QUANTITATIVE ANALYSIS OF THE LANDSCAPE POTENTIAL FUNCTIONS (SUITABILITIES) OF THE TATRANSKA LOMNICA

MODEL TERRITORY

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The aim for the submitted contribution was focused on presenting an algorithmic system capable to determine the principal features of the investigated territory along with the automation of the functional delimitation evaluation by an automatic computer.

PRINCIPLES OF THE BASIC /PARTIAL/ POTENTIAL FUNCTIONS

The knowledge of the natural and social-economic structure of the model territory was a precondition for the selection of the bas;: /partial/ potential functions on the basis of which the presumptions and possibilities of a various utilization of the chosen part of Slovakia were established. The basic potential function in this sense are understood as space variables. The determination and selection of the basic potential functions is limited primarily by the sensibility of the TATRA NATIONAL PARK /in abbrevation TANAP/ landscape and its hinterland to the anthropis activity and utilization. Their selection represents those possibilities of utilization and thus also loadings of the landscape t; the individual activities which are suitable and permissible for this area without having an deteriorating effect on its structure The authors made attempts to find out and quantify the complex landscape potential functions, and their spatial differentiation in the model territory on the basis of the basic potential functions expressing the landscape's suitability for:

(1)- agricultural production,

(2)- winter recreation,

(3)- water resources,

(4) — social-economic activities,

(5) - summer recreation,

(6) - forest stands,

(7) - road network building-up,

(8)— recreation communications,

(9) - building-up of tourist facilities,

(10) - building-up of health service facilities,

(11) - housing,

(12) — building-up of technical production facilities.

The basic potential functions expressing the partial suitabilities of the landscape to fulfil and satisfy certain functions and needs of the society allow not only an easier determination -f their limiting values but also an easier spatial differentiation and quantification of them. Such a structure of the landscape's potential functions enables the scientific worker to solve by means of mathematical techniques questions of the priority and hierarchy of the potential functions in the sense of their realization, i.e. in the sense of the landscape's functio- nal utilization.

According to Drdos et al. /1980/ the evaluation plain of the diagnosis of the landscape represents the knowledge and evaluation :f the landscape potential function. The individual basic potential functions, qualitatively determined and spatially differentiated by Mazur et al. /1979/ and maps of Drdos /landscape's suitability for winter recreation, summer recreation, road network building-up, recreation communications, forest stands/ and *naps* of Huba /delimitation of the landscape - natural and landscape protection/ the authors quantified by applying the bal-method in the sense of the studies published by liuchina /1973, 1974/ and Armand /19 75/.

The quantification of the individual basic potential functions, the determination of their bal-scale were dependent on both the number of the limiting factors and the effect of other negative factors on the basis of which a more detailed differentiation and more accurate results were obtained in comparison with the results obtained by the afore-mentioned authors.

(1) The landscape's suitability for agricultural production was the model territory expressed by three basic qualities. The area not suitable for agricultural production was qualified with the 0 value and that suitable with the bal-value 2.

(2) The suitability for winter recreation /especially skiing/ was spatially differentiated with 5 qualities. Quality 0 received areas with unsuitable conditions for skiing and quality 4 areas with most suitable conditions for skiing. As negative, resp. limiting factors were evaluated unsuitable relief conditions, possible avalanches, vegetation and land coverage.

(3) The landscape's suitability in regard to possible water resources and thus regular water supply was evaluated in 5 quality degrees. The lowest 0 quality degree characterized flysh and granite substrates compared with the quality degree 4 characterizing riverines with rich water resources.

(4) The suitability for social-economic activities was evaluated on the basis of the protected differentiated landscape types designed by M. Huba. six qualitatively different protection categories were evaluated. Bal-value 0 received the most protected category of landscape without any social-economic activity. From the standpoint of the landscape protection the bal-value 5 received the at least protected spaces. This basic potential function thus also indicates the sensibility of the landscape types to the social-economic activity which of course is understood in a limited extent, in the sense of the permissibility and needs of the TANAP and its protected hinterland.

(5) The suitability for the summer recreation is expressed in 5 bal-values as follows: least value, i.e. 0 value - arable land, highest value 5 - landscape characterized by the High Tatra mountain lakes. As regards the forested areas they were separated into the submountain and brook rich group which were given higher values than to the adjacent forest.

(6) The potential function of the forested areas, respecting the criteria of the forest protection was expressed in 3 categories. Unsuitable areas /dwarfed pines and alpine folding/ received value 0, suitable conditions in the TANAP - forest area understood in the sense of permissible human interventions were given the value of 1 bal and areas spreading in the protected zone were classified with the value 2.

(7) The landscape's suitability for the possible building-up of a road network was evaluated on the basis of the landscape system sensibility and the real structure of the landscape and followingly expressed by 4 categories. In the 0 category were areas unsuitable for the building-up of roads, in the highest 3 category were areas fully meeting the requirements for road network building-up.

(8) The potential function and its suitability for building-up recreation communications respects to a high extent the attractivity of the landscape and is differentiated by 3 qualities /0 - bal unsuitable, 2 - bal very suitable/.

(9) The suitability of the landscape's potential function in regard to the building-up of various tourist facilities was expressed by 2 basic categories. Landscape characterized by very limited and unsuitable conditions was

divided into 9 subtypes and the second type with moderately limited and suitable conditions for the building-up of tourist facilities has 3 subtypes. This scale was generalized in 6 degrees on the scale 0-5 bals (unsuitable - very suitable conditions).

(l0) The suitability for building-up new health curing facilities /medical institutions, sanatoriums, etc./ reflected by the natural-climatic conditions was evaluated on the basis of the climate functional types - map of K. Tarábek. The scale had 4 values (0 - unsuitable, 3 - very suitable conditions).

(11) With regard to the landscape's suitability for housing we proceeded in the quantification and differentiation as in the case of the tourist facilities building-up. A 4 bal evaluation from 0 to 3 was used taking into consideration also the landscape protecting criteria, the present structure of the landscape along with the real requirements and needs of the whole society.

(12) The suitability for building-up of technical production facilities was considered in connection with the real needs taking into account also the economical facilities directly connected with the agricultural production. Only 2 values were used (0 - unsuitable, 1 - suitable conditions).

In order to be able to process the obtained data in an automatic computer it is necessary that the data be available in the form of discrete numerical values; this can be achieved by dividing the model territory into squares. Another geometric network may also be used, however in regard to an all automatized evaluation and drawing of maps by the computer's printing device the application of the square network proved to be the most suitable. At first the network was used in the data bank of the Slovakia territory, now built at Geographical Institute of the Slovak Academy of Sciences /SAV/, with a 1 km side. In order to obtain a more accurate final graphical representation of the model territory and a more accurate spatial differentiation the territory was divided in a regular network of squares /side 500 m/. Thus 416 squares /area 104 km^2/ were obtained.

METHOD OF DATA PROCESSING

In the complex evaluation of the landscape potential function /suitability/ the principal component analysis /PCA/ were used with the aim to find the principal /key/ and yet independent components of the landscape potential function. The R procedure with the varimax rotation was applied. The obtained components are in substance new, each other independent, complex variables. Each of these variables may express up to two complex indirectly dependent properties - bound with either the positive resp. negative orientation of the component loadings.

In the determination of the key functions of the particular area /territorial units/ we start with the component score and the assumption that each territorial unit must have at least one function /must be utilizable at least for one purpose/.

Let be $C_i – (c_{i1}, c_{i2} \dots\ c_{ir})$ the image of an i – th territorial unit in the r-dimensional space of the new component dimensions /i.e. the component score/. Then we design a new c` score expressing in it also the negatively oriented interpretable signs of the components, i.e. $C`_i – (c`_{i1}, -c`_{i1}, c`_{i2}, -c`_{i2}, \dots\ c`_{ir}, -c`_{ir})$. By arranging the component score for each territorial unit from the highest to the lowest positive score we get the arrangement of u the functions of the territorial units from the most significant to the almost insignificant functions. Many values of the component score however are very low and thus do not represent the real significant feature /sign/ of the territorial unit. The number of the principal signs of each territorial unit is limited by the criterion obtained from the postulate that each territorial unit must be utilizable at least for one purpose. The criterion represents the value P calculated from the equation /l/:

$$P = \min \left\| \max \left| abs(c_{ij}) \right|\ _{j=1}^{r} \right\|\ _{i=1}^{k}, \qquad /l/$$

where *r* is the number of components,

k the number of territorial units.

The territorial unit 1 will have as much principal /key/ signs as many values of the vector C_i will be larger or equal to the P value. Because the sequence of the principal sign of each territorial unit is now known, we are able to use the maps of the functional delimitation according to the priority, secondary and other supplementary functions. The described procedure is explicated in more details in the study published by Poláčik and Oťaheľ /1979/.

PROCEDURE APPLICATION IN THE MODEL TERRITORY

Analytical results obtained from maps and available data confirm that the basic potential functions /l/ - /12/ depend one on the other as proved by the correlation matrix for PCA.

Between the potential functions /suitabilities/ there exist strong correlation bonds /e.g. the pairs /9/ and /ll/, /4/ and */I/* and /6/ and */10//*. These strong correlations indicate that these potential functions carry many equal informations which can be integrated into new complex variables - components. From the correlation matrix 3 principal components were extracted which reflect the basic structure of the model territory functional potential /its suitability/. The matrix of the component loadings is in Table 2.

Table 1. Correlation matrix /1 /-/12/ [$r_{ij} \geq$ abs (± 0.30)]

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
1	1.00											
2		1.00										
3			1.00									
4	0.74		0.51	1.00								
5	-0.69			-0.64	1.00							
6	-0.40		0.39		0.46	1.00						
7	0.75		0.48	0.90	-0.63		1.00					
8	-0.70		-0.34	-0.87	0.66		-0.83	1.00				
9	0.73	0.30		0.77	-0.66		0.87	-0.73	1.00			
10	-0.49				0.47	0.55	-0.35		-0.52	1.00		
11	0.74			0.76	-0.67		0.86	-0.74	0.95	-0.54	1.00	
12				0.30	-0.39		0.30	-0.31				1.00

Table 2. Principal components matrix /loadings≥ abs (±0.40|/

	Comp. 1	Comp. 2	Comp.3
7	0.96		
4	0.93		
9	0.91		
11	0.91		
1	0.82		
3	0.48	0.68	
6		0.86	
10		0.78	
5	-0.71	0.45	
8	-0.89		
2			0.79
12			-0.64

Component 1

This dimension condensates on one side the potential functions /suitabilities/ in the following order:

/7/ - road network building-up /comp. loading +0.96/

/4/ - social-economic activity /comp. loading +0.93/

/11/ - housing / comp. loading +0.91/

/9/ - tourist facilities building-up /comp. loading +0.91/

/l/ - agricultural production /comp. loading +0.83/

and on the other side

/8/ - recreation communications /comp. loading -0.89/

/5/ - summer recreation /comp. loading -0.71/

Following judgment of the character of the basic potentials /7/, /4/, /11/, /9/, /l/ resp. /8/ and /5/ we may this complex variable define as the complexity of the social-economic activity and on the other side the complexity of the summer recreation. The component clearly indicates the indirect dependence between the suitability of the landscape for the social-economic activities and the summer recreation.

Component 2

The component replaces the basic potential functions /suitabilities/ in the order:

/6/ - forest stands /comp. loading +0.85/

/10/ - building-up of medical institutions /comp. loading +0.78/

/3/ - water resources /comp. loading +0.68/

This complex variable might be defined as the dimension of the specific potential functions because they are the key basic potential functions that indicate the quality and the significance of the model territory.

Because of the magnitude of the component loadings with an opposite sign it is impossible to define the component in the' sense of this orientation; this fact also proves the uniqueness of this series of the basic potential functions and of the whole complexity.

Component 3

The interpretation of this component is the most simple. On one side it expresses the potential function /landscape's suitability/ for the winter recreation /2/ - comp. loading + 0.79 and on the other side the building-up of technical production facilities /12/ - comp. loading - 0.64. Unlike the basic potential functions these potential functions develop a new gradation.

EVALUATION OF THE FUNCTIONAL DELIMITATION OF THE MODEL TERRITORY

The components are expressing the complex potential function which in the territorial projection are considered by the suitabilities of the functional utilization of the territory. From three components 5 interpretable independent and indirectly independent functions were obtained.

Map 1 illustrates the delimitation of the territory according to the dominant functions and thus it is the graphical representation of the component score maximum values obtained for each territorial unit.

Map 2 and 3 show the delimitation of the territory according to the supplementary functions /the second and third largest value of the component score in each territorial unit/. The criterion limiting the number of the functions has the value 0.6 /*P* - 0.6/ in this set.

The northwestern part of the territory is primarily suitable /see Map 1/ for both the summer and winter recreation. The mid- -zone spreading from southwest to northeast has a first class complex potential of specific functions and the southeastern part of the model territory is primarily suitable for the social-economic activity corresponding to this territory, i.e. such inactivity which in the chorological direction has no detrimental effect in the landscape.

The second map in continuity of Map 1 illustrates that some parts of the model territory are characterized by an already depleted function - they are monofunctional, especially in the northwestern part where large areas are suitable only for the summer recreation. Those territories which were suitable primarily for the winter recreation can be utilized also for the summer recreation. The central zone of forests with specific functions /water resources, forest stands and curing/ is suitable for the summer recreation. The southeastern part has a supplementary function to the social-economic activity - the winter recreation /is utilizable for winter recreation/.

Map 3 contains information on another possibility of utilizing certain parts of the area and confirms that the central forested zone can be utilized also for the winter recreation. It is obviously and functionally the most suitable and valuable part of the model territory and therefore also maximum protection should be provided for it.

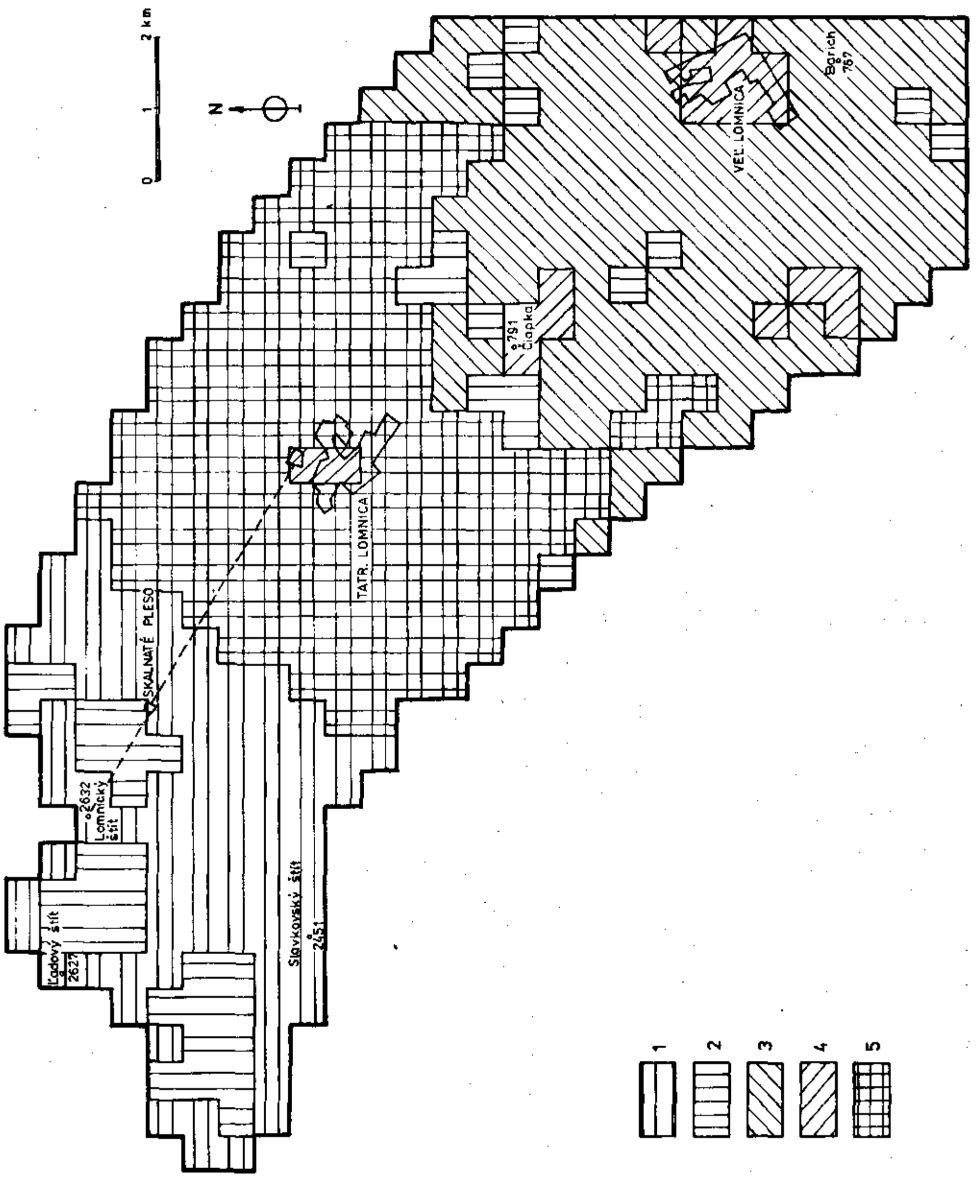

Fig. 1. The functional delimitation according to the principal /preferential/ potential. 1 - The landscape potential /suitability/ for summer recreation; 2 - the landscape potential for winter recreation; 3 - the landscape potential for social-economic activities; 4 - the landscape potential for building-up of technical production facilities; 5 - the landscape potential for specific activities.

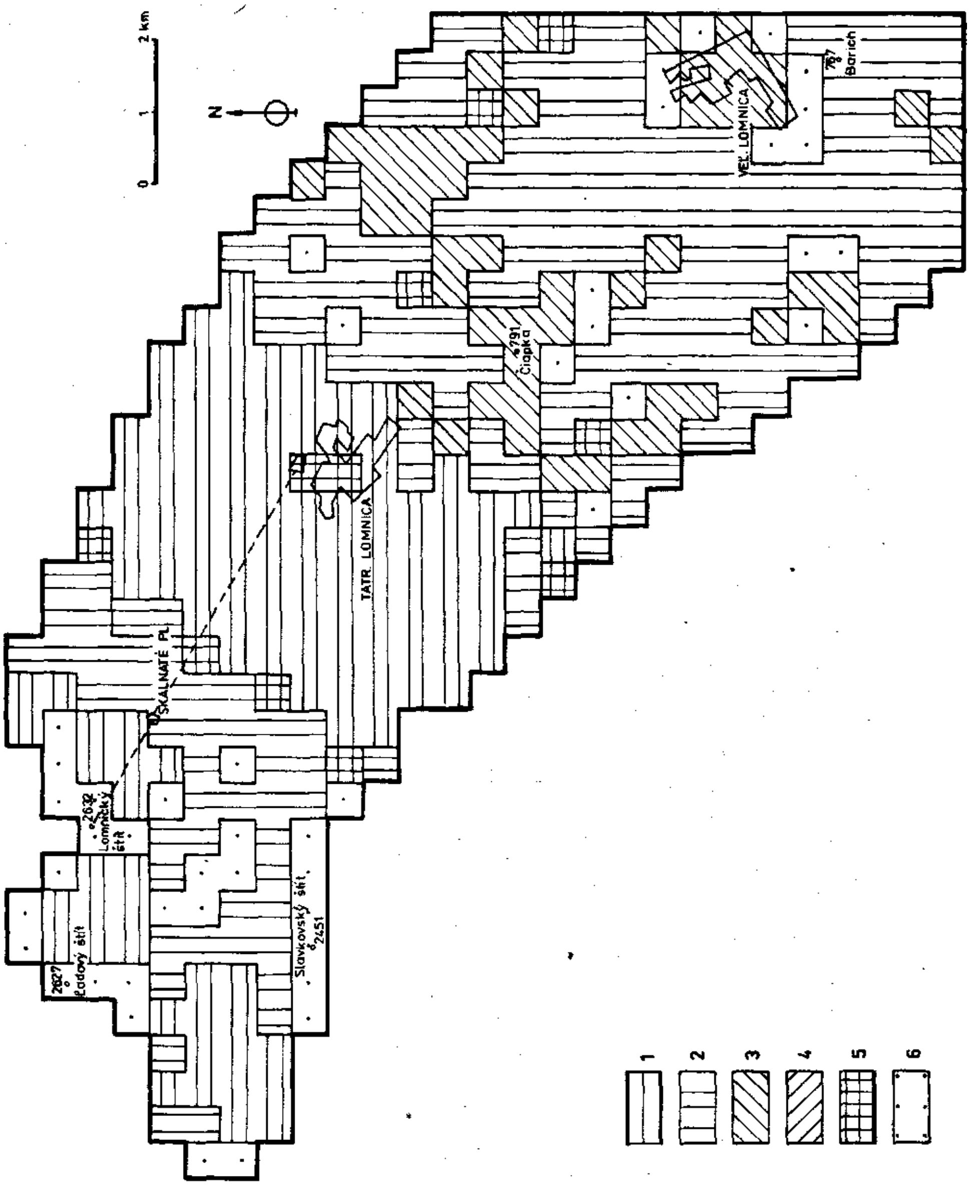

Fig. 2. The functional delimitation according to the second-rate potential. 1 - the landscape potential for summer recreation; 2 - the landscape potential for winter recreation; 3 - the landscape potential for social-economic activities; 4 - the landscape potential for building-up of technical production facilities; 5 - the landscape potential for specific activities; 6 - the monofunctional area /the area hasn't second-rate potential/.

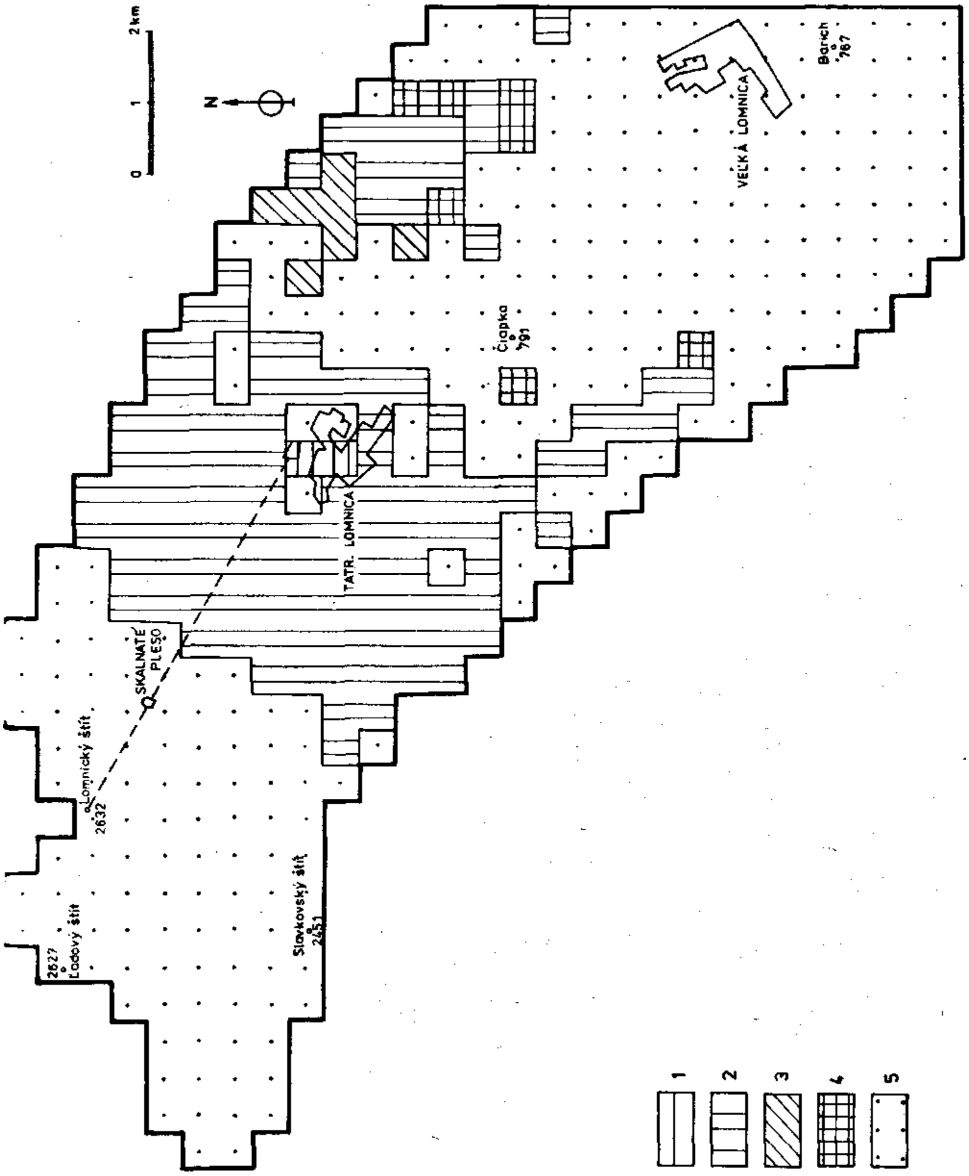

Fig. 3. The functional delimitation according to the third-rate /supplemental/ potential. 1 - the landscape potential for summer recreation; 2 - the landscape potential for winter recreation; 3 - the landscape potential for social-economic activities; 4 - the landscape potential for specific activities; 5 - the monofunctional or bifunctional area.

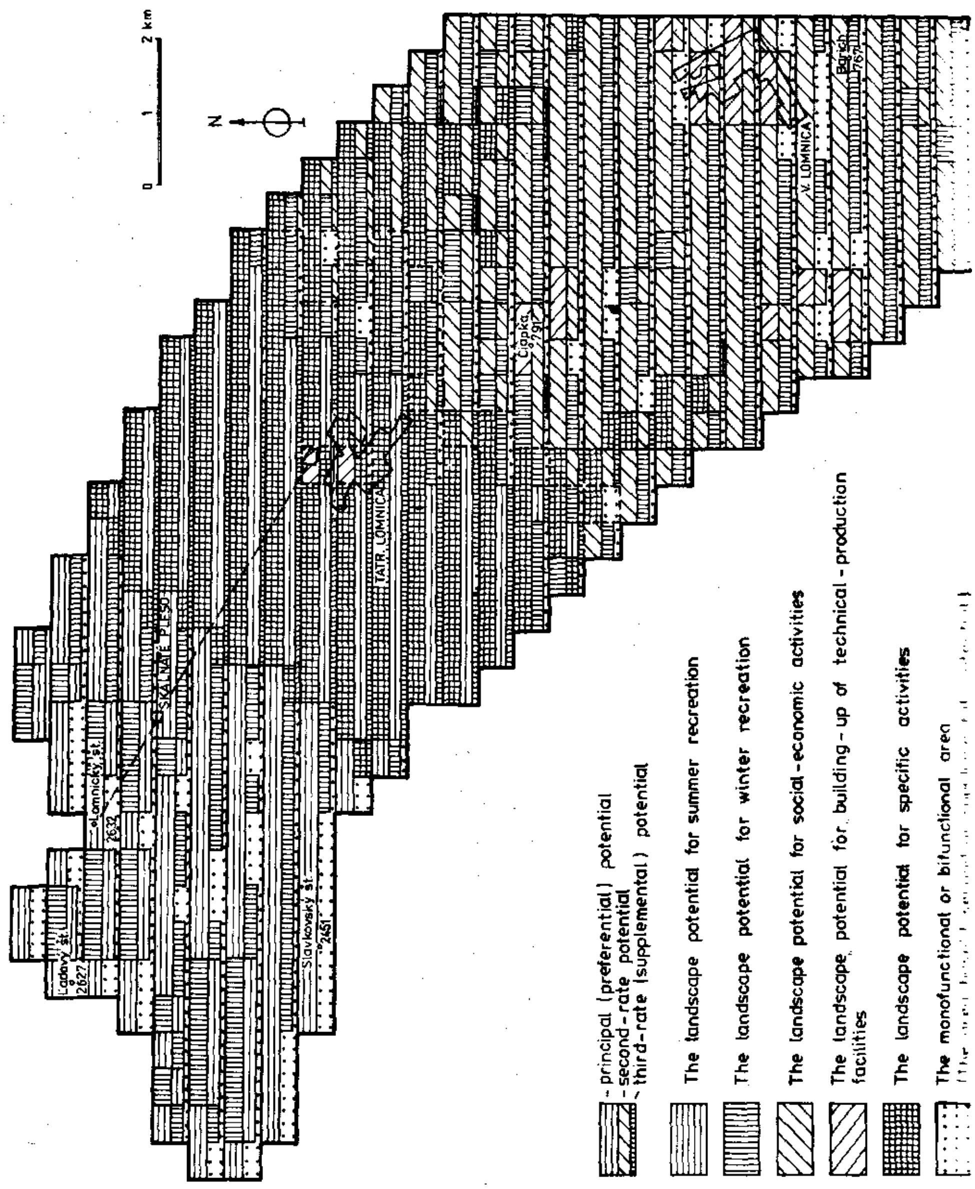

Fig. 4. The hierarchy of potentials of the experimental area 1.- a/ principal /preferential/ potential, b/ second-rate potential, c/ third-rate /supplemental/ potential, 2 - the landscape potential for summer recreation; 3 - the landscape potential for winter recreation; 4 - the landscape potential for social-economic activities; 5 - the landscape potential for building-up of technical production facilies; 6 - the landscape potential for specific activities; 7 - the monofunctional or bifunctional area /the area hasn` t second or supplemental potential/.

Map 4 is a synthesis of Maps 1-3. In each territorial unit are illustrated the functions with regard to their importance. On the map can be seen also an area needing more protection. The territories are suitable only for the summer and winter recreation resp. they are characterized by the specific functions /cf. Map 2/ i.e. not even on one level of the functional delimitation -.hey are suitable for the building-up of technical production facilities and the social-economic activity.

CONCLUSION

The method described in this contribution is able:

a/ to find the principal signs of the territory potential function as a complexity of definite basic potential functions;

b/ the all-automatized transition from input numerical data to the functional delimitation of the territory;

c/ provides the base for the planning activity in the landscape through identification of the hierarchy of functions of an arbitrary area within the observed area.

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