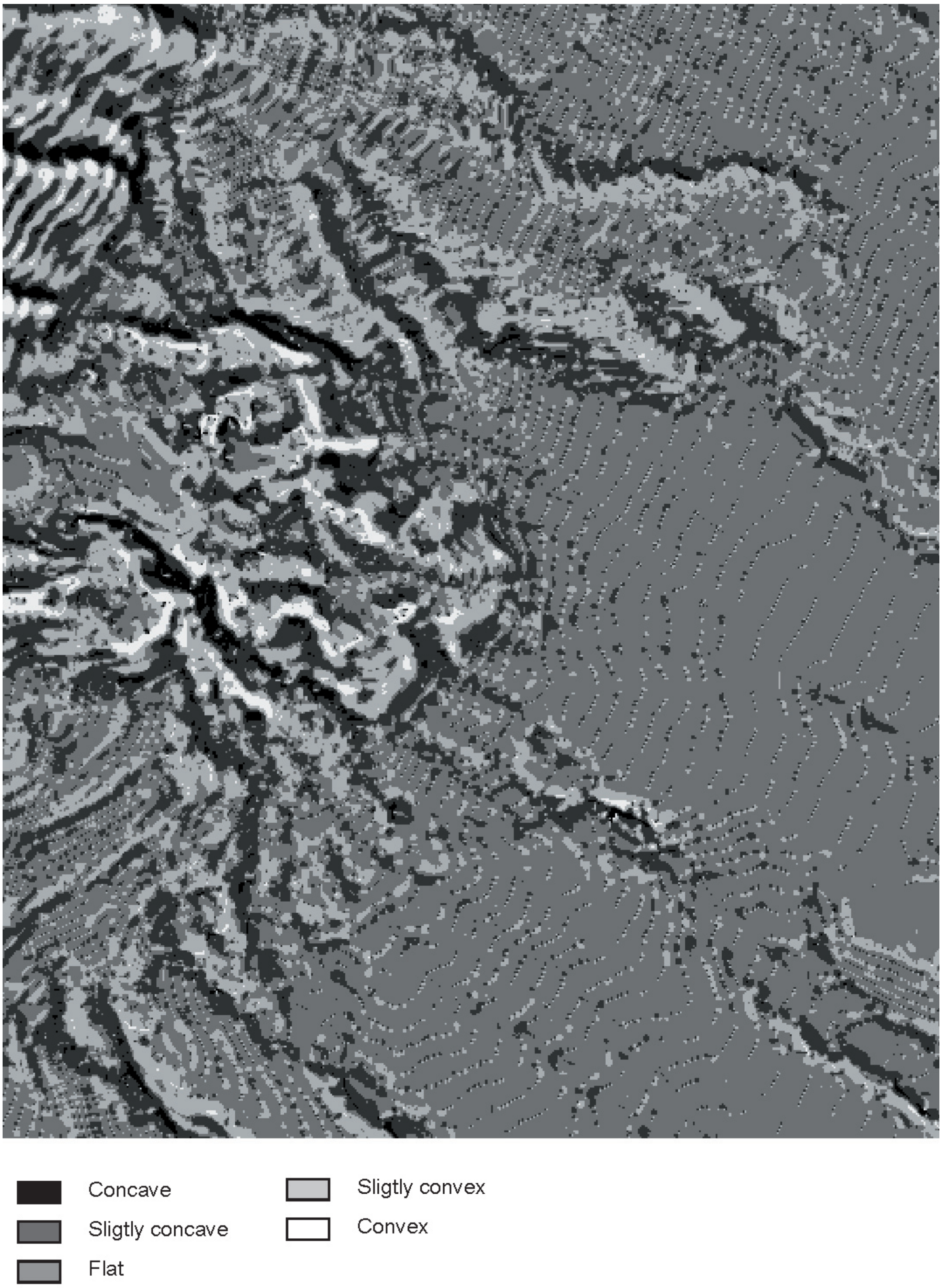


Fig. 8. Curvature map of the model locality Tatranská Lomnica

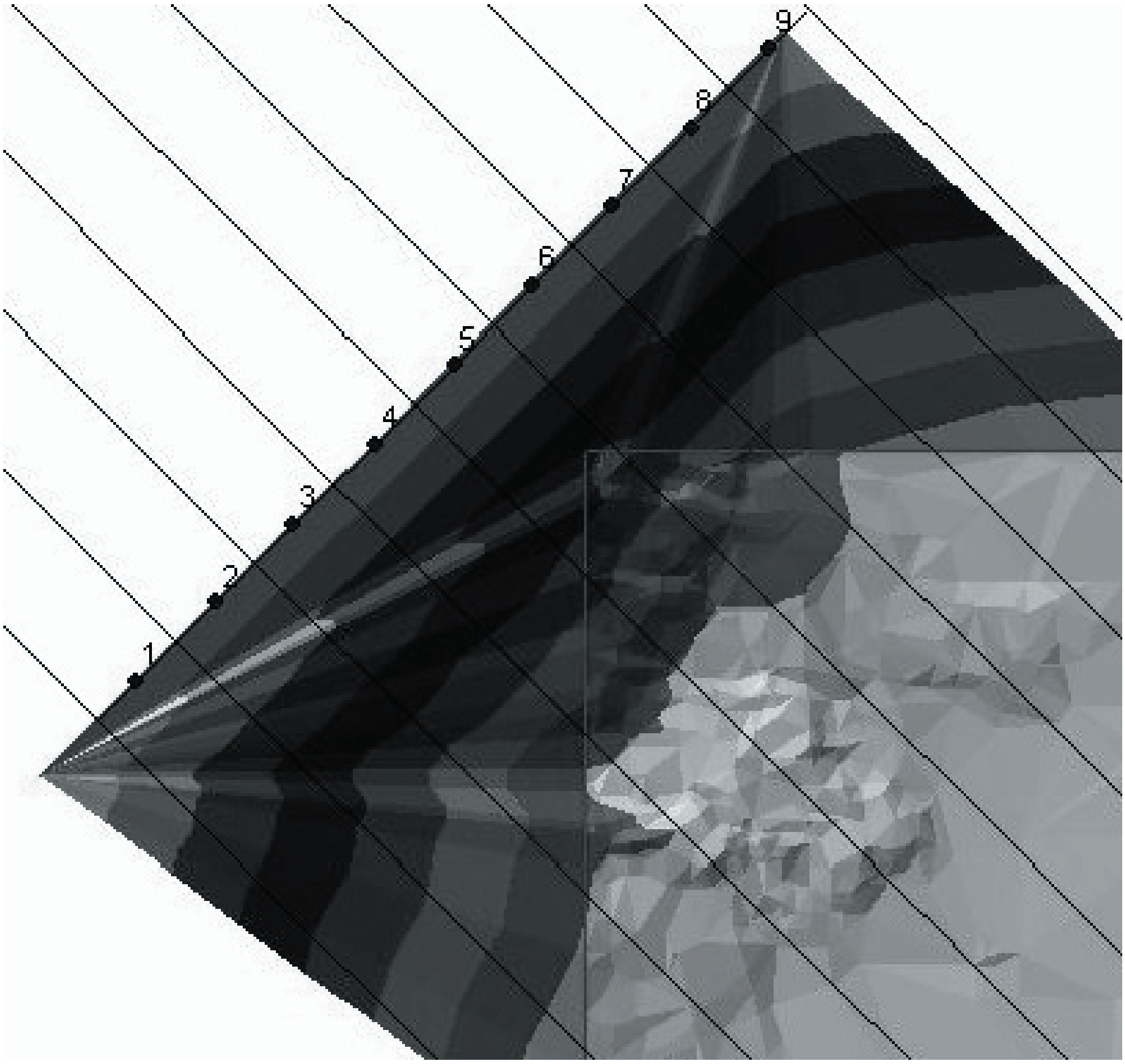


Fig. 9. Creation of Wiewshed Map

Fig. 10. Final Wiewshed Map

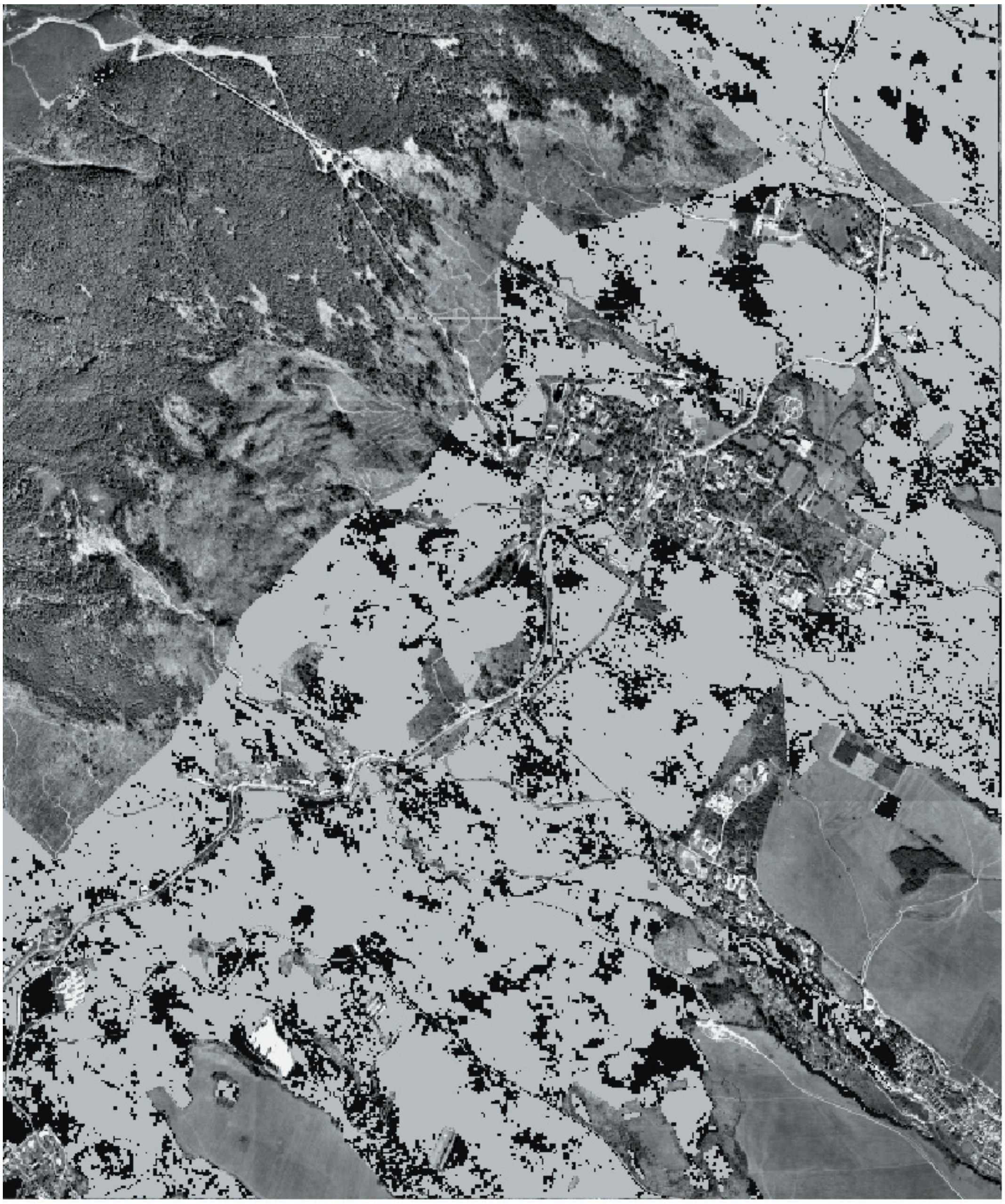


Fig. 11. Map of damage to forest stands

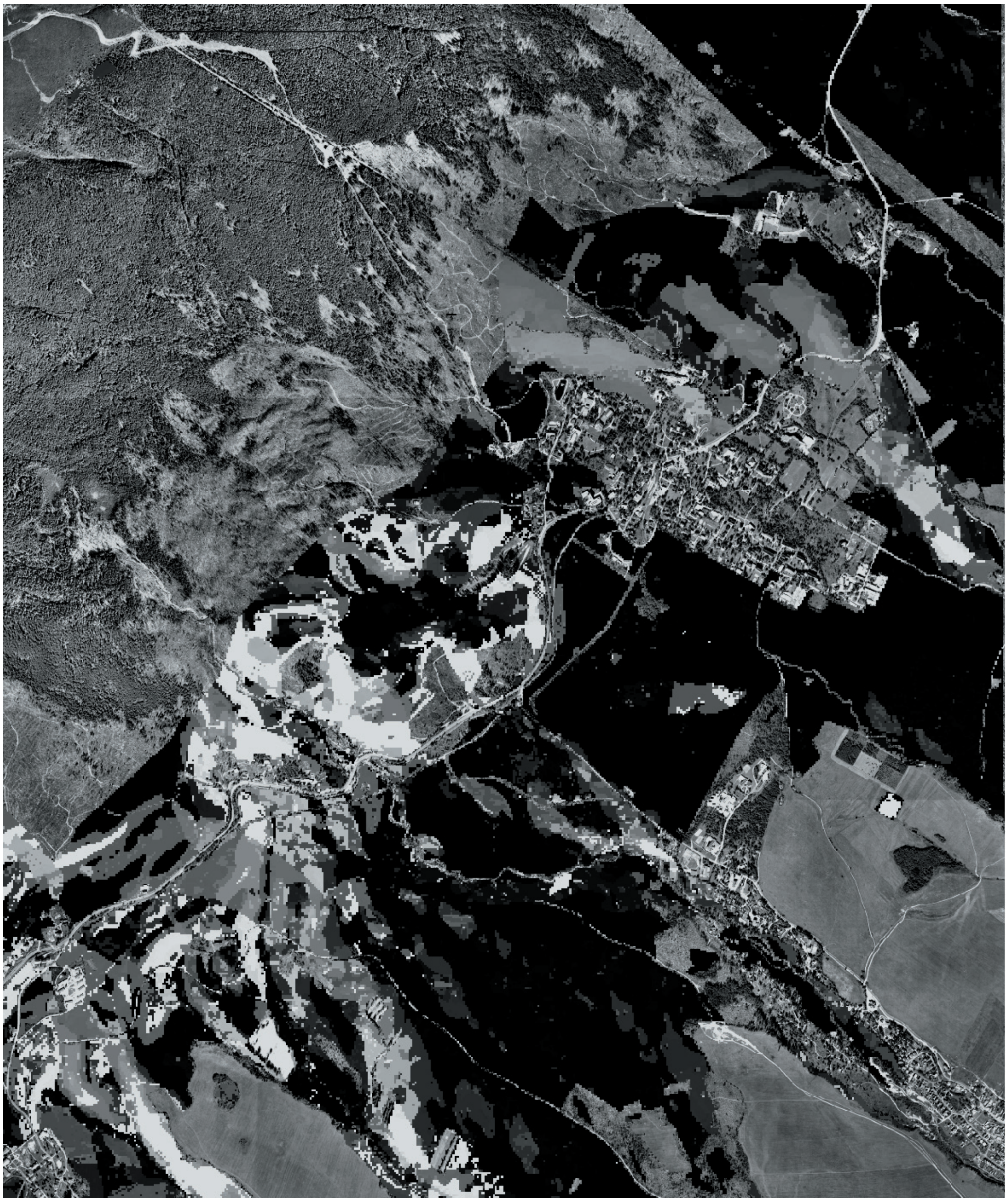
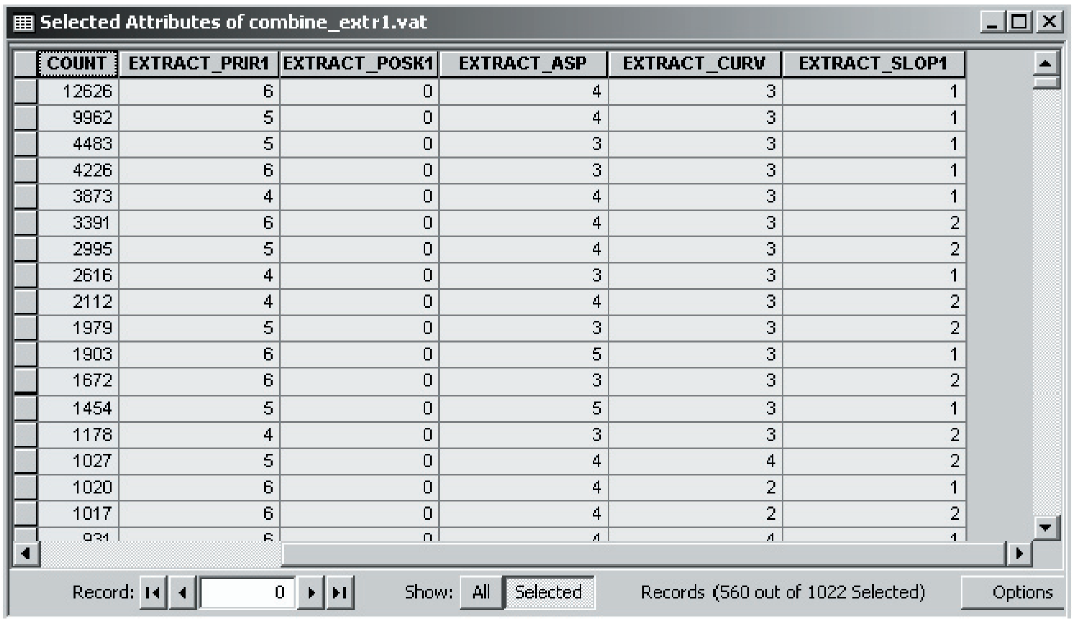


Fig. 12. Combinations of all layers

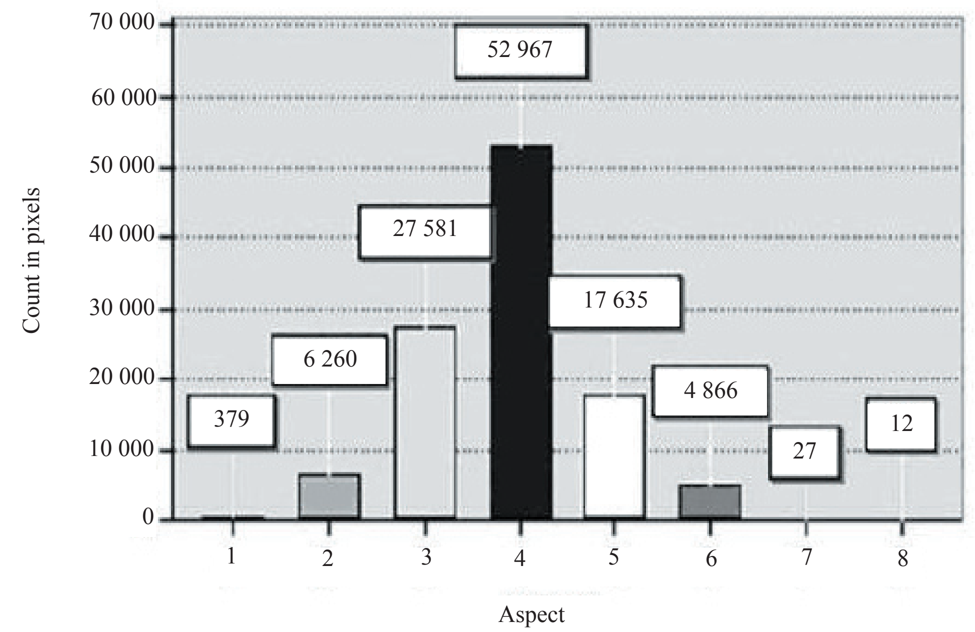


Selected Attributes of combine_extr1.vat

COUNT	EXTRACT_PRIR1	EXTRACT_POSK1	EXTRACT_ASP	EXTRACT_CURV	EXTRACT_SLOP1
12626	6	0	4	3	1
9962	5	0	4	3	1
4483	5	0	3	3	1
4226	6	0	3	3	1
3873	4	0	4	3	1
3391	6	0	4	3	2
2995	5	0	4	3	2
2616	4	0	3	3	1
2112	4	0	4	3	2
1979	5	0	3	3	2
1903	6	0	5	3	1
1672	6	0	3	3	2
1454	5	0	5	3	1
1178	4	0	3	3	2
1027	5	0	4	4	2
1020	6	0	4	2	1
1017	6	0	4	2	2

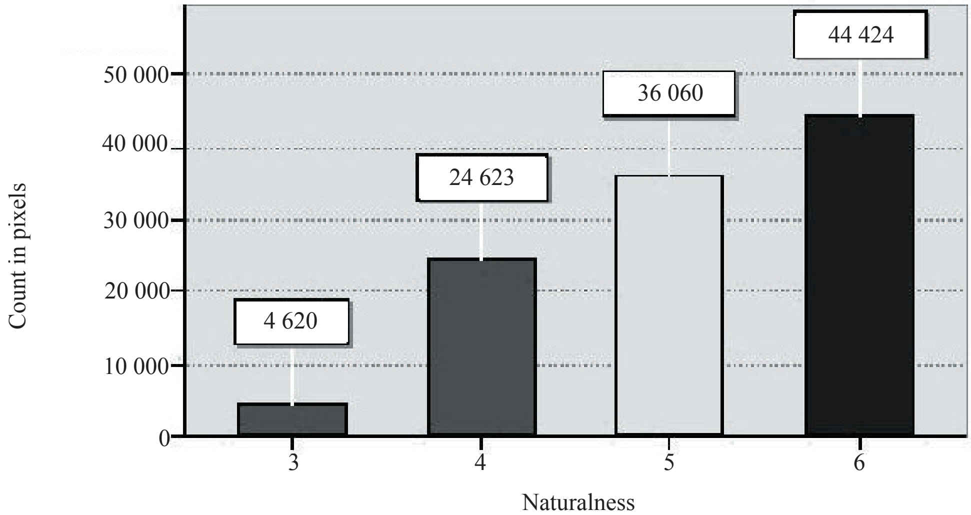
Record: 0 Show: All Selected Records (560 out of 1022 Selected) Options

Fig. 13. Final attribute table of combined data ordered descending by count of pixels expressing the damage class to the forests



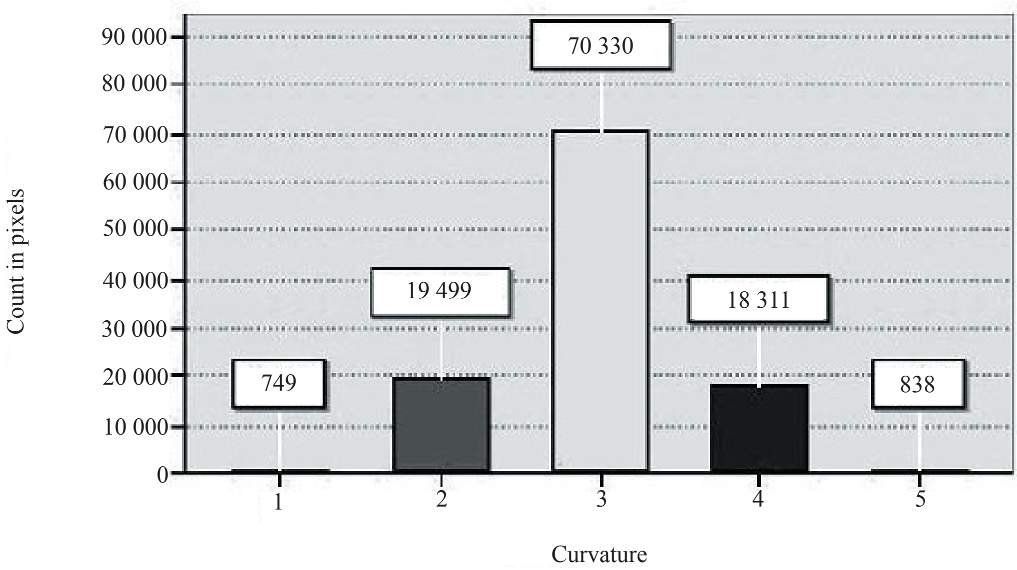
1 – North, 2 – Northeast, 3 – East, 4 – Southeast, 5 – South, 6 – Southwest, 7 – West, 8 – Northwest

Fig. 14. Aspect (exposition) of damaged forest stands in the model locality Tatranská Lomnica



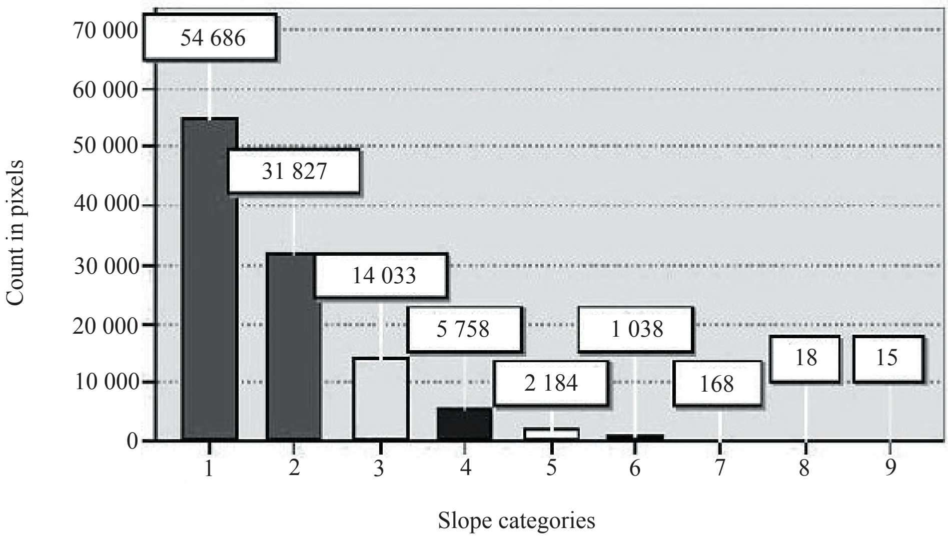
3 – Average, 4 – High, 5 – Very high, 6 – Extraordinary

Fig. 15. Naturalness of damaged forest stands in the model locality Tatranská Lomnica



1 – Concave, 2 – Slightly concave, 3 – Flat, 4 – Slightly convex, 5 – Convex

Fig. 16. Curvature of damaged forest stands in the model locality Tatranská Lomnica



1 – 0 to 4 deg, 2 – 4 to 8 deg, 3 – 8 to 12 deg, 4 – 12 to 16 deg, 5 – 16 to 20 deg, 6 – 20 to 24 deg, 7 – 24 to 28 deg, 8 – 28 to 30 deg, 9 – 30 to 32 deg

Fig. 17. Slope analysis of damaged forest stands in the model locality Tatranská Lomnica

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Možnosti využití GIS pro hodnocení ekologických škod na příkladě větrné kalamity, která proběhla v Národním parku Vysoké Tatry

Souhrn

Článek prezentuje jednu z možností využití geografických informačních systémů (GIS) při hodnocení ekologických škod na příkladě větrné kalamity, která proběhla v Národním parku Vysoké Tatry v listopadu 2004. Do hodnocení byly zahrnuty poškozené lesní porosty v okolí Tiché and Kôprové doliny a obcí Vysoké Tatry a Vyšné Hágy. Poškození lesních porostů bylo kvantifikováno prostřednictvím hodnocení újmy na funkcích lesů metodou Kvantifikace a hodnocení funkcí lesů (Vyskot, I. a kol., 2003), kdy byly jednotlivé lesní porosty zařazovány do tzv. tříd poškození. Prostředí GIS ArcView bylo využito pro parametrizaci vztahu míry poškození lesních porostů větrnou kalamitou a geomorfologických podmínek jejich stanovišť.

Hodnocením stavu lesních porostů a GIS analýzou vztahu mezi geomorfologickými parametry a třídami poškození před a po větrné kalamitě bylo zjištěno:

- zcela poškozeny byly porosty lokalizované na svazích bez výrazných terénních nerovností, jihovýchodní expozice s mírným sklonem 0–8 %,
- na území v okolí Tatranské Lomnice byl prokázán vliv horských štítů a terénních zlomů Vysokých Tater (konkrétně Lomnického štítu a Skalnatého plesa); na prudkých svazích se sklonem nad 20 % pod Skalnatým plesem porosty nebyly významně poškozeny,
- nebyla prokázána přímá závislost mezi stupněm přirozenosti porostů a rozsahem poškození.

Received July 30, 2007
Accepted October 23, 2007