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SUGGESTED LANDSCAPE AND AGRI-ENVIRONMENTAL CONDITION ASSESSMENT

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In its first study, the working group of land evaluation and land use (agriculture) has outlined the scientific area, described its connections to other sciences and examined the international data providing needs. In its second study we collected the available digital maps and datasets for the regardless of their scale to help data communication in a common information collecting work platform. We evaluated the general availability, the stage of digitalization, difficulty in availability and their information content. For further evaluation we took into account the legal and decision support background and the possibilities of regulations and publicity. Furthermore we described the legal background of the land protection and agricultural (land use), the survey of the Hungarian and EU data providing tasks, the survey of the operation of land protection and agri-environmental programs and institutions. We analysed methodologies on the fields of agricultural suitability-environmental sensitivity, suitability of agricultural production, agro-ecological value and environmental sensitivity. In our third study we connected models and databases and created a possible parameter set (indicators). Our suggested indicators were introduced in oral presentations on Science's Day, at the Hungarian Academy of Sciences, in 2006. These were as follows: landscape indicators: a) 1. landscape pattern, 2. landscape fragmentation, 3. land use stability, 4. connectivity, 5. state of health of the landscape; b) agri-environmental indicators: 1. areas brought into the programs and their distribution by target programs, 2. rate of large and small scale farming (and the rate of extensive and intensive agriculture), 3. nitrogen output (organic+inorganic), 4. erosion. The chosen indicators were described as follows: name of the indicator, explanation for choosing the indicator, definition of the indicator, possibility of measuring/estimating the indicator (with available maps and datasets), planned monitoring activity with the indicator.

Introduction

In its first report the Working Group delimited the scopes of land evaluation and agricultural land use assessment and outlined the tasks in research related to those fields of study. It also revealed their relations to other disciplines and investigated the achievements and perspectives of data collection and processing in Hungary as well as the international requirements of data provision. Professional, legal, institutional and financial backgrounds to research were also studied.

For the second report all available digital maps and data bases – irrespective of scale – had been collected with the purpose to allow the design of a joint information input window. The information sources collected included maps of land use, of landscape factors (topography, drainage, biota, climate, soils etc.), of landscape protection/nature conservation as well as of protection of agricultural environment and of agroecological zonation. They were assessed according to availability, coverage, degree of processing, ease of access and information content. In addition, the background of legal regulation and decision support system was considered. An overview was provided on the legal regulation of landscape protection and agricultural land utilization, data supply requirements in Hungary and in the European Union and the efficiency of programmes in landscape protection/protection of the agricultural environment and of their institutional system were evaluated. A special emphasis was put on comparisons between land evaluation approaches and their harmonization, on the evaluation of present land use against land potential and on the identification of land use conflicts. Methodological summaries were prepared for agricultural land capability, environmental sensitivity, agricultural land suitability and agroecological value. As major aspects of assessment, theoretical elaboration and practical applicability were investigated.

In the third report of the Working Group models and data bases were related to each other and prospective sets of parameters (indicators) were presented. The description of each indicator followed a common scheme, including

– name of indicator;
– justification for the inclusion of the indicator;
– definition of the indicator;
– opportunities for measuring or estimating indicator values (with the list of useful maps and data bases);
– monitoring of changes in indicator values.

The selection of indicators had been preceded by conferences with the participation of experts and the wider public, including thematic workshops. Improvements and corrections were made based on the experience of discussions. Finally, test areas were found and the results attained were evaluated. The proposed indicators are detailed here based on the paper presented on Science Day at the Hungarian Academy of Sciences in 2006.

Landscape metrics

A new development in landscape ecology, the concept of landscape metrics is founded on the recognition that the spatial structure of the landscape is in close interaction with ecological processes taking place within it (TURNER 1989, TURNER and GARDNER 1991) and the study of structure, therefore, allows conclusions for the nature of landscape functioning. A wealth of information can be gathered on landscape functioning from the analysis of the landscape mosaic, i.e. what kind of land cover and habitat units, also distinct visually, build up the landscape. Spatial heterogeneity is partly manifested in the mosaic distribution of patches, forming distinct sets. A landscape is composed of patches, corridors and matrix. This concept has led to the construction of the patch-corridor-matrix model (FORMAN and GODRON 1986) and the list of indices which numerically describe landscape pattern (FORMAN 1995). The patches are shaped by the heterogeneity of the substrate, natural disturbances and human impact.

According to the widely accepted and popular patch-corridor-matrix model the composition of the landscape is measurable since three-dimensional landscape objects show typical two-dimensional arrangement on the map. Among the elements of the landscape the most extensive is the matrix, which is usually easily identifiable. Patches are relatively distinct areas with mostly homogeneous environmental conditions and delimited by changes in land cover, which truly reflects general alteration. Patches are of dynamic character and can be mapped at all scales. They are arranged in a clear hierarchy (MILNE 1988). In the model, the second type of landscape element is the corridor, a linear object easy to define: it is usually a narrow strip in the landscape, different from the bordering matrix on both sides. Occasionally corridors are isolated but more often connected to patches.

The assessment of landscape pattern – including that from a statistical approach – is highly dependent on scale. Landscape pattern is usually assessed at the following levels:
- patch geometry;
- patch typology and
- landscape pattern at micro, meso and macro regional levels.

The indices of landscape geometry are mostly additive and computed by simple equations. Some of them are comprehensive measures, while others cannot be interpreted for spatial distribution but are still useful in landscape ecology, e.g. such simple parameters as the relative number or the percentage distribution of patch types.

Landscape indicators

Landscape pattern

Landscape pattern in its narrower sense is defined as the geometry and/or spatial arrangement of landscape patches, resulting from both natural and man-induced processes.

With regard to the objectives of the project, it is advisable to apply the following indices, also compatible with the patch analyser of the Fragstats and ArcGIS softwares:
- perimeter/area ratio;
- patch shape (important for landscape functioning);
- number and relative size of patches (since the same patch density may mask highly different landscape patterns, e.g. agricultural plots of regular shape and patches of zigzag border lines with the same patch density value).

The morphological description of ecotones may also be informative for a landscape pattern analysis.

The assessment of possible interactions within patches is a more complicated task, which may involve a set of 8 to 10 indicators, the most simple being the size distribution and the density of patches and more complex are those representing the internal structure of patches, their isolation and neighborhood conditions as well as contrasts between them.

For the computation of the above landscape pattern indices maps of nation-wide coverage and national data bases are available (land cover maps of various scale at the Hungarian Institute for Surveying and Photogrammetry, such as CORINE CLC100 and CLC50). They are suitable for an overview survey at 1:100,000 or 1:50,000 scale. The outcome of planned work will present a momentary picture of landscape pattern and does not mean continuous monitoring of change. Temporal changes could be grasped by another indicator, the continuity of land cover.

Landscape diversity

In addition to the range of the character of landscape elements, the definition of landscape diversity emphasizes the positions of patches of similar function relative to each other. It provides important information on the condition of the landscape. The indices of patch geometry alone are not sufficiently sensitive to describe the ecological functioning of the landscape. To this purpose the spatial arrangement of paths of similar ecological function has to be analysed. Biodiversity is a fundamental principle in landscape management but it is closely related to fragmentation and to the potential connectedness of landscape elements.

The first step towards measuring the degree of diversity is an ecological classification of patches. In the next step the spatial arrangement of patch types is mapped. Since patch size is usually of several square kilometers, a detailed survey of 1:10,000 or 1:25,000 scale seems to be desirable. The implementation of mapping of this kind does not appear feasible for the whole territory of Hungary.

Instead another indicator, Shannon's diversity index at landscape level is proposed. This index provides information of sufficient detail to achieve the objectives of the project.

For the typology of patches the data bases of the National Ecological Network and of the NATURA 2000 areas can be used. Further refinement can be achieved through the application of the MÉTA (Map Representation of Habitats in Hungary) and CORINE data bases.

Land cover continuity

If information is available for several dates, this indicator is suitable to monitor landscape change induced by human use. It is relevant for decision-makers what impact decisions affecting agriculture exert on regional resource management. In its simplest interpretation this functional indicator shows the percentage of areas with no land cover change based on the comparison of land cover distribution for the same territory at two or more dates. For instance, selecting agricultural land of 200 ha area for the application of the indicator and 20 ha of the area is built up, the index of land cover continuity will have a value of 0.9 (180/200). Its maximum value is 1 and land cover change affecting the whole are of study is not interpretable neither for content nor mathematically.

The primary data source for the indicator is CORINE Land Cover LCL100 and LCL50. The measurement involves comparisons of land cover conditions (percentage areas) by CORINE Land Cover categories between two (or more) dates of time.

The indicator serves monitoring in time and calls attention to certain landscape processes, including increasing fragmentation by roads and other elements of infrastructure. Agricultural land lost during urbanization can be recorded. Positive tendencies, such as the expansion of pastures, can also be surveyed.

Landscape coherence

Landscape coherence is one of the most complex indices of landscape pattern and an essential tool for land management. It expresses landscape fragmentation and patch isolation on the one hand and landscape connectivity on the other. Landscape fragmentation is defined as the disruption of ecological connection, natural movements, dispersal patterns, gene flows etc. between natural habitats – especially by human activities. As it increases interpatch distances and decreases patch sizes, it is basically regarded as a negative phenomenon. Isolation refers to the lack of contacts for a single landscape element (and the inhabiting populations) with its neighbors. On the other hand, landscape connectivity, the opposite of fragmentation, means the degree to which the structure of the landscape facilitates or impedes natural movements. A landscape is well connected if organisms, plant and animal populations can readily move and natural processes can extend among habitat patches over the long term (MERRIAM 1984, TAYLOR et al. 1993). Land use change towards a more intensive type is generally unfavorable for the health of semi natural habitats and decreases their connectivity.

The remedying processes in a semi natural landscape can counteract fragmentation effects over longer periods of time but drastic impacts on anthropogenic landscapes, like the consequences of large-scale cultivation in the agricultural landscape, cause serious isolation and the general landscape pattern deteriorates. The fragmented populations are more susceptible to extinction. With the decimation of key (or flagship) species the whole ecosystem could impoverish and biodiversity could be reduced.

As for a range of landscape properties, there is no generally accepted and comprehensive indicator of all aspects of landscape coherence in literature, although a landscape cohesion index has been proposed in the EU SENSOR Project. Since the composition and arrangement of patches and of matrix are of decisive importance, connectivity and fragmentation are closely related to overall landscape pattern. However, biologists emphasize that connectivity should be described by actual organism movements between patches or inferred from emigration success, dispersal success, search time or cell immigration from animal movement simulation studies (GOODWIN and FAHRIG 2002).

Most landscape ecologists suggest that the maximum number of connections has to be determined. The connectance index is calculated as the percentage of the maximum possible functional joining between patches of the same type. Connectance can be based on either Euclidean distance or functional distance (proximity). Patch cohesion index measures the physical connectedness of the corresponding patch type. If patch types are more aggregated in their spatial distribution, they are more physically connected and, thus, show higher patch cohesion values (GUSTAFSON 1998).

In the present project the application of the gamma index seems to be most instrumental (FORMAN and GODRON 1986). This simple index computes the percentage of actual links between habitat patches (L) compared to the number of all possible links (Lmax):

$$\gamma = L/L_{max} \times 100.$$

The number of links can be calculated from the number of nodes (V), if V > 2:

$$L_{max} = 3(V-2).$$

Thus,

$$\gamma = L/3(V-2).$$

With the advent of Geographical Information Systems a new opportunity opened for the automatic estimation of landscape fragmentation and connectivity (BLASCHKE 2000). The most widespread computer model applied to this purpose is Fragstats (MCGARIGAL and HOLMES 2002). The new achievements of „network science" (BARABÁSI 2002) can also be used in the estimation of the evolution of connectivity in a landscape. Even here, a useful data base for the identification of patches could be CORINE Land Cover.

Landscape „health" (Ecological functionality)

In land evaluation it is rather difficult to estimate the ecological quality of landscapes, i.e. to what extent they are able to fulfill their multiple functions. The „health" of the landscape is meant to describe the efficiency of landscape functioning. It is to be investigated whether a landscape under pressure of various intensities is able to meet social requirements; what degree of self-regenerating capacity it manifests; how sensi-tive it is to pressures from outside and what the acceptable limits of external impact are. Such considerations emerge before any decision on land use selection, landscape planning or rehabilitation measure. Well-founded answers could be useful underpinned with parameters showing how far the state of the landscape is removed from one-time natural conditions.

In contrast to the above properties of the landscape, objective and easily measurable indicators are hard to find for this purpose. The index of landscape „health", however, should also be based on landscape pattern indices supplemented with further indicators. No reliable data are available on the population dynamics of living communities in the landscape, the vitality of individual ecosystems and its interactions with landscape parameters. The cooperation between ecology and landscape geography have not yet reached the level where the area necessary for the optimal functioning of an ecosystem could be estimated or, in lack of a contiguous area, what patch-corridor pattern could provide the carrying capacity for a beech forest or a sand grassland.

For a temporary approach a group of indicators is suggested. The first member of the group is the degree of human impact, expressed as hemeroby grade, a long-proposed but seldom used indicator (BLUME and SUKOPP 1976). The rate of man-induced modifications in the landscape are referred to seven relative categories with the growing intensity of human impact: ahemeroby, oligohemeroby, mesohemeroby, β-euhemeroby, α-euhemeroby, polyhemeroby and metahemeroby. This rate of differentiation is neither too coarse nor too detailed and, relying on some key partial properties, the assessment can be carried out in a relatively simple manner. Ahemeroby means the natural environment, in principle intact, and the grade of metahemeroby built-up urban and industrial environments. In Europe ahemeroby is restricted to some tundra environments at most, thus, in Hungary the range narrows down to 6 categories.

Hemeroby grades are identified from land cover classes. Since in recent decades for the assessment of land cover CORINE classes have been used, they are related to hemeroby grades (CSORBA 2005).

A complex parameter can be generated from the hemeroby pattern for micro and mesoregions by weighting areas with the corresponding hemeroby grades. The more intensive human impact is, the higher is the weight by which the percentage of each hemeroby category receives. Metahemeroby is provided with the highest weight.

The „health" of the landscape, however, only partially depends on the type of land use. Landscape pattern has to be involved into an ecologically more precise assessment. In our opinion, comprehensive fragmentation by transport infrastructure and built-up areas is a useful auxiliary indicator, the second member in the group. Fragmentation has been computed for all the 229 micro regions of Hungary (CSORBA 2005).

As further indicators information on the health conditions of forests and on infection by invasive plants (*Amorpha fruticosa, Asclepias syriaca, Ambrosia artemisifolia, Solidago gigantea, Echynocis lobata* etc.*)* would be needed. This could constitute the third indicator in the group.

The elaboration of the minimum three but altogether eight (or more) indicators is a methodological task for the future.

Agri-environmental program based landscape indicators

The areal extent and ratio of agricultural land enrolled in agri-environmental programmes in light of different priorities

The agri-environmental programmes appeared in the European Union's agricultural policy at the end of the 1980's. The aims of these programmes were to support the emergence of environmental aspects in common agricultural practice and to sustain the countryside.

The realization of these programmes became obligatory for the member states in 1992, with the launch of the Common Agricultural Policy (CAP). Within the the frames of these programmes, farmers assumed the obligation – at least for a period of five years – to adopt farming methods, which are beyond the so called 'good agricultural practice'. The farmers are compensated for their additional costs and the loss of incomes, which are an effect of the compliance of the relevant measures.

The priorities principally support environmental-friendly farming (extensive grassland management, integrated and organic farming), conservation of natural values, sustenance of the character and historical features of agricultural landscape, and high-quality production of agricultural goods.

Although the index of areal extent of agricultural land enrolled in agri-environmental programmes does not provide direct information on the environmental efficiency of the relevant measures, however it is one of the most important indicators in terms of demonstrating national and regional influence of agricultural policy making.

Especially in cases of low productivity territories, the danger of environmental degradation may increase, as common, usual agricultural practice is not in consonance with the environmental features of these farmlands. One of the main objectives of the programme is to provide financial support for and involve farmers managing lower productivity lands. These measures may assist to the spread of environmentally-sound farming methods on a wider scale.

The participation in the priorities is on voluntary basis. Though it must be considered, when analysing the territory index that zonal priorities are not optional everywhere and the participation in the horizontal priorities can only be chosen if territory-specified criteria are fulfilled. A good example for the latter is the small scale farming on homesteads, where small parcel cropping is subsidised. Such territories occur sparsely in the country and their extension is rather small. Because of the above mentioned reasons, the success of the one or another specialised priority and the extension of the land, can not be adjudged in comparison with priorities, such as integrated crop management.

If we would define the indicator, than it is the extent and ratio of the territories that are signed up to the agri-environmental priorities of the National Rural Development Plan. This indicator suits and matches the essential requirements of the broadly-used indicator list of EU classification („Area of agricultural land enrolled in agri-environment programmes under Regulation 1257/1999, classified by type of agri-environmental measures”).

Data to define indicators can be obtained from the following sources:

- Areal data from the contracts of the MVH-IIER files
- Management register (Ministry of Agriculture and Rural Development – Department for Agri-environmental Issues)
- Agri-environmental Information System (AIS): with the configuration, actuation and maintenance of this information system, factual areal statement can be achieved (requires plot-defined GIS registration)

Beside a better information flow between the Ministry of Agriculture and Rural Development and the Agricultural and Rural Development Agency, the public utilisation of data should be ensured on settlement level. Following statistical record demonstrates a possibility of the utilization of the indicator.

Table 1. Distribution of the agri-environmental subprogrammes of the National Rural Development Plan on the basis of signed contracts, number of plots and engrossed territories
Table 1. A Nemzeti Vidékfejlesztési Terv agrár-környezeti alprogramjainak területi kiterjedése az aláírt szerződések, a táblák és területek alapján

Subprogramme	*number of contracts*	*number of plots*	*area (ha)*
Standard arable farming	9454	65019	547615
Maintenance of extensive fisheries	135	768	19429
Management of grassland habitats	3450	12673	156664
Establishment of grass balks	3	9	8
Grassland management with regulations on habitat development	53	235	933
Grassland management with regulations on habitat development of corncrake (*Crex crex*)	220	561	4853
Grassland management with regulations on habitat development of great bustard (*Otis tarda*)	410	1329	43132
Grassland establishment on Environmentally Sensitive Areas	32	89	1077

Contd. Table 1.
1. táblázat folytatása

Subprogramme	*number of contracts*	*number of plots*	*area (ha)*
Integrated crop management	2732	19272	188611
Integrated plantation	5050	15632	35855
Alfalfa cultivation with regulations on habitat development of great bustard (*Otis tarda*)	151	314	3052
Plant cultivation for „bee pasture”	21	35	81
Reed management	157	637	10261
Ecological grassland management	216	1181	25266
Ecological crop cultivation – under conversion 1.	2	3	5
Ecological crop cultivation – under conversion 2.	37	236	2449
Ecological crop cultivation – under conversion 3.	9	84	433
Ecological crop cultivation – converted plot	273	1682	16428
Ecological plantation – under conversion 2.	6	21	45
Ecological plantation – converted	75	153	520
Arable crop management with regulations on habitat development	29	183	1209
Arable crop management with regulations on bird habitat development	527	2992	16241
Arable crop management with regulations on habitat development of great bustard (*Otis tarda*)	298	2381	23523
Homestead farming	363	2321	2587
Total	23703	127810	1100277

source of information: Agricultural and Rural Development Agency (2006)

Ratio of small parcel and large field farming (with respect to the ratio of extensively and intensively cultivated lands)

The indicator is suitable to evaluate the consonance between landscape properties and plant cultivation, to formulate in numbers the condition of landscape mosaics, especially in terms of arable farmlands. With the help of maps alterations in estate structure can be traced (back) and demonstrated, which may change the landscape functions and are often consequences of political changes (e.g. certain territories of Hungary, where former farmer’s co-operative large field arable lands have been divided into private small field lands). Since it is a derivative index, it can only be interpreted if its components are explained.

Large field, intensive cultivation

It is an industrial cultivation that can be characterised by ascendant industrial expenditures, increased energy input and significant crop growth. On a landscape scale it manifests as large mosaics with monocultural cropping. Previously it meant a significant source of danger for the environment, nowadays environmental friendly intensive cultivation does also exists.

Small-plot, extensive farming

The production is fundamentally based on the sustainable use of natural resources. The decisive factors of the production are human skills and experience. In case of plant cultivation the production is adapted to landscape properties using its distinct microrelief conditions. It appears as small mosaics in landscapes.

In accordance with the above mentioned, the ratio of large field farming and small parcel cropping cultivation is an index that:

– can not be interpreted on protected areas (as there isn't any land use activity);
– shows the balance of land protection and use (the bigger the extensively cultivated, small parcel areas are, the better the harmonisation of protection and use have been accomplished);
– must be maintained for habitat networks in so called agri-zones (above 10% of the total area, small parcel cultivation lands can not be consolidated, though its increase can facilitate the growth of biodiversity and it is also favorable from landscape aesthetical point of view)

Amongst the available database, a good starting point can be the mapseries „Position of areas on the environmental sensitivity and agri-production scale" of the National Agri-environmental Programme. It contains land classification (protected, transitional, agrarian) on county scale. Based on this, the index can be measured and calculated according to the CORINE land cover database, which is now available in 1:50 000, besides the 1:100,000 scale version.

During the monitoring it can be survey (and assessed as well):

– how successful and effective the priorities have been,
– in what manner did they inspire the utilisation of extensive, small parcel cultivation and
– where small-plot cultivation lands' portion has to be raised further on.

Nitrogen emissions (organic + anorganic)

Until the mid '50s in Hungary, chemical fertilizers were basically not in use at all. Organic fertilizing routine could only recover the third of the nutrients withdrawn from the soil by plants. Hungary's agronomical nutrient balance of phosphorus has turned positive in the first part of the '60s, whilst nitrogen and potassium only in latter part of the same decade.

By the end of '80s both the phosphorus and potassium supply of Hungarian soils has reached the so called 'good' and 'very good categories'. In the mentioned time period, it was possible to measure 800–1000 kg/ha P_2O_5 and K_2O accumulation. As for the nitrogen supply we can mention that more than 70% of our soils belong to the 'medium', or a higher category. The 'annual positive balance period' has lasted until 1990. The nutrient up-take of the cultivated plants of a given year has neither been in balance until the '60s, nor after 1990.

From the '90s on till nowadays, the nutrient management can be characterised by negative phosphorus and potassium balance. In regard of the nitrogen, the balance has became slightly positive after the year 1999. According to data of the nutrient balance, the amount of nitrogen has been roughly covered by the manure practice (NÉMETH 1996).

One of the most important declared aim of the agro-environmental subsidies is related to the reduction of the negative effects on our environment, and to accordingly decrease the utilised amount of chemicals used in everyday agricultural practice. The widely and mostly used agent of nutrient dosage is organic and inorganic nitrogen. This is because the most 'spectacularly' effect on yield growth can be achieved with gradually increased nitrogen input. At the same time nitrogen overdose may lead to the highest environmental risk and causes negative effects. These phenomenons originate in the high and intense mobility of various chemical forms of nitrogen and in rapid transformation processes.

Environmental nitrogen may come from various source, though the highest amount of the potentially pollutant nitrogen is the result of agricultural activity. With respect to its origin, there are organic sources and inorganic as well, provided the use of artificial fertilizers. The amount of nitrogen in the environment is one of the most important pressure (impact) indicator, which fundamentally determines the state (condition) of surface and underground water.

The protection of surface and underground water resources against the impact of nitrogen deriving from agricultural activity is regulated by the 27/2006. (II. 7.) statutory order (and its predecessor 49/2001. (IV. 3.) through the utilization of the data deriving from data supply obligations.

Beside the identification data of the farmer and (stock-)farm, the database is proportioned into two fundamental part, which are:

- animal stock data and technological description of the farm (plant level), and the
- agricultural field-linked data typical for manure (both organic and inorganic) activity.

Animal stock dataset shows the number of animals on the 31st December of the given year. Cohort classes on species level must be described as well.

Breeding technology decisively determines the amount, the nitrogen content and the effect of dung on our environment, therefore it has to be described in precise details. Beside all the above mentioned points, it is essential to note the amount and portion of the annually generated dung that:

- has been utilised during agricultural activities (crop cultivation etc.),
- has been stored, and/or
- has been sold or bought to/from another farm.

All categories are presented on the datasheet. The necessary data regarding the storage of the dung is part of the information that has to be supplied on the farm.

The other important dataset is dealing with the utilised amount of nitrogenous fertilizers. In this section the following points must be noted on the datasheet:

- name of the settlement,
- the topographical number of the relevant field (parcel),
- type of fertilizer,
- specific nitrogen content of the fertilizer,
- the utilised amount, and finally
- the nitrogen amount per managed hectare.

Table 2. Data supplying sheet for farmers
2. táblázat Adatszolgáltató adatlap a gazdálkodók számára

Data supplying sheet for farmers

1. Basic data of the person practicing agricultural activity

Name of farmer					
Official residence/ZIP code		Settlement		Street, nr.	
Standard statistical number				Tax id.code	
Name of contact person				Telephone nr.	

2. Data of the stock-farm (separate data sheet has to be filled for each farm!)

Name of stock-farm (if any):			Settlement and address		
Street, nr.		Topographical nr.		Nitrate Sensitive Area **Y/N**	

2.1. Annual mean number of livestock in 2005

Animal species		Type of animal breeding (farming type)		Nr. of animals
denomination	code	denomination	code	piece

2.2. Amount of annual dung quantity and amount of dung stored at 31st of December

Liquid manure	Stored liquid manure		Farmyard manure (dung)	Stored farmyard manure (dung)		Stored N fertilizer	
m^3	m^3	code	t	t	code	in N tons	code

3. Data on manuring (fertiliztion) methods in the year of data supply

Settle-ment	Field code	Topo-graphical nr. of the field	Culti-vation method	Area [ha]	Utilised liquid manure [m^3/ha]	Utilised farmyard manure [t/ha]	Utilised N fertilizer [in N kg/ha]	Total amount of N of utilised organic manure [kg/ha]	Type of organic manure

Declaration: (Salesmen should indicate customers and vice-versa if the dung, manure does not derive from own farm)

Name		Address		Street, nr.	
Sold/bought amount [t]					

Date: ………………………………………………

signature

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- name of the settlement,
- the topographical number of the relevant field (parcel),
- type of fertilizer,
- specific nitrogen content of the fertilizer,
- the utilised amount, and finally
- the nitrogen amount per managed hectare.

A data supply obligation included in the law forms the basis of the database in terms of measuring and estimating possibilities. The 27/2006 (II. 7.) statutory order and its predecessor 49/2001. (IV. 3.) specifies data supply obligation for farmers and growers managing fields on Nitrate Sensitive Areas (NSA) till the 28th of February each year. Relevant data has to be sent to the competent authority of the given county, which is – from the 1st of January 2007 – the Directorate for Plant Protection and Soil Conservation of the Agricultural Administrative Authority. The limitation of the use of the data is the non-holistic data supply. At the launch of the programme in 2002, only 15–20% of the nitrate sensitive plough lands were covered by data supply. Regarding the data on the number of animals and breeding technologies the situation was much better. The initial difficulties primarily came from the information shortage among the farmers themselves. Thanks to the effort of the professional in the field of soil protection, more and more farmer fills the datasheet correctly and returns it to the competent authority. This 'development' is stimulated by other circumstance as well, because a certificate stating the precise fulfillment of data supply has to be attached to numerous applications and tenders. From 2006, there is an option for sanctioning the mismanagement of the data supply.

Following chart demonstrates the increase of data supply affinity in Pest County. Though such significant leap could not be demonstrated in all counties, the number of received datasheets has exceeded 1000 in many of them.

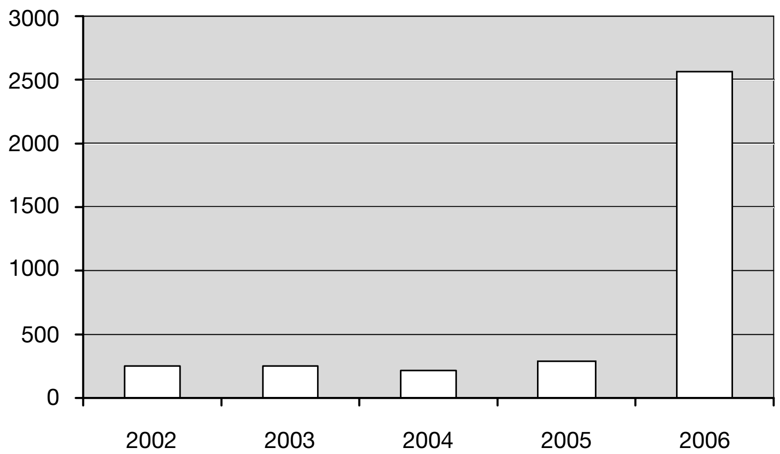

Figure 1. Number of nitrate datasheets obtained from Pest County
1. ábra A Pest-megyében összegyűjtött nitrát adatlapok száma

The potential impact of various animal breeding technologies on nitrate sensitive areas (NSA) – which form the half of the countries agricultural territory – can be analysed in virtue of data regarding the technology, method and type of breeding of the farms. Comparison can be accomplished between nitrate sensitive and non-sensitive areas in terms of area specific animal stock or technological development. Later on technological development and animal stock growth can be modeled on a time scale as well.

With the analysis of dataset of the utilised dung, it is achievable to characterize the nitrogen input on parcel, field, farm or region level. One of the most easily accessible dataset is the nitrogen input per hectare. This informative index can be relevant for the total or only the manured agricultural area. Unfortunately, in lack of crop yield data it is not possible to estimate or calculate nutrient balance of an area. With the complex evaluation of the data concerning dung (manure) storage and use it is achievable to specify the real environmental impact through the validation of animal stock. For instance environmental impact can be lower even in case of high-animal-density regions, if it is characterised by well-developed dung storage and utilization, while a lower state of development in these technologies and agritechniques can cause more serious problems even at lower animal density. By the assessment of data from the past it is possible to define the trends of development.

Water erosion

The effects of natural erosion belong to the most important processes that affected and still affecting the landscape development. The climax vegetation causes equilibrium between the rate of water induced soil erosion and natural soil formation. Man interrupted this equilibrium with cultivation of the soil, cutting the forest, introducing arable farming, orchards, vineyards, pastures and grasslands. This interference caused severe increase of water erosion processes.

Erosion is a Latin origin word: "…destruction of any living or non-living material; chewing away and sometimes destruction of other material, force or medium".

From pedological point of view, erosion is "...a summary of degradation forces that causing continuous thinning of the upper soil layer or its fast degradation, this way its yield is weakening or becomes unsuitable for arable farming". There are several well-known methods for measuring soil water erosion.

Qualitative methods reveal the presence of water erosion with categories

a) based on map, stereo-photo or aerial photo analyses,
b) based on examination of soil profiles (comparison of eroded and quasi-original soil profiles).

Quantitative methods:

a) Using the fix point method with measuring sticks. It is not easy to use, there are a lot of influencing factor.
b) Measuring water erosion on parcels under natural rainfall provides exact data from small areas (1–300 m^2). Data available on the following settlements: Somogybabod, Csákvár.
c) Measuring water erosion on parcels under artificial rainfall provides exact data from small areas (1–300 m^2). The advantage of rainfall simulations is that we can make unlimited number of replications. Disadvantage: expensive. Data available on the following settlements: Nemessándorháza, Somogyvár, Somogybabod, Balatonszabadi, Tihany.
d) Use of the Soil Protection Information and Monitoring System. The system has special measuring points where 1 m^2 metal plates are buried, this way the change of soil thickness can easily be measured. Data are available on 36 sites.

Estimating and forecasting water erosion with models

The most widely used soil water erosion model is the Universal Soil Loss Equation (WISCHMEIER and SMITH 1978, CENTERI 2002). This model was used to prepare the soil loss map of the following settlements in Hungary: Nemessándorháza, Somogyvár and Balatonszabadi. The soil loss calculation maps, made by the USLE model are available for the following areas:

1. sample site of the Mosoni Plain ESA (Environmentally Sensitive Area) (approximately for an area of 240 hectares at the scale of 1:10000).
2. sample site of the Borsodi Plain ESA (approximately for an area of 240 hectares at the scale of 1:10000).
3. part of the Sárvíz Valley (approximately for an area of 1000 hectares at the scale of 1:10000).

Other models used besides USLE in Hungary are:
a) EPIC (Erosion Productivity Impact Calculator) (HUSZÁR 1999),
b) WEPP (HAS (Hungarian Academy of Sciences-RISSAC (Research Institute of Soil

Science and Agricultural Chemistry), HAS-Research Institute of Geography) (CENTERI et al. 2004),

c) EUROSEM (Szeged University) (BARTA 2004),
d) SWAT (Veszprémi University – Keszthely),
e) MEDRUSH (HAS-Research Institute of Geography) (TÓTH et al. 2001).

For the monitoring of the rate of water erosion we plan the following activities:

1. On the chosen research sites it is possible to set up extra water erosion monitoring sites in the network of Hungarian Soil Protection Information and Monitoring System. The method is simple and economically viable. The method is based on a 1 square meter aluminum plate, buried under the soil surface. Researchers check the soil thickness above these plates yearly, thus they can measure the rate of soil water erosion or sedimentation.
2. The Hungarian Soil Protection Information and Monitoring System separates the slope into three sections: upper slope third, middle slope third and lower slope third. In connection with the monitoring sites it is possible to measure the thickness of the soil layers with a Pürckhauer type sore sampler in every slope third and at least in 5 replicates. This way we can collect enough data from one site for statistical analyses even in one year if we compare the slope sections.
3. Besides the core sampling it is possible to collect average soil samples from the upper 0–20 cm (or even deeper 20–40, 40–60 etc.) layers. We can use the laboratory results (together with the data on land use, amount and type of fertilizer, depth and way of soil management etc.) to describe the movement of soil nutrients and soil organic matter over the slope. It is possible to conclude information about water erosion based on other soil parameters (e.g. pH, stickyness or particle size distribution).
4. It is possible to prepare forecast about the rate and spots of possible soil loss rates with USLE (and possibly with WEPP, MEDRUSH or EUROSEM models), maps of soil water erosion (in case the database are available).

References

BARABÁSI A. L. 2002: Linked. The new science of networks.

BARTA K. 2004: Talajeróziós modellépítés a EUROSEM modell nyomán. Doktori (PhD) disszertáció. Szeged, p. 84

BLASCHKE, T. 2000: Die Vernetzung von Landschaftselementen: Die Rolle von GIS in der Landschaftsplanung. Landschaftsplanung und GIS 6., p. 17–26.

BLUME, H. P., SUKOPP, H. 1976: Ökologische Bedeutung anthropogener Bodenveränderungen. Vegetationskunde Heft 10. Bonn–Bad Godesberg, p. 75–89.

CENTERI CS. 2002: A talajerodálhatóság terepi mérése és hatása a talajvédő vetésforgó kiválasztására. Növénytermelés. 51: 211–222.

CENTERI, CS., BARTA, K., JAKAB, G., BÍRÓ, ZS., CSÁSZÁR, A. 2004: Comparison of the results of soil loss prediction with WEPP and EUROSEM models based on ‘in situ’ soil loss measurements. Conference Proceedings of the 4th International Congress of the ESSC, p. 355–357.

CSORBA P. 2005: Kistájaink tájökológiai felszabdaltsága a településhálózat és a közlekedési infrastruktúra hatására. Földrajzi Értesítő, 54: 243–263.

FORMAN, R. T. T. 1995: Land Mosaics: The Ecology of Landscapes and Regions. Cambridge University Press, Cambridge, UK

GOODWIN, B. J., FAHRIG, L. 2002: How does landscape structure influence landscape connectivity? Oikos 99: 552–570.
GUSTAFSON, E. J. 1998: Quantifying landscape spatial pattern: what is state of the art? Ecosystems 1: 143–156.
HUSZÁR T. 1999: Talajerózió-becslés az EPIC-EROTOP módszerrel. Földrajzi Értesítő, 48: 189–198.
MCGARIGAL, K., HOLMES, C. 2002: Fragstats: Spatial pattern analysis devloped for quantifying landscape structure. USDA Forest Service, Pacific Northwest Research Station, Corvallis, OR.
MERRIAM, G. 1984: Connectivity: a fundamental ecological characteristic of landscape pattern. In: Brandt, J., Agger, P. (eds.): Proceedings of the First International Seminar on Methodology in Landscape Ecological Research and Planning Vol. I. Roskilde Universitessforlag GeoRue, Roskilde, Denmark) p. 5–15.
MILNE, B. T. 1988: Measuring the fractal geometry of landscapes. Appl. Mathem. Comput. 27: 67–79.
NÉMETH T. 1996: Talajaink szervesanyag-tartalma és nitrogénforgalma. MTA TAKI, Budapest
TAYLOR, P. D., FAHRIG, L., HENEIN, K., MERRIAM, G. 1993: Connectivity is a vital element of landscape structure. Oikos 68: 571–573.
Termelői adatbázis, MVH, 2006.
TÓTH A., SZALAI Z., JAKAB G., KERTÉSZ Á., BÁDONYI K., MÉSZÁROS E. 2001: Talajpusztulás modellezése a MEDRUSH modell alkalmazásával. Földrajzi Értesítő, 49: 1–4.
TURNER, M. G. 1989: Landscape ecology: the effect of pattern on process. Annual Review of Ecology and Systematics 20: 171–197.
WIENSR J. A., MILNE B. T. 1989: Scaling of 'landscapes' in landscape ecology, or, landscape ecology from a beetle's perspective. Landscape Ecology 3: 87–96.
WISCHMEIER, W. H., SMITH, D. D. 1978: Predicting rainfall erosion losses. USDA Agriculture Handbook 537, Washington, D. C., p. 58
Working document VI/43512/02 Final on common indicators for monitoring the planning of Rural development and working document VI/12004/00. Common Evaluation Question with Criteria and Indicators

A KÖRNYEZET ÁLLAPOT ÉRTÉKELÉS JAVASOLT TÁJI ÉS AGRÁR-KÖRNYEZETGAZDÁLKODÁSI INDIKÁTORAI

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Kulcsszavak: tájökológia, indikátorok, agrár-környezetvédelmi program

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indikátorainkat a Tudomány Napja alkalmából, a Magyar Tudományos Akadémián 2006-ban elhangzott előadásunk alapján mutatjuk be. Ezek a következők: a, táji indikátorok: 1. tájmintázat, 2. tájtagoltság, 3. tájhasználati állandóság, 4. összekapcsoltság (konnektivitás), 5. a táj egészségi állapota; b, agrár-környezetgazdálkodási indikátorok: 1. a programokba bevitt területek nagysága és célprogramonkénti megoszlása, 2. a nagytáblás és kisparcellás termesztés aránya (ezen belül, extenzív és intenzív művelési arány), 3. nitrogén kibocsátás (szerves+szervetlen), 4. erózió. A kiválasztott indikátorok feldolgozásának szempontjai, főbb pontjai az alábbiak: az indikátor neve, az indikátor kiválasztásának indoklása, az indikátor definiálása, az indikátor mérési/becslési lehetőségei (a felhasználható térképekkel és adatbázisokkal), az indikátorral tervezett monitoring-tevékenység.