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GEOECOLOGICAL MAPPING IN A KIS-SÁRRÉT STUDY AREA

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Összefoglalás: Napjaink tájkutatásának fő célja megvizsgálni, hogy egy adott terület hasznosítási típusa mennyire felel meg a táji adottságoknak és milyen társadalmi tevékenység helyezhető el a legkisebb kockázattal a tájban. Az ember, mint meghatározó tájalkotó tényező, egyre nagyobb intenzitással befolyásolja a táj alakulását, működését. A kutatás célja a választott mintaterület antropogén-technogén táji mechanizmusának feltárása, a táj felépítésének és működésének megismerése. Mintaterületünk a Körös-Maros Nemzeti Park északi része Biharugra környékén. Fontos nemzetközi madárátvonuló és fészkelőhely, 1997 óta védettséget élvez. Határmenti elhelyezkedése a tájhasznosítás szempontjából speciális feladatok megvalósítását igényli a határ mindkét oldalán. Ezek közül fontos a környezeti tudatosság, a konfliktusok kezelése, az agrár- és vidékfejlesztés, valamint a környezet- és természetvédelem összehangolása. Fontos a település hatása is a tágabb környezet alakítására. A tájhasználat során elsősorban a terület természetvédelmi funkciójára kell figyelmet fordítani, ez pedig tudatos tájhasználatot jelent. A legmegfelelőbb tájhasznosítás csak a környezetgazdálkodási és a fenntartható fejlődés alapelveinek a figyelembevételével történhet. A tanulmány kísérletet tesz a biharugrai mintaterület jelenlegi tájökológiai állapotának meghatározására és a jövőbeni kezelés főbb szempontjainak megállapítására a természetvédelem és a tájtervezés számára. A kutatás eredményeinek gyakorlati alkalmazásával lehetőség kínálkozik a természetvédelmi határok bővítésére, szakmailag megalapozottá válhat az egységes európai zöldfolyosó-hálózatok kialakítása (ECONET, NATURA2000). A tényleges területhasználat és a területhasználat-korlátozási térkép összevetésével meghatározhatók azok a javasolt (ökológiai szemléletű) beavatkozások, amelyek elősegítik a Körös-Maros Nemzeti Park, a gazdálkodó szervezetek és a lakosság optimális területhasználatának kialakítását.

Summary: Nowadays, the main aim of landscape research is to find out how a land use type of a given area suits the land potential and what sort of social activities can take place there with the minimum risk. Humans, as determinant factors of the landscape, have more and more influence on the functioning and shape of the landscape. The goal of the research is to explore the antropogenic-technogenic processes along with the structure and function of the landscape. The study area is part of the Körös-Maros National Park and it can be found in the North of the park, near the village Biharugra. It is an important bird and wildlife habitat, protected since 1997. It is a peripheral rural landscape near the frontier, which means peculiar tasks for both sides of the border. The most important of these are raising the environmental awareness of the inhabitants, the handling of environmental conflicts, the harmonisation of agricultural and rural development with environment protection and nature conservation and to find out how the natural state of the settlements affect the wider environment. While using the land particular attention must be gave to nature protection, which means conscious land use. The most adequate land use can be chosen on the basis of the principles of environmental management and sustainable development. This study tries to specify the present landscape ecological state of the research area and to provide some guidelines for future nature conservation and landscape planning. By using the results of this research there is a possibility to extend nature conservation area and the unified European network of green corridors could be established (Natura 2000). Comparing the map of actual and limited land use we can determine all those suggested interventions wich will help to form the optimal land use for the inhabitants, the agricultural organizations and the National Park.

Keywords: landscape ecology, land use, biodiversity, geoecological mapping, ecotope – forming function, nature protection function

INTRODUCTION

The essay is introducing an interdisciplinary landscape ecology analysis in the Körös-Maros National Park, Kis-Sárrét area. The changes caused by human activities explain the neccessity of the research, as nowadays it is evident that people play an important part in shaping the land. The qualitative and quantitative characteristics of the relationship between nature and human are revalued.

Applied landscape ecology researches point out – from knowing a state of a land – how to work out an appropriate proposal for the future, which sketches the potential of the land around the examined area. Mainly the project is to fit the different social activities into the land with the least risk (*Miklós,* 1994).

The aim of the essay is to estimate the ecotope-forming functions and natural protection values of the land with the help of the connection between the protected and non-protected area's soil and vegetation in the Biharugra part of the Körös-Maros National Park. A further aim is to allocate all those potential land-shaping processes, which can determine the structure of the land use and the function of a given land.

The ecotope-forming function expresses the changing extent of the anthropogenic impact affecting the land. Because the natural protection value can be decreased very easily we have to give attention to preserve the species present. Knowing some land functions and comparing the actual land use with the map of limited land use, all those interventions can be specified which help to create an optimal land use of an area.

METHODS AND DATA

Our method of geoecological analysis lays the emphasis on the ecotopes as spatial cells of the ecosystem. During the examination of landscape function, estimating the biogenic factors is indispensable. The abiogenic factors have a great influence on the attributes of the biotopes and the ability of regeneration, evolution and the composition of the biogenic factors also depend on it (*Keveiné Bárány,* 2003). This complex view is better for practical use and it helps in carrying out real geoecological research and planning. (*Deák,* 2003.)

By the above-mentioned method, we classified the landscape patches (ecotopes) by taking the vegetation and plant association into consideration along with the dominant land use. The ecotope is determined in space, through the effects of biotic and abiotic components of the landscape.

Our task was to define the functions and the developmental tendency of the study area with the segregation of its homogenous units and examine their structure.

Considering the geoecological mapping the analysis consisted of three steps. Data collection meant separating the information into a database on the basis of remote sensing data of the maps and satellite imagery, monographies of the study area and some data of the descriptive mapping (examining the ground-water level, the vegetation, climate and the relief). Some geoecological data like the plant associations and soil samples of the vegetation patches were point-like data. By analysing the gathered soil samples we defined the type of soil with the help of customary soil examination methods. During our research work we accomplished a twenty-four hours-long microclimate measurement as well. The purpose of this measurement, carried out in a meadow called Nagy-Szik, was to acquire more microclimate data of the wide saline steppes. All these climate attributes and the special soil characteristics give an opportunity for specific vegetation to form.

While processing the data, we were using a special system called the Geographical Information System (GIS) just to establish the connection between the quantitative and qualitative attributes of these data. We used the following software: ArcInfo 7.0, ArcWiev 3.1, and ERDAS Imagine 8.2.

During the geoecological-based land evaluation we examined the filter- and buffer function of the sampled area, and we also had a look at the ecotope-forming and nature protection function too. The method of evaluating the ecotope-forming and nature protection values of different plant associations was published in 1997. *Keveiné Bárány (*1997) was the first to use this method. The following step of the synthesis was to visualise cartographically the evaluation of landscape efficiency (making a geoecology map). This process resulted in three maps made in a complex problem-orientated way.

Selection criteria for the investigated area and it's geographical characterisation

The study area called Kis-Sárrét belongs to the Körös-Maros National Park since the 8th of January 1997 (*Fig. 1*). This area (Kis-Sárrét) is located on a 0.7899 km^2 field near the frontier (borderline), south from the villages Körösnagyharsány, Biharugra, Zsadány, Mezőgyán, and Geszt. The area − isolated by both county border and frontier − is being considered a periphery from both economical-social and geographical view. It is very important to mention the almost untouched natural values, such as: wetlands, alkaline soils, plant communities, the species diversity caused by the mosaic land structure assign the land international significance. During the designation of nature conservation sites investigations aiming to achieve sustainable land use methods were not emphasised. The deficiency of this kind of examination is one of the main causes of the neccessity of geoecological research. To achieve this preservation of biodiversity it is inevitable to make sure that we keep an appropriate land-size and look after adequate- sized flora and fauna populations. We have to take into account all these principles during the protection (*Rakonczay,* 1998).

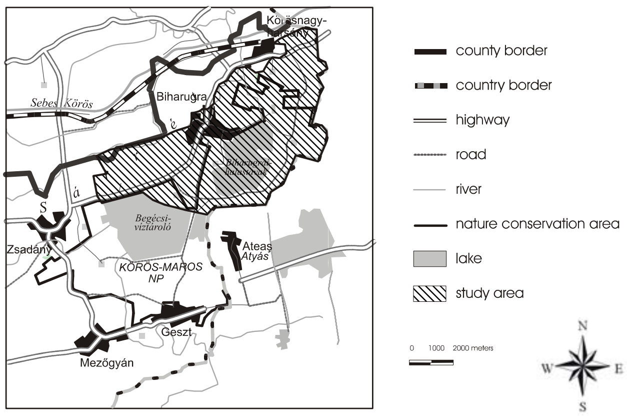

Fig. 1 Geographical location of the researched area

The research is examining the state of the biotic and abiotic factors, their interaction and operation around the sub-river basin. Our goal was to provide a basis, which can be useful in geoecological examinations for other areas.

Next we are going to survey some abiogenic factors which have influence on the geoecological system of the sample area.

Geographical characteristics of the study area

The Kis-Sárrét is a flat plain area on the alluvial fans south of Sebes-Körös with surfaces above 85-95 meters altitude. At present, Quaternary gravel, sand and clay predominate on the surface, which results in floodplain, meadow and alcalic soils. Around 1910 an embankment surrounded the swampy area of Biharugra. In the 1960s, the draining and filling up of nearby swampy areas established another part of the fishpond system. A canal connected to the river Sebes-Körös is the main water supply for the fishpond system (*Pécsi*, 1969).

In the 19^{th} century the landscape has been changed by the regulation of the rivers and the building of agricultural drains. In 1905 there was a remarkable wave of artifical fishpond creation which significantly changed the landscape. The amelioration works in the 80ths and the above-mentioned anthropogenic actions resulted in a continuous drying up of the water meadows. The hydrography of the area is extremely varied. The Kis-Sárrét part of the Körös-Maros National Park is located on the 2500 km^2 river basin of the Sebes-Körös.

As a result of the frequent floods and diminishing arable lands in the year 1860 the Sebes-Körös was regulated and a new river bed was created. From this time on the former landscape of the flood basin consisted of a mosaic system of billabongs, dried-up rivers, dried-up surfaces, meadows and grasslands. In the hydrography respect the fishponds of the Begécs and Biharugra area belong to the central area of Kis-Sárrét. Those ponds were built in 1905. Nowadays it is 20.20 km^2 of which 16.57 km^2 are water surfaces and 2.62 km^2 are sedgy.

This area is quite rich in small canals and watercourses. In our study area – north-east from Biharugra – two patches of protected meadows can be found (Ugrai- and Sző-rét). They get their water supply only from precipitation but sometimes from the Biharugrai-Tápláló-drain in an artificial way.

Because of the good water supply conditions the whole area of Kis-Sárrét is extremely rich in groundwater. The difference of the groundwater levels between the humid and the arid periods reaches 3-4 meters at times. Therefore, the whole of this area is endangered by periodic groundwater flooding.

On account of the special geological structure the salt concentration in the groundwater is high and its wash-out is mostly weak. The waters of Pliocene layers contain high amount of sodium hydrogen carbonate and sodium chloride.

This area – in terms of the drying tendency of Alföld-Plain – is droughty and has arid mezo-scale climate. The micro-scale climate is quite important because it has a more extreme climate compared to its environment.

Its wildlife is adequate for the landscape potential. The ecosystem of our study area belongs to the Tiszántúl flora district; 40 protected and 3 strictly protected plant species can be found here. Concerning the fauna this is a part of the Közép-Duna fauna district and the Alsó-Tiszavidék.

Around Biharugra fishponds and wetlands have developed and temporarily they give an appropriate biotope for the migratory birds. The fishponds of Biharugra are perfect nesting, passage and resting places for all the nationally and internationally protected bird stock (e.g. white-goose). Several IUCN Red List bird species can be often seen around the place.

As we know, marsh reclamation, surface water drainage, deforestation, nitrification and the use of insecticides are the concomitants of water regulation and all of these processes cause drying out in wetlands which means the biotopes are exposed to danger. The plant associations of the wetlands, the reedbeds, marshlands and meadows are forced back to a small area. The ecosystem is degraded, and ruled by semi-natural conditions so many species have dissapeared. This area is a Ramsar site since 1996 and it also belongs to the Important Bird Areas (IBA).

RESULTS

Table 1 Landscape patches of the researched area

	Landscape patches
1.	reed-dominanted fens
2.	humid grasslands, meadows
3.	alkalic solonetz meadows
4.	water surfaces with duckweeds vegetation
5.	dry grasslands
6.	brook forest
7.	carolina poplar
8.	arable lands

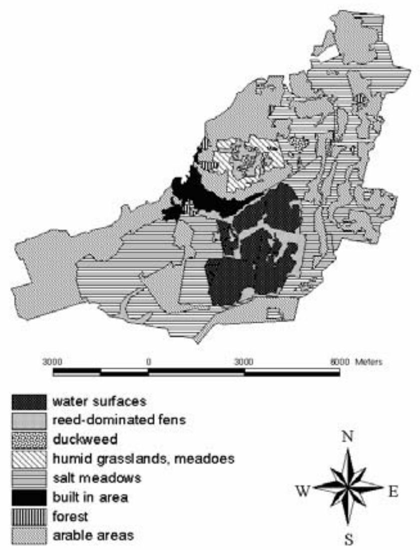

Fig. 2 Ecotopes of the study area

The structure of the landscape

One of the main points of geoecological research is to examine landscapes under the influence on human impact. On this sort of landscape mainly the crops are mixing with different kinds of weed plants. The arable lands and the fishponds are sometimes directly connected with the protected landscape patches, which results in conflict.

Surveying the area, all the available databases and the botanical and coenological survey of the protected areas (*Kertész,* 1997) helped us to choose the mosaically covered landscape patches (*Table 1*).

Determining the values of the ecotope-forming and nature protection functions and during the geoecological mapping procedure, we only examined those representative geoecological patches wich can also be mapped (*Fig. 2*).

We defined the ecotopes covering the land by the aggregation of the biotopes.

From the next examinations we left out the water surfaces of Ugrai-lake, the built in areas in Biharugra village and the forest patches. The attributes of the brookforest add to the attributes of the reed-dominated fens and humid grasslands patches. The dry grasslands' parameters add to the degraded vegetation of alkalic solonetz meadows and wet garsslands.

Buffer capacity of the soils

The soil is one of the most important abiogenic factors of the landscape processes. We accomplished the evaluation of the soil's filter capacity function with the earlier used analysis for geoecological mapping (*Leser and Klink,* 1988). To characterise the filter capacity we need the mechanical composition and the consistence of the soil.

The mechanical buffer capacity is the ability of the soil with which a part of the infiltrating contamination can be fixed. The soils usually have high mechanical buffer capacity, apart from the patches of brook forest and the humid grassland. Those two got medium value as a consequence of the permanently high level of ground water.

The physical-chemical buffer capacity namely the adsorption capacity primarily depends on the surface-associated activity. The patches of dry grasslands, fens and meadows have got high physical-chemical buffer capacity, the salt meadows and carolina poplars show medium values and finally the brook forest and humid grasslands have quite low buffer capacity.

Considering that the sample area is under protection we do not have to count on a serious polluting economical impact but some human activities make a contribution to metal accumulation in the soil. Unfortunately, the deposition of the communal waste of the surrounding local villages is not sorted out yet and the already existing waste piles are illegal. The heavy metals – with physical, chemical and biological transformation of the environment – can easily dangerously accumulate in some places. The buffer capacity of the soil concerning heavy metals is highly pH-dependant. Soil samples from the uppermost soil layer (30 cms) showed that the heavy metal fixing ability of the soils is strong in the brook forest and stronger in the other patches (*Mezősi and Rakonczai,* 1997).

Microclimatic characteristics of salt lands

The special microclimatic features of the salt lands and the soil characteristics make it possible for a unique vegetation to form. During a 24-hour microclimatic surveying we measured the air temperature, humidity, the wind speed and the temperature of the soils in 2-5-10-20-30 cms depths.

The measurements prove that the Nagy-Szik area has more extreme microclimate compared to its surrounding wetlands. The temperature fluctuation per day is relatively high; it even appears in the changes of soil temperature going down deeper, the amplitude shows decreasing tendency.

With the daily strong rise in the temperature, there was a powerful wind from the surrounding wetlands, of which the direction changed because of the decrease of the nightly temperature (*Duray and Hegedűs,* 2000).

Ecotope-forming values of the study area

The ecotope-forming function of the landscape patches was defined by the quantification of the maturity (M), naturalness (N), diversity (D) and the intensity of anthropogenic impact (A). The method we used is based on a German geoecological mapping technique and improved by the team of the Department of Physical Geography and Geoinformatics, University of Szeged (*Mezősi and Rakonczai,* 1997).

Maturity is the vegetation's successional stage. The long-lived complementary communities of the sampled area, which follow natural succession, are the following: alkalic solonetz meadows, meadows, dry grasslands and carolina poplar. All communities can be considered to be in a degraded phase, which is indicated by the anthropogenic effects. The humid grasslands, fens, brook forest and duckweed communities are more durable, stable and almost untouched.

Naturalness is indicating the regeneration ability of the community and all these are – even against the effects of disturbing factors – stable and the ecological potential of the habitat is suitable. The communities of the alkalic solonetz meadows, humid grasslands, fens, brook forest and duckweed represent higher levels of naturalness. The meadows, carolina poplar, dry grasslands have lower naturalness level.

The more diverse a community is, the more stable too. The measurement of diversity can be defined by the species richness (R) and the structural diversity (S). The reed-dominated fens, brook forest areas and dry grasslands are the richest in species. The communities of the meadows and humid grasslands show a medium value and the communities of duckweeds show low number of species. Compared to the surrounding places, the communities of carolina poplar, dry grasslands, alkalic solonetz meadows and duckweed have high structural diversity. We can conclude that the diversity (according to the richness of the species and the structural diversity) of the brook forest and dry grasslands areas is the highest. After this come the salt meadows and carolina poplar, the humid grasslands, meadows and finally the least stable so more sensitive reed-dominated fens and duckweed communities.

The most important anthropogenic affect the arable lands, the grazed dry grasslands and the carolina poplar influenced by forestry. There is little human impact on the meadows. The remaining areas show almost natural conditions in terms of conservation.

The ecotope-forming values change between 11 and 17 (*Table 2*). The communities of reed-dominated fens and brook forest have quite high ecotope-forming value (16.5-20) and it is also high in the duckweeds, alkalic solonetz meadows, humid grasslands and meadows (12.5-16). The ecotopes of dry grasslands and carolina popler are a bit lower (8.5-12).

Table 2 Ecotope-forming functions of mixed landscape patches

Type of plant communities	M	N	R	S	D	A	EV
reed-dominanted fens	4	5	4.5	1	2.25	5	16.25
duckweeds vegetation	4	5	1.5	1.5	1.5	5	15.5
humid grasslands, meadows	3.5	5	3.75	1	2.25	4.5	15.25
alkalic solonetz meadows	3	4	3.75	1.5	2.5	3.5	13

Dry grasslands are the richest in species which indicate degradation and the area's general richness of species is also considerable. The most stable, natural and diverse community is the brook forest. This ecotope can be found in the patches of reed-dominated fens and humid grasslands. Despite their low species diversity natural fens, humid grasslands and meadows are stable and have got high ecotope-forming value (*Fig. 3*).

The ecotope factor expresses the stability of the communities of the given area. If the ecotope-forming value is high, the stability and regeneration of the population is high as well. On the examined area the ecotope-forming value is above 11, it means that the present environmental impact does not reach a dangerous level.

Natural protection values of the study area

With the evaluation of the natural protection values (NPV) we can define the different protection demands for the different areas. One of the methods of defining the natural protection function is the above-mentioned German technique. In this case we need to define – apart from the ecotope-forming values (EV) – the rarity (R), endangered status (E), current values (C) and ability for regeneration (Re).

During the assession of natural protection we took into account the rarity of flora and fauna species and also their endangered status. The current value represents the percentage of the vegetation-pattern in the possible potencial vegetation. The ability of regeneration denotes the duration needed for the complete regeneration of the ecosystem.

The natural protection values change between 28 and 34. According to the results the brook forest fens and duckweed communities have quite high values (32.5-50) and require special protection. The remaining parts of the land, the humid grasslands, alkalic solonetz meadows, dry grasslands and carolina poplar have high natural protection values (24.5-32) and they are also natural conservation areas. In practice the natural protection function is altering in the areas of carolina poplar characterised by forestry and hunting activity. As a result of grazing on the patches of dry grasslands the vegetation is highly degraded. During the determination of natural protection values and its geoecological mapping we worked with aggregated landscape patches similary to the ecotope-forming values. In this way we got the natural protection values of the homogenous landscape units as it is seen in *Table 3.*

Table 3 Nature protection function of mixed landscape patches

Type of plant communities	EV	R	E	C	Re	NPV
reed-dominanted fens	16.25	2	5	5	4.5	32.75
duckweeds vegetation	15.5	2	5	5	5	32.5
humid grasslands, meadows	15.25	2	5	5	5	32.25
alkalic solonetz meadows	13	2	5	5	4	29

In the case of geoecological evaluation – apart from analysing the naturalness and human impact – we need to examine the ecological requirements of the species in detail. With describing the natural conservation aspects of the plant communities there is a possibility to allocate another kind of natural protection value. This technique takes the temperature-, water- and soil reaction of the plants into consideration (*Simon,* 1992; *Zólyomi et al.,* 1967). This kind of qualifying methodology was used to check our method.

Proposal for an optimal land use

Kis-Sárrét – appart from the strictly protected patches – is an area used by humans and it is the reason of how the current land use suits the attributes of the land. By the results of the data processing and evaluation and taking the present and future natural-social demands into consideration the proposal of an optimal land use in the near future could be accomplished. This prediction is based on geoecological maps, which are the products of geoecological mapping, made in different problem-orientated combinations.

Map of limited land use

The map of limited land use is a structural model edited by the results of geoecological mapping and the present land use (*Fig. 3*). According to the results of our investigation, on the strictly protected parts of the study area it is allowed to use the land as meadows and in some places as pasture (Ugrai-rét, Sző-rét, and Nagy-Szik); the carolina poplars are under forestry management. It would be advisable to discontinue all the agricultural work in this area.

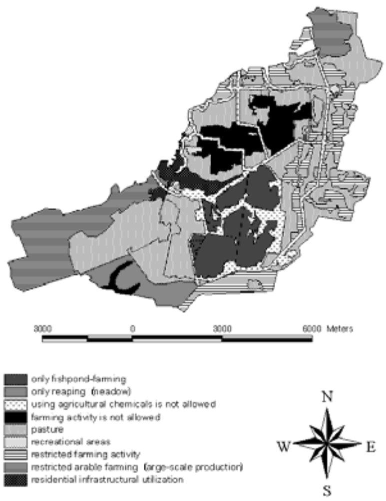

Fig. 3 Map of limited land use

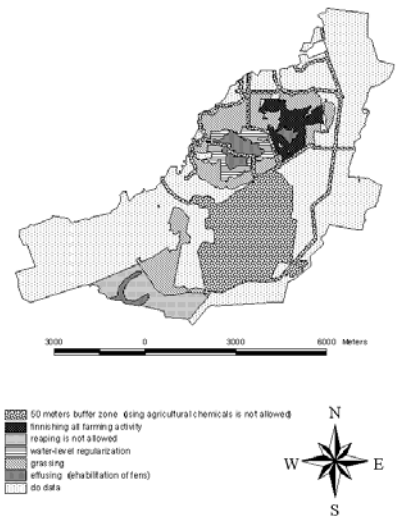

Fig. 4 Map of necessary ecological interventions

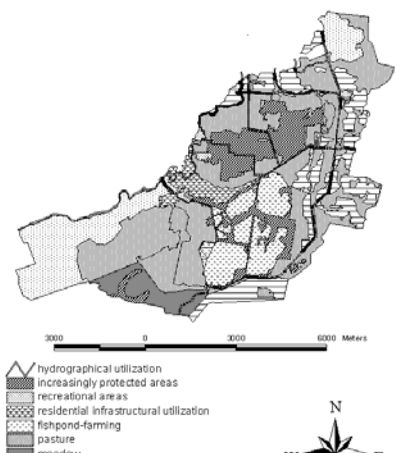

Fig. 5 Map of optimal land use

On the protected alkalic solonetz meadows the grazing and mowing are the most used forms of farming. When grazing, the animals can cause structural damage in the soil. Such processes take place on the dry grasslands (Cserepes-dűlő), therefore in this area only mowing should be allowed for the sake of the protection of the salt lands' plants. On the relict fens of Kis-Sárrét some fishponds have been formed (Biharugra fishponds).

The differently protected and mosaically structured ecotopes are in direct contact with the arable lands and this is the reason why some land use conflicts arise. In the small gardens near the border (Vaskapu-dűlő, Mályvás) only limited small-scale farming is allowed. West from Biharugra village the intensive large-scale farming is dominant.

The map of limited land use shows that about half of the study area (50.1%) belongs to a partly limited land use category. All these activities can be done without restriction but others are prohibited. On 40% of the land only controlled farming is allowed like fishing, grazing, mowing and recreational activities. On the strictly protected area it is justified to forbid every kind of farming. It means a 4.5% part of the land. On the parts lying around canals, rivers and fishponds (4.5) the natural environment should be protected by suppressing the agricultural chemicals (prohibited limitative category).

Map of necessary ecological interventions

The map of necessary ecological interventions is based on a dynamic model, which is edited on the basis of the map of limited land use and the demand for land use of the present and the future (*Fig. 4*).

On those areas which are strictly protected and proposed for amelioration the roads have to be given up apart from those for demonstration and treating.

For the sake of the protection of the soil and plants of the solonetz lands on Nagy-Szik it is inevitable to work out more strict rules on mowing and grazing cows.

On Cserepes-dűlő – for soil protection reasons – grazing has to be stopped. The rehabilitation of fen vegetation and the water-supply of the humid grassland are urgent tasks for the sake of the valuable bird species' biotope protection. In the near future a monitoring system has to be established, which should aim the prevention of the wetlands' further drying up. We also need to specify the origin and the amount of water subsitution.

For the protection of waters there has to be a buffer-zone designated fifty meters from the shoreline.

All the above-mentioned interventions correspond with the directives of the European Union and international agreements (Ramsar Sites, CITES etc.). Arable lands which are valueless, peripheral and have poor soil quality and low agricultural potential should be transformed into grassland.

Map of optimal land use

We achieved the map of optimal land use with the help of the prediction model of the geoecological mapping procedure. This map is deduced from the map of limited land use and the map of necessary ecological interventions (*Fig. 5*).

When using the land first we have to keep eyes on the function of the natural protection. It means a conscious land use and – where it is necessery –extending the border of natural protection. Extending the borders of natural protected areas towards Romania would fit the plans of European ECONET and NATURA 2000 system, which are uniform eco-corridor systems. It would connect the similar Romanian ecotopes to the protected Hungarian ones.

Because these landscape patches are mosaically structured homogenous units and directly connected to arable lands it is essential to designate buffer-zones to soften the degradation processes and human impacts.

Another conscious land use type harmonises traditional land use with the optimal land use and the nature protection ambitions. The untouched landscape, the closeness of the country border, the low income level and the unfavourable agricultural conditions are convincing reasons for qualitative soft-turism. Designating recreational areas and biofarming-zones are used to reach these goals.

CONCLUSION

By the geoecological mapping procedure there is an opportunity for multiaspect evaluation which takes into consideration the conditions, the potential and the risk factors of the areas. It is established that on the Kis-Sárrét part of the Körös-Maros National Park – a peripherial area having poor soil quality and low agricultural potential – the use of agricultural methods have to be decreased and more attention need to be paid to protect the salty land patches and wet biotopes. Applying the results of the methodology presented in this paper provides a very good possible way to shape substainable and euroconform land use for the land owners and users.

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