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ISOECOLOGICAL CURVES ON CHARACTERISING THE ECOTYPES IN CENTRAL MECSEK MTS OF HUNGARY

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Ecological indicator values, widely used in botany, are empirical scales worked out for the most important factors. Values of environmental factors determine the position of the vegetation units in a multidimensional abstract space. Their latest version in Hungary is the category system of Borhidi (1995), which is adjusted to the European systems (e.g. Ellenberg et al. 1992). Indicator values or categories, respectively, can be found, according to European practice, in a relational computerised database (Horváth et al. 1995) which is accepted as a standard for the botanists.

An example of isoline analysis, completed using ecological indicator values of vegetation samples, is presented on a model area in Mecsek Mts of South Hungary. It has varied vegetation with diverse kinds of human interference near Pécs. From the existing indicator values we applied here temperature (TB), water demand (WB) of plants and soil reaction (RB). Each single isocurve was constructed from the similar indicator values on a computerised way (Surfer 6.1). All the curves were made by the use of averages, single values and certain groups of ecological indicator values. Only the figures made by the averages are presented here, because there is no additional information in the case of the use of single curves.

Curves of temperature and water indicators (isoTB, isoWB) show climatic conditions changed by human impact. Curves of soil reaction (isoR) show in a given moment the actual vegetation, in time dimension that parts of environment which are more sensitive to acidification.

Analysing isoecological curves, human impact is easily recognisable (e.g. in the surroundings of clear-cuttings, etc.). On the basis of our results added to a monitoring system environmental impacts of future industrial and forestry establishments can be modelled. Isolines, using above-mentioned indicator values help to reveal and quantify environmental change, which is model-valued possibility for preparing environmental impact studies and making quick decisions.

Key words: ecological indicator values (TB, WB, RB), Kriging methods, isolines (isoT, isoW, isoR)

INTRODUCTION

Human interference changes the existing natural environment-tolerance relations. During determination of trends of changes we can refer to a base state and its successional changes considered as natural. Relative ecologi-

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cal indicator categories are quantitative representatives of natural impact factors. Based on a great amount of field observations and partly on measurements, they arrange species on an ordinal scale (Meusel 1943, Pogrebnjak 1929/30, Iversen 1936, Vorobjov 1953, Walter 1951, Tüxen and Ellenberg 1937, Ellenberg 1939, 1950, 1952, 1954, 1974). Most widely used characteristics of plant species are their presence or absence and their dominance relations. In Hungary Soó (1964–80) and Zólyomi et al. (1967) applied first Ellenberg's (1952, 1954) ecological indicator values. Revision of these ecological indicator values (TWR) and their extension to the whole Hungarian flora were completed by Zólyomi, Horánszky and Simon (in Simon 1992). A new adaptation of the Ellenberg scale (Ellenberg et al. 1992) and elaboration of new indices (Borhidi 1995) show a growing interest for bioindication and an ever increasing demand for practical application.

Since long is known that on polluted, by human activities influenced areas certain species disappear, others appear, so with their presence or absence species indicate human impact. It can be observed as degradation of vegetation; so changes in the local flora can be considered as a measure of human impact. One group of phytoindicator values are ecological indicator values worked out for determination of natural ecological state (e.g. TWR); some of them is available for representing degradation.

In the international practice in our days appear more and more computerised ecological models for description of phenological properties of vegetation. Determining units of vegetation are usually connected with remote sensing techniques. First steps were already taken in computerised presentation using isocurves of ecological indicator values (Ellenberg 1974, Bemmerlein-Lux et al. 1991).

In our work we present application of isoecological curves (isoT, isoW, isoR) based on ecological indicator values (Borhidi 1995). Isolines constructed by ecological values help to detect and quantify environmental changes.

Study area

Misina-Tubes hill is situated in the southern part of Hungary, above the city of Pécs. Position of the ridge is NW–SE, southern part of it turns to east. The steep ridge mounts 600 m above the surrounding lowlands. Its building rocks are Triassic limestone banks and on the northeastern parts Rhaetian sandstone – two lower hills of the northern slope consist also of this latter kind of rock. Study area measures 8.5 km^2, forming a part of the green belt of the city of Pécs.

Vegetation map of Misina-Tubes hill

On the vegetation map (Fig. 1) of the area (Morschhauser 1995a) it is seen that the southern part of the area on the southern slopes are covered

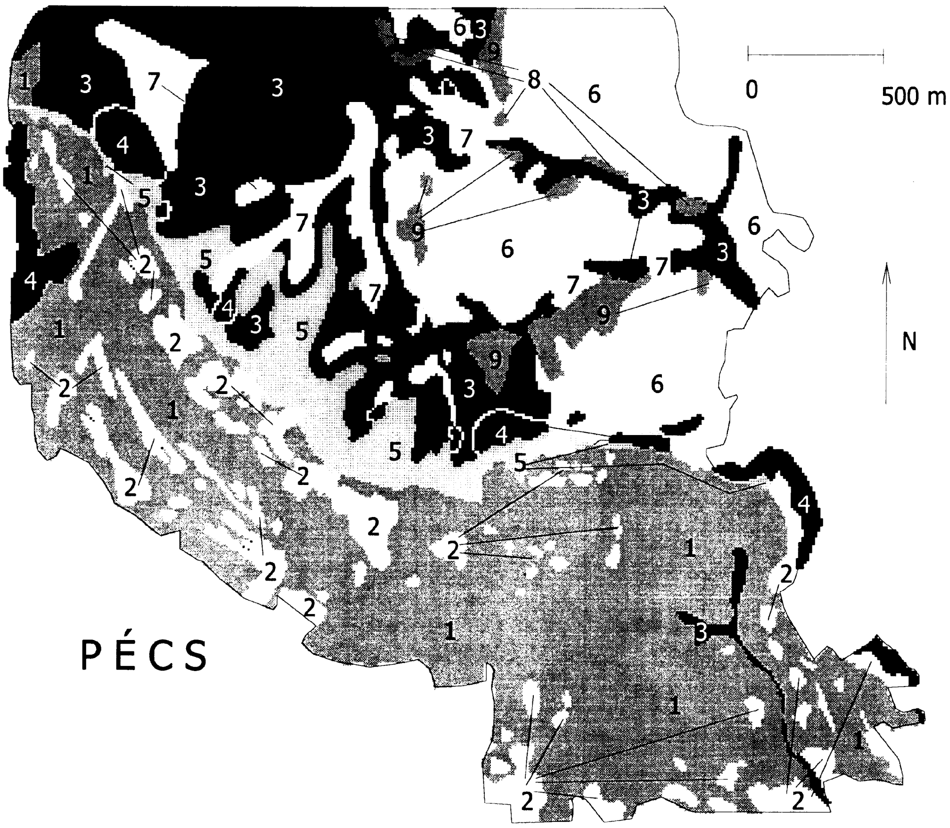

Fig. 1. The vegetation map of Misina-Tubes hill. 1. Vergilius oak limestone woodland (*Tamo-Quercetum virgilianae*), 2. hairy oak-shrub-woodland-dry grassland mosaic (*Inulo spiraeifolio-Quercetum pubescentis* et *Serratulo radiatae-Brometum pannonici*), 3. oak-hornbeam wood (*Asperulo taurinae-Carpinetum*), 4. silver lime-flowering ash rock forest (*Tilio tomentosae-Fraxinetum orni*), 5. top forest (*Aconito-Fraxinetum orni*), 6. turkey oakwood (*Potentillo micranthae-Quercetum dalechampii*), 7. beech forest (*Helleboro odoro-Fagetum*), 8. gorge forest (*Scutellario altissimae-Aceretum*), 9. acidophilous oak forest and beech forest (*Luzulo forsteri-Quercetum, Sorbo torminalis-Fagetum*)

mostly by an extrazonal oak forest (*Tamo-Quercetum virgilianae*) of sub-Mediterranean character. On the rocky steps of limestone occurs edaphic shrubwood-grassland mosaic (*Inulo spiraeifolio-Quercetum pubescentis* et *Serratulo radiatae-Brometum pannonici*). In the deep valleys oak-hornbeam wood (*Asperulo taurinae-Carpinetum*) developed and rock forest (*Tilio tomentosae-Fraxinetum orni*) on moving stones. On the ridge of Misina-Tubes hill can be found top forest (*Aconito-Fraxinetum orni*) as a special edaphic relict between the xerotherm and mesophilous forests. On the northern parts zonal forest communities cover the biggest area: in oak-hornbeam forest (*Asperulo taurinae-Carpinetum*) on the upper places, and turkey oakwood (*Potentillo micranthae-Quercetum dalechampii*) on the lower places. On the cold northern slopes beech forest (*Helleboro odoro-Fagetum*) is the typical, rock forest (*Tilio tomentosae-Fraxinetum orni*) is the common on the rocky places. Some stands of gorge forest (*Scutellario altissimae-Aceretum*) are lying along the streams. In extreme acidophilous sites oak and beech forests are formed (*Luzulo forsteri-Quercetum, Sorbo torminalis-Fagetum*).

METHODS

Sampling

Coenological relevés were made using quadrat method. Size of the quadrats: generally 400 m^2, in shrubforests 50 m^2, in calciphilous oak forests 225 or 400 m^2. Sizes were determined using the results of a minimi-area survey. In relevés cover of plant species were estimated twice a year. Sites of the relevés were chosen so that they should represent the variety of the vegetation units, including differently degraded types, too. Summarised data (spring and summer examination) of 250 relevés from Misina-Tubes were analysed.

Data analysis

Vegetation data collected on the field were supplemented with adequate ecological indicator values. Analysis of herbaceous layer were completed based on presence-absence cover data using Surfer computer program. Locating the results on the map, places of similar grade of T, W, R may be connected with curves drawn by interpolation method (Mucina et al. 1988). Interpolation map, compiled from ecological indicator values, is presented in a case study of Misina-Tubes.

Nomenclature of plant communities bases on Borhidi (1996).

RESULTS AND DISCUSSION

Ecological indicator values analysed in case studies correspond to those basic climatic factors, which determine in the first place the spatial pattern of vegetation. Extraordinarily various relief formations intensify the impact of these climatic factors. Factors of secondary importance, influencing spatial pattern of vegetation are edaphic conditions, e.g. soil acidity, analysed in our survey.

isoT

T: relative "temperature figures" reflecting the heat supply of habitats where species occur (mainly based on the distribution of species according to the latitudinal vegetation zones and altitudinal belts). Its values correspond to a 9-grade scale, according to growing heat demand. In our survey area species from T5 (montane mesophilous broad-leaved forest belt) to T9 (eu-Mediterranean evergreen belt) occurred. Average is based on presence-absence is T5–T7. Significant difference can be observed between greatest warm and cool foci. It shows clearly that this hill is situated in the submontane broad-leaved forest belt (T6), where on southern slopes thermophilous, on northern slopes montane mesophilous broad-leaved forest species can also play a role (compared to Morschhauser 1995b, Kevey and Borhidi 1998).

In Figure 2, compiled from curves of average T, calculated considering cover of plants, two areas can be clearly distinguished: on southern slopes plants of higher, on northern slopes plants of lower heat demand can be found in masses. Great curve density around the ridge represents great heat differences in small distances caused by different insolation characteristics. Towards southern and southeastern foothills heat values are gradually increasing, which can be explained partly with characteristics of limestone (surface banks), partly with "heating" properties of the near-lying city. Mesoclimatically warmest is the southwestern, coldest is the opposing northeastern slope, clearly presented on Misina hill, following the border of xerotherm oak forests (*Tamo-Quercetum virgilianae*, *Potentillo*

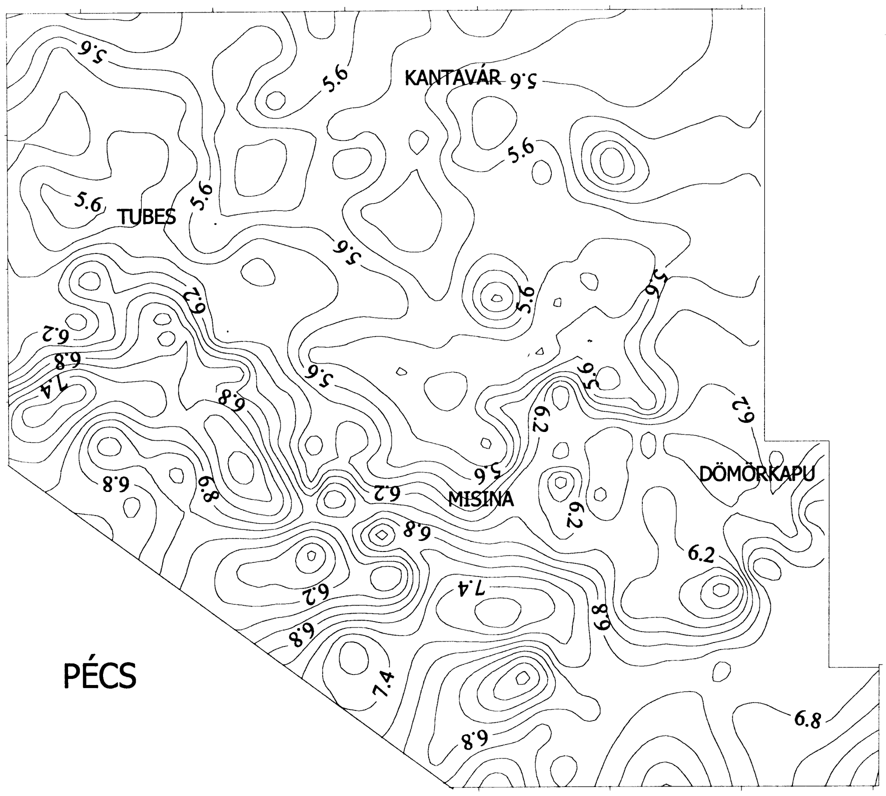

Fig. 2. Misina-Tubes hill, T weighted average

micranthae-Quercetum dalechampii). On lower situated places, closed around by Misina-Tubes ridge, getting smaller amount of insolation, a cold focus can be found with a value of 5.4 occurring in some deep valleys. On the other hand caused by a long southern valley on the western part of the area, the 7.4 maximum observed on the southwestern slope of the Tubes including shrubwood-grassland mosaic (*Inulo spiraeifolio-Quercetum pubescentis* et *Serratulo radiatae-Brometum pannonici*) quickly decreases under 6.0. Connected patches of cold foci in the northern part of the area drawn on the basis of the spatial distribution of the oak-hornbeam wood and beech wood in the valleys.

isoW

W: relative "moisture figures" (occurrence in relation to soil moisture or soil water table) according to a 12-grade scale. Values are increasing towards greater water supply. On the study area W values change on a wide scale from W1 (plants of extremely dry habitats or bare rocks) to W7 (plants of moist, non drying-out and well-aerated soils). Considering presence-absence, maximum of W1 is on Kis-Tubes, where we can find only steppe vegetation instead of trees. This peak is stretching further in direction of Tubes. Southern slopes of the ridge are drier, we can observe a moisture gradient from peaks to foothills, too. Average W curves – calculated considering cover of plants – (Fig. 3) present more extreme water supply characteristics.

Comparing to the former map, we can observe new and more determined foci. Rocky areas of Misina and Dömörkapu are proved to be also extremely dry habitats (struggle zone of forest and steppe), lowest W val-

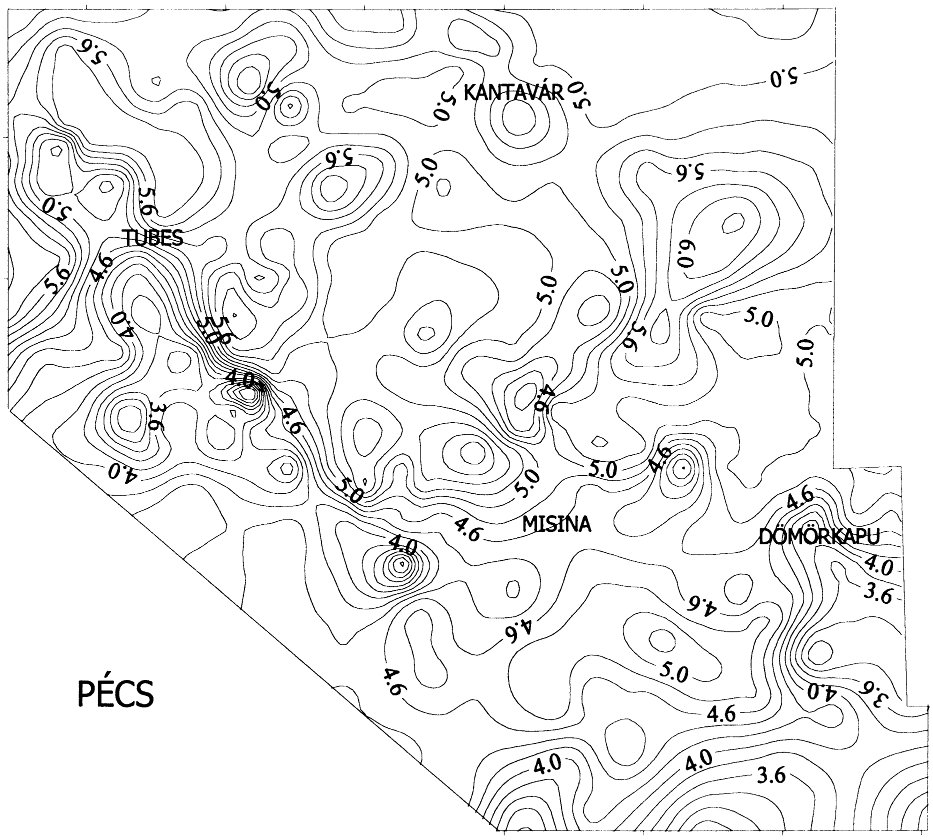

Fig. 3. Misina-Tubes hill, W weighted average

ues are on Kis-Tubes (under 3.9). These values increase with a quick jump above 5.6 on the northern slope. The difference between the two slopes are connected with different building rocks and precipitation distribution, too. Water supply on the northern slope is far more balanced; water surplus can be observed in the valleys in form of surface waterflows. This is represented e.g. by a wet focus with a value above 5.7 in the northern part and the northeastern corner of the area, at a creek-junction with beech forest, gorge forest (*Helleboro odoro-Fagetum, Scutellario altissimae-Aceretum*). The forest cutting areas occur as extreme moisture foci where the evaporation is lower because of the lack of trees. Southern slopes are dry, partly because of good draining properties of the building rock. Here dominate underground waters, which appear at the foothills. The valleys of southern slopes are also separated from surrounding dry areas by water supply covered with oak-hornbeam wood and rock forest (*Asperulo taurinae-Carpinetum, Tilio tomentosae-Fraxinetum orni*). In areas bordering the city another drying trend can be observed; its possibly explanations were already mentioned above, discussing heat relations.

isoR

R: reaction figures reflecting to the occurrence of plants in relation of soil reaction of the habitat. Its values correspond to a 9-grade scale, according to increasing basicity. In our area its values are represented from R4 (moderately acidophilous plants) to R9 (explicitly calciphilous plants and ultrabasic specialists). Influence of different building rocks can already be observed using presence-absence: foci appear on places, where soil is thinner, so influence of building rock is directly felt: on Triassic limestone 7.0 (basifrequent plants), on sandstone 6.0 (plants of neutral soils). In this case the acidity of building rock does not appear in the average of plant species. Examining curves compiled from average Rs calculated considering cover of plants, the impact of two kinds of building rocks is more markedly distinguishable.

Sandstone vegetation with its extreme average value of 4.8 can clearly be separated from the average 8.2 of limestone vegetation in the southern slope. On rocky limestone surfaces there are more basiphilous foci dominated by R7–R8 (basifrequent-basiphilous) plants of shrubwood-grassland mosaic (*Inulo spiraeifolio-Quercetum pubescentis* et *Serratulo radiatae-Brometum pannonici*), as in the former map, and they are markedly separated from loess surfaces of northern slope. Acidity characteristics here show a

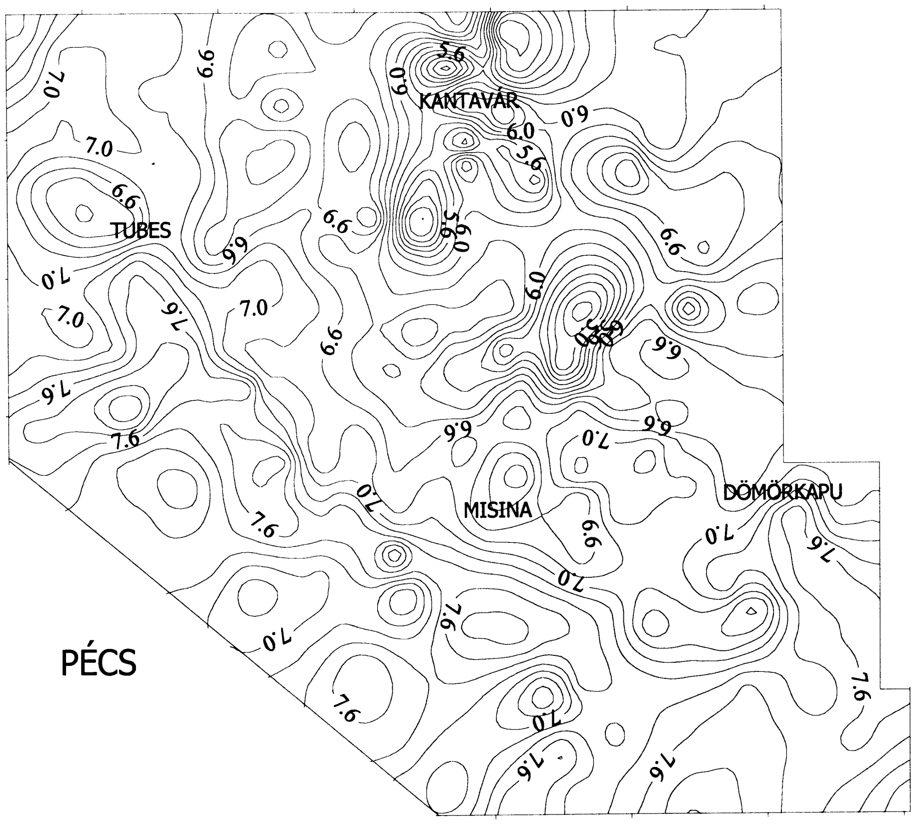

Fig. 4. Misina-Tubes hill, R weighted average

smaller variability on greater areas, except from acid-soil sandstone hills on the northeastern part of the area, where R5 is dominant plants of slightly acid soils in acidophilous oak forest (*Luzulo forsteri-Quercetum*). Our results are in accordance with the rock types marked on the geological map of the area (Horvát 1972).

CONCLUSIONS

Using ecological indicator values of temperature (T) and water supply (W) we were able to describe different climatic characteristics based on vegetation. Misina-Tubes ridge proved to be a mesoclimatic demarcation line by both indicator values. These factors are intensified by influence of relief, so zonal communities give place to communities of other vegetational zones (extrazonality). The closeness of the city of Pécs increases the influence of warm-dry climatic effects. Differences in building rocks (e.g. morphology, water economy) also helps climatic extremities to develop. Different pH characteristics become recognisable through thin soils. Isoecological curves can be used for documentation and forecasting of local influences of climatic change and human settlement to vegetation. Temporal changes can be followed by monitoring surveys. From influences of air pollution, e.g. acid precipitation can be awaited first of all on acid, then on neutral soils. Limestone areas are less sensitive because of remarkable buffer capacity of this kind of rock. Foci of different sensitivity can be determined using isocurves – so aimed studies can be planned.

*

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