Degree of human transformation of landscapes: a case study from Hungary

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Abstract

CORINE land use categories were used to identify the scale of human impact on the landscapes. The test area covered 12 natural microregions in north-eastern Hungary (*Figure 1*). It was found that of the 12 microregions the oligohemerobe areas dominated in three, β-euhemerobe in eight whereas α-euhemerobe areas prevailed in one of them. The standard deviation value of the oligohemeroby data is the highest. There is not a single microregion in the study area with unfavourable landscape structure for ecotops from the aspect of human impacts. It is reasonable to weigh the different hemeroby levels. The dataset in *Table 3* is the numerical representation of the degree of anthropogenic impacts when spatial ratios are taken into account. Adding up the weighed hemeroby values the degree of anthropogenic load on the landscape can be calculated. The resulting parameter can be called the hemeroby index *(Table 5).*

Keywords*:* hemeroby, CORINE

Introduction

The scale of human impacts on landscapes is very important in ecological landscape evaluation. To characterise various forms of anthropogenic landscape modification effects (from noise to soil pollution) is a difficult task.

In a chapter of a volume of studies published by the European Environmental Agency in 2005, indicators of the undisturbed natural environment are introduced (The European… 2005). These indicators seem to be odd at first sight. According to this concept those segments on the Earth surface should be considered free of human impact, where:

– population density is less than 1 inhabitant/km^2,
– there are not any roads or waterways used for transportation within 15 km,
– there are neither settlements nor railway lines within 2 km,
– lands are not and have never been used for agricultural purposes, finally,

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– there is not any light emission visible from a spacecraft in the night.

According to these criteria 83% of the mainland is affected by human impact in a global dimension. On the basis of these criteria there are barely any undisturbed areas in Europe, and in Hungary no intact areas exist at all. These criteria are probably too strict, but if we are looking for real ecological refuges, in areas meeting the criteria mentioned above there are not significant anthropogenic effects with a good chance. In this study a method based on the land use categories of the CORINE Land Cover 50 database is presented. It can be an adequate tool to identify the degree of man-induced transformation of landscapes (Csorba, P.–Szabó, Sz.–Csorba, K. 2006).

Levels of hemeroby and the CORINE categories

There are different levels of anthropogenic impacts though. *Less strict* parameters are required for a *better differentiation* between areas with weak or medium level of human impacts in the Carpathian Basin.

CORINE land use categories were used for the development of the method. The Finnish researcher J. Jalas introduced categories of hemeroby (synanthropy) in 1955. The original categories were as follows: oligohemerobe, mezohemerobe, euhemerobe, polyhemerobe and metahemerobe. German scientists added the α- and β-euhemeroby categories, this way the classification in its present form contains 7 categories (Bastian, O.–Schreiber, K-F. 1994; Bornkamm, R. 1980; Grabherr, G. *et al.* 1998).

For the evaluation of anthropogenic impacts on microregional level the following classification were used (*Table 1*).

Table 1. Classification of satellite image evaluation categories of CORINE into hemeroby levels

Hemeroby levels	CORINE categories
ahemerobe level	absent in Hungary
oligohemerobe level	3.1.1: deciduous forests 3.2.1: natural grasslands, close-to-natural meadows 3.2.2: low shrubs, shrub areas 3.2.4: transitional shrub-forest areas 3.3.2: bare rock 3.3.3: sparse vegetation 4.1.1: continental marshes 4.1.2: peat bogs 5.1.1: rivers, waterways 5.1.2: lakes
mesohemerobe level	2.3.1: meadows/pastures 3.1.2: coniferous forests 3.1.3: mixed forests

Table 1. (Continuation)

Hemeroby levels	CORINE categories
β-euhemerobe level	2.1.1: non-irrigated ploughlands 2.4.1: mixed annual and permanent cultures 2.4.2: complex cultivation structure 2.4.3: agricultural areas with significant natural vegetation
α-euhemerobe level	2.2.1: vineyards 2.2.2: orchards
polyhemerobe level	1.3.2: waste dumps 1.4.1: urban green spots
metahemerobe level	1.1.1: continuous settlement structure 1.1.2: discontinuous settlement structure 1.2.2: road and railway network with the related areas 1.2.4: airports 1.3.1: areas of raw material extraction 1.3.3: building sites 1.4.2: sport- and recreation areas

Application of hemeroby levels of the CORINE categories in a study area (north-eastern Hungary)

The map showing human impact for the 12 microregions or microregion groups of north-eastern Hungary was prepared on the basis of the classification shown in *Figure 1* (Csorba P. 1996, Csorba P. 1996/a). Percentage values of hemeroby levels within the area of the microregions are presented in *Table 2*.

Of the 12 microregions in three the oligohemerobe, in eight the β-euhemerobe and in one the α-euhemerobe category is dominant by percentage. The most uniform microregions are Harangod, Szerencsköz and Central Zemplén. The first two are characterized by β-euhemerobe arable lands (87% and 86 % of their area). The latter has close-to-natural (oligohemerobe) vegetation only slightly affected by human impacts. The strong human interference in the world-famous Tokaj wine growing area is marked by the fact that the highest ratio of α-euhemerobe areas among the 12 microregions can be found here. The ratio of densely built up metahemerobe areas is around 5% on an average, with the lowest values found in Central Zemplén and and the highest ones in the Hernád Valley.

In the 12 microregions or microregion groups the *β-euhemerobe and oligohemerobe categories are dominant*. It means that they are composed by areas of semi-natural and close-to-natural levels of anthropogenic impact even though these categories have the highest standard deviation value. The lowest standard deviation value belongs to Harangod microregion (4.6%), and the highest one is found in Central Zemplén microregion (85.5%). Polyhemerobe areas like waste dumps and urban green areas play a negligible role in the study area.

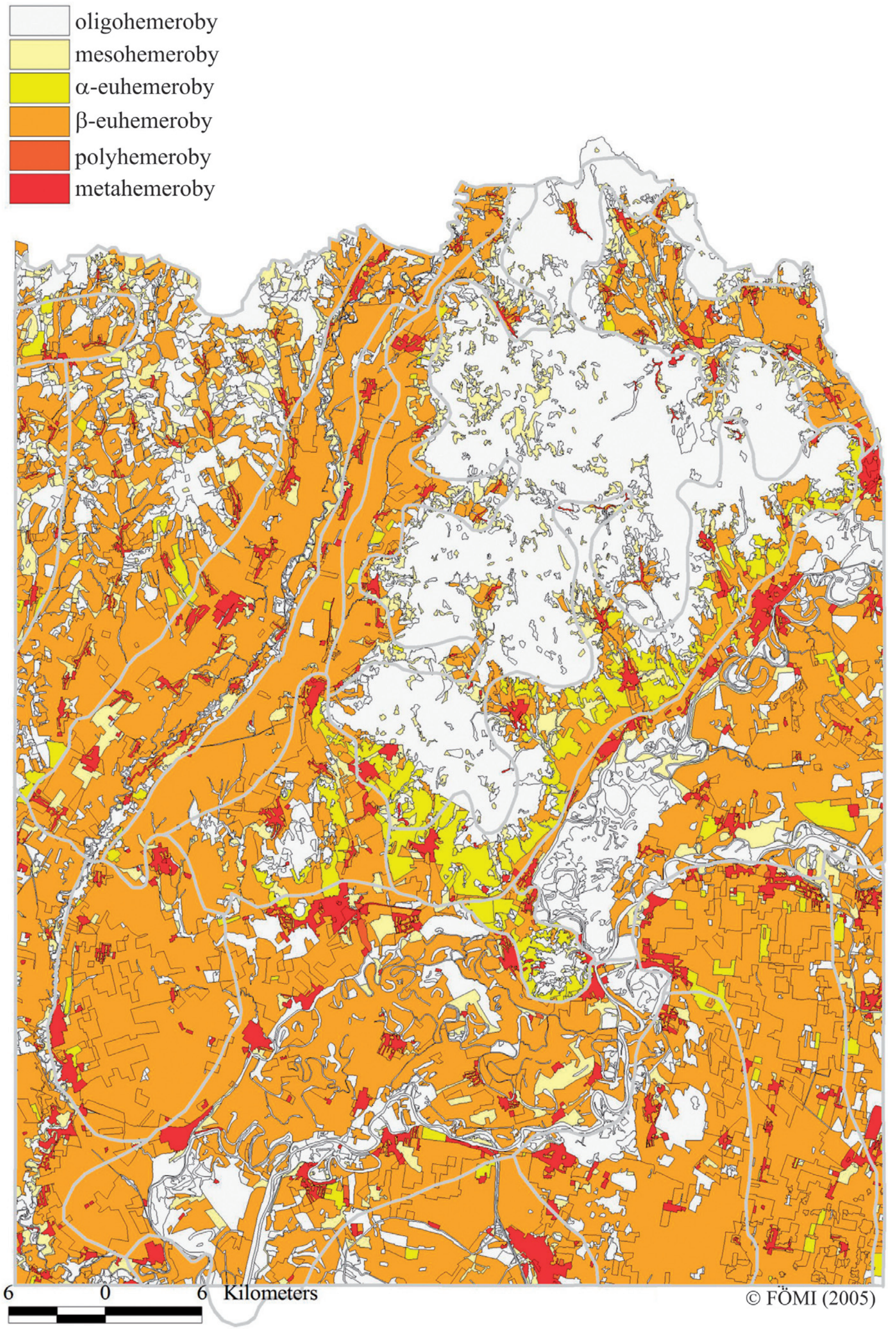

Figure 1. Hemeroby map of the study area

Table 2. Percentage values of hemeroby levels within the 12 microregions or microregion groups in north-eastern Hungary (highest values for the individual microregions are shown in bold)

Microregions	oligo-hemerobe	mezo-hemerobe	β-euhe-merobe	α-euhe-merobe	poly-hemerobe	meta-hemerobe
Eastern Cserehát	36.9	11.9	**47.6**	2.1	0.0	1.5
Hernád Valley	13.3	8.0	**72.0**	0.6	0.0	6.1
Szerencsköz	6.3	4.1	**86.0**	0.7	0.1	2.8
Taktaköz	28.5	5.3	**59.1**	0.9	0.3	5.9
Harangod	4.6	2.0	**87.1**	1.0	0.0	5.3
Szerencs Hills	19.1	6.5	**59.6**	9.9	0.1	4.8
Tokaji Hill	34.4	1.7	15.4	**42.8**	0.4	5.3
Tokaj Foothill	**40.9**	8.7	23.0	23.9	0.0	3.5
Abaúj Foothills	28.4	12.5	**53.7**	1.7	0.0	3.7
Central Zemplén	**85.5**	8.1	3.4	2.0	0.0	1.0
Hegyköz Hills	30.0	13.0	**50.7**	1.2	0.3	4.8
Vitány Horsts	**77.1**	11.0	10.9	0.0	0.0	1.0
Average	*33.7*	*7.7*	*47.5*	*7.2*	*0.1*	*3.8*

Further data analyses

Cumulative curves plotted from the data in *Table 2* clearly demonstrate the scale of human impacts within the microregions of the sample area. Characteristic curves are presented in *Figure 2*.

Smoother curves indicate an even distribution of the spatial extent of different hemeroby categories within the microregions. Steep curve sections refer to hemeroby levels dominant in the given microregion. *Figure 2* shows that the curves of Eastern Cserehát and Tokaj Foothill microregions are the most even indicating that hemeroby categories have much more uniform spatial distribution in these microregions than in the Central Zemplén or Vitány Horsts microregions.

In a landscape ecological sense this *uniformity in the distribution of hemeroby categories refers to a very high spatial diversity of microregions*. There is not any category occupying more than 50% within the area of such microregions.

Close-to-natural ecological features dominate those microregions where oligo- and mesohemerobe categories prevail, thus pointing to minor human intervention. Most microregions in the study area are characterised by semi-natural ecotops (euhemerobe levels). A*s far as the scale of anthropogenic impacts is concerned there are not any microregions* in the study area *with unfavourable landscape structure for ecotops,.*

Hemeroby ratio categories *provide a reliable fundament for qualitative evaluation of landscape structures* so that landscape ecological evaluation can be rendered more accurate.

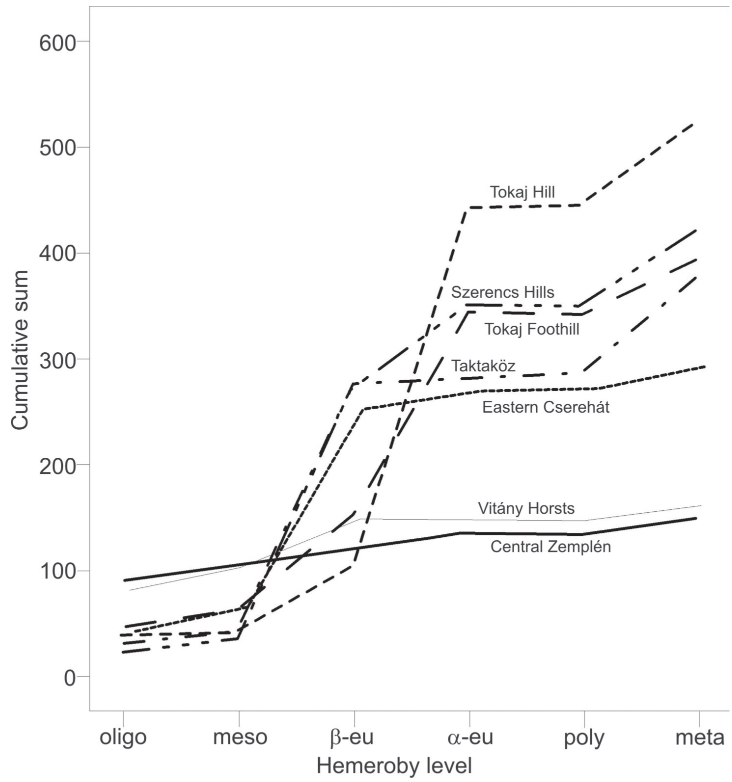

Figure 2. Cumulative curves of the hemeroby categories of selected micro regions in the study area

Issues of data weighing

It is desirable to *add weights to hemeroby categories* because increasing anthropogenic impacts on landscape structure lead to more serious disturbances. A mesohemerobe landscape section with a spatial ratio of 10% has quite a different effect on landscape functions than a polyhemerobe or a metahemerobe section has with the same spatial extension. The impact also depends on the spatial pattern of patches with significant anthropogenic effects upon the landscape. For instance if a metahemerobe patch *hinders the functioning of the most important landscape ecological corridors it will have a much stronger effect on landscape functions than in the case when it blocks the connections of a peripheral landscape unit*. For example a waste dump can play different roles depending upon what importance does the blocked landscape structure element have in relation to the landscape functions.

It would be reasonable therefore to weigh the different hemeroby levels just as a differentiation is necessary in the case of the evaluation of ecotop fragmentation effects of motorways and minor roads. Using a simple weighing based on the scale of anthropogenic impacts the role of euhemerobe, polyhemerobe and metahemerobe categories will be more emphasized. For the accurate description of ecological role however, weighing should be linked to the exact location of the eu-, poly-, and metahemerobe patches and related to the function of the given area in the landscape structure. Such a classification requires further research. From the aspect of landscape ecology it would be an important step forward to determine multiplying factors for each hemeroby category (*Table 3*).

Table 3. Multiplying factors for the hemeroby levels

Hemeroby level	Multiplying factor
Oligohemeroby	1
Mesohemeroby	2
α-euhemeroby	4
β-euhemeroby	8
Polyhemeroby	10
Metahemeroby	15

Weighed hemeroby values of microregions in the study area are presented in *Table 4*.

Table 4. Weighed hemeroby values of the study area (highest values for the individual microregions are shown in bold)

Microregions	oligo-hemerobe	meso-hemerobe	β-eu-hemerobe	α-eu-hemerobe	poly-hemerobe	meta-hemerobe
Eastern Cserehát	36.9	23.8	**190.4**	16.8	0.0	22.5
Hernád Valley	13.3	16.0	**288.0**	4.8	0.0	91.5
Szerencsköz	6.3	8.2	**344.0**	5.6	1.0	42.0
Taktaköz	28.5	10.6	**236.4**	7.2	3.0	88.5
Harangod	4.6	4.0	**348.4**	8.0	0.0	79.5
Szerencs Hills	19.1	13.0	**238.4**	79.2	1.0	72.0
Tokaji Hill	34.4	3.4	61.6	**342.4**	4.0	79.5
Tokaj Foothill	40.9	17.4	92.0	**191.2**	0.0	52.5
Abaúj Foothills	28.4	25.0	**214.8**	13.6	0.0	55.5
Central Zemplén	**85.5**	16.2	13.6	16.0	0.0	15.0
Hegyköz Hills	30.0	26.0	**202.8**	9.6	3.0	72.0
Vitány Horsts	**77.1**	22.0	43.6	0.0	0.0	15.0

The dataset is the *numerical manifestation of the degree of anthropogenic impacts with the spatial ratios duly taken into account*. If the weighed hemeroby values for each microregion are summed up the degree of anthropogenic load on the landscape can be calculated. The resulting parameter can be called the hemeroby index (*Table 5*).

Table 5. Hemeroby indices of the microregions in the study area

Code	Denomination	Values
6.8.53	Eastern-Cserehát	290
6.8.61	Hernád Valley	414
6.8.62	Szerencsköz	407
1.7.11	Taktaköz	374
1.9.33	Harangod	444
6.7.22	Szerencs Hills	423
6.7.21	Tokaji Hill	525
6.7.23	Tokaj Foothill	394
6.7.12	Abaúj Foothills	337
6.7.11	Central Zemplén	145
6.7.31	Hegyköz Hills	343
6.7.32	Vitány Horsts	158

Figure 3 shows the classification of microregions based on hemeroby indices.

The method presented here should be considered as a first approach that is to be refined and made more exact by detailed investigations. However, the method in its present form is already a step forward as the quantification

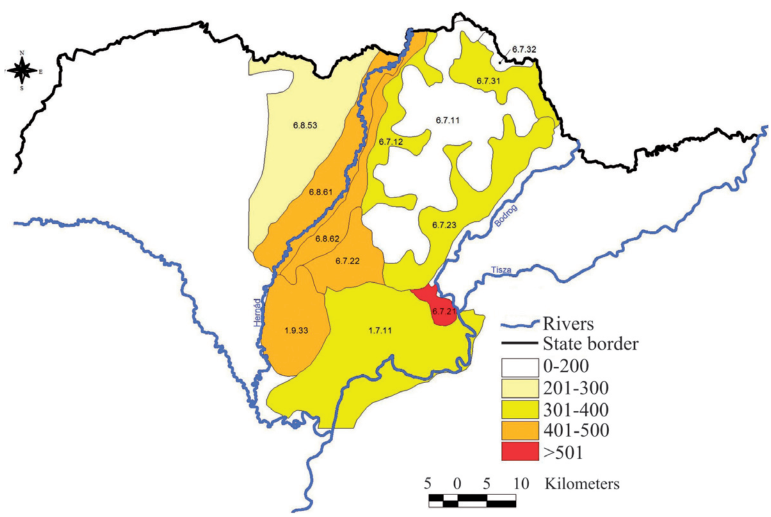

Figure 3. Hemeroby index map of the micro regions of the study area

of human impact on microregions of the study area and of their differentiation has been accomplished.

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