LANDSCAPE-ECOLOGICAL MAPPING IN THE SURROUNDINGS OF SZEGED

ÁRON JÓZSEF DEÁK, ILONA BÁRÁNY-KEVEI

University of Szeged, Department of Climatology and Landscape Ecology, Egyetem u. 2, 6722 Szeged, Hungary, e-mail: aron@geo.u-szeged.hu(university), kornyezetvedok@vnet.hu(home) keveibar@earth.geo-u-szeged.hu

Abstract

Deák J.Á., Bárány-Kevei I.: Landscape-ecological mapping in the surroundings of Szeged. Ekológia (Bratislava), Vol. 25, Supplement 1/2006, p. 26–37.

The new challanges (needed decrease of the area of arable land as joining to EU, overproduction of some crops, defence against increasing floods, environmental and nature conservation demands) raise the question of sustainable, nature-friendly, traditional landscape use and the habitat restoration of the agricultarally intensively used areas. For all these works we must know the different landscape-ecological factors (e.g. surface deposits, geomorphology, hydrogeological situation, climate, soil, vegetation, landscape use) and their spatial spread. We have maps on the above mentioned factors except the actual vegetation and actual landscape use in Hungary. It is important to know the history of the vegetation too to see the development of the landscape.

Recently researchers of the Academy of Hungary's Institute of Ecology and Botany (MTA-ÖBKI) introduced 3 new systems to map the vegetation of Hungary: the **Modified General National Habitat Classification System** (***m-ÁNÉR***) (Molnár, Horváth et al., 2000) and its further developed versions **(mm-ÁNÉR)** (Bölöni et al., 2003); the ***CORINE biotope-map*** system (***CÉT***) (Molnár, 2000) and the ***CORINE Land Cover*** system (***CLC***) *(*FÖMI, 2000*)*.

In this work we show the development of the landscape since the late 18th century via historical and actual CLC-CÉT biotope maps of the surroundings of Szeged. Our actual vegetation mapping work makes part of the new national programme for vegetation-mapping called MÉTA (Hungarian Biotope Map Database, HBMD) which is organized by the Hungarian Academy's Institute of Botany and Ecology in the years 2003–2004.

As a further aim we compare the created vegetation maps with the existing other maps (especially with geomorphological, geological and soil maps) and present the problems of the actual landscape (e.g. secondary alkali-sodification, invasive tree-species, effects of the town).

Key words: biotope-mapping, CORINE, CLC–CÉT mapping, landscape history, landscape-level vegetation pattern, fen-head, alcali-sodic foot

Introduction

Szeged and its surroundings, is situated in the Great Hungarian Plain in Southeastern Hungary and has a special position as here meet landscapes with different characteristics. In the central of the area lays the South-Tisza-valley, which is bordered in the west by the Dorozsma-Majsaian Sandlands, and in the east by the Marosszög (Hungarian flood area of the river Maros) (Marosi, Somogyi, 1990). Here joins the river Maros to the river Tisza, which influence the whole landscape.

Although the natural areas (especially the forest-cover) of the Carpathian-basin has been decreasing since the iron-ages, until the mid-19th century Hungary could preserve a huge part of its natural vegetation cover, which included grasslands and wetlands in the Great Hungarian Plain.

The major changes in this region happened after the regulation of the riverways during the late 19th century. The more nature-friendly, ancient so called *cape-economy* which was dominated by fishing and cow raising, was substituted by cultivation of cereals being in line with the requirements of the increasing population and economy (Bellon, 2000). It changed not just the life of the people but it led to the decrease of natural areas (especially wetlands) and the extinction of some species.

The process of loosing the natural vegetation cover became much faster during the 20th century. It can be seen also that the size and the economical position of a given settlement influenced this process, as the loss of the natural values was faster in the neighbourhood of the biger towns because of the greater human impacts.

Describing the change of the vegetation-cover I created a 1:50 000 landscape historical map-series using the CLC-CÉT (CORINE Land Cover-CORINE-Biotope-map) categories on the basis of old maps (maps of 1st, 2nd, 3rd military surveys) for the late 18th, mid-19th, early 20th centuries. The 2002 map was created according to Deák's own field research with the help of SPOT-4 satelite images (CNES, 1998).

A more detailed 1:25 000 map for the whole Csongrád county according to the m-ÁNÉR system is under construction which tries to explore the natural biotope-pattern of the county. First result is the map of Csongrád-Nagyrét Nature Reserve (Deák, 2001). This work is part of the first attempt to create an actual vegetation map for Hungary in the now running MÉTA (Hungarian Biotop-Map Database) programme (2003–2004) which is co-ordinated by the Hungarian Academy's Institute of Ecology and Botany in Vácrátót.

Methods

Using biotopes (habitats) instead of plant associations has several advantages. The classic coenological mapping puts more stress on the natural habitats, while the biotope-maping includes the highly human influnced weed-communities, planted forests, introduced species dominated habitats, arable lands or even human settlements too. This complex view is better for practical use as well as for the joint-sciences. It helps to do real landcape-ecological researches and plannings.

The used 3 biotope category-systems in Hungary are good for different purposes, and on different scale as their focuses are different, but somewhat overlapping.

The first accepted system in Hungary was the **General National Habitat Classification System (ÁNÉR)** published in Fekete et al. (1997). In 2000 (***Modified General National Habitat Classification System (m-ÁNÉR)***) and in 2003 (**mm-ÁNÉR**, official category-system of the MÉTA programme (Hungarian Biotope-Map Database) (Bölöni et al., 2003) the system was refreshed. This system approaches the landscape from the side of the nature conservation. It groups the described plant-communities into bigger units. It includes comprehensive categories not just for the natural communities but also for the disturbed grasslands, forests, arable land and urban areas. This system is good on 1:25 000 or finer maping scale. This is convenient just for mapping the actual vegetation because the categories are so fine that we can't use it several centuries back because of the less descriptive information of data.

The **CORINE biotope-map (CÉT)** (Molnár, 2000) and ***CORINE Land Cover (CLC) (CLC50 1.4. version,*** FÖMI, 2000*)* systems were introduced together. The use of the CÉT is required, because the CLC is too general for natural or semi-natural habitats. However the CÉT is more general than the m-ÁNÉR, but finer than the CLC. The CÉT includes categories only for natural and semi-natural biotopes! So the CÉT and the CLC must be used together for maping a whole area using CÉT for natural and semi-natural biotopes and CLC for anthropogenic and agricultural biotopes. These categories can be used from 1:50 000 to 1:200 000 scale to give a more comprehensive look at a certain landscape.

The base-maps of the biotope-maps are the 1:25 000 and 1:50 000 Gauss-Krüger topographical maps of the Hungarian Military's Ágoston Tóth Cartography Institute (1992) in our work.

The vegetation researchers can only trust in one reliable, fresh, official field-database now in Hungary at similar works: the State Forestry Service's forest-management plans (ÁESZ, 1998a) and maps (1998b).

We need old maps to create landscape historical map-series. In Hungary the first reliable maps were resulted by the 1st military survey (1764-1787), which has a very fine 1:28 800 scale. This is the base of the late 18th century map. The maps of the 2nd military survey (1806-1869) helped to describe the situations in the middle of the 19th century, as the Szegedian parts were made between 1863-1864 showing the state of the landscape at the beginning of the regulation of the riverways. The situation after the regulation of the riverways is shown on the maps of the 3rd military survey (1:75 000, 1872-1887) and presented on the early 20th map.

All the different maps and their information are converted to the presently used Gauss-Krüger maps with GIS technology using ArcView 3.2.

Results and discussion

In this following section I'll review the results of will landscape historical map series which has 4 parts (late 18th, mid-19th, early 20th, & present situtation maps).

Landscape changes on the investigated area from the 18th century

By the **end of the 18th century** (Fig. 1) almost *half of the natural vegetation cover* disappeared in the surroundings of Szeged. Since the medieval times Szeged was a regional political, cultural, and commercial centre. Szeged was the end point of the Transylvanian salt and wood-transport, an important market and pier-place as here meets the flood areas of the river Tisza and Maros with the Sandlands of Kiskunság and the Loesslands of Banat. The local inhabitants broke up the good-quality, flood-free lands covered by chernozem type of soils in the western (Röszke-Öthalom) and southeastern (Torontalian) boundary soon.

Beside the arable lands in the western boundary of Szeged extended vineyards existed (like Kálvária-hegyek, Francia-hegyek, Tarján). Between the vineyards some patches of the steppe-fields survived and were used as pastures.

The biggest grasslands were situated in the western boundary of Kiskundorozsma. Only few *arable lands*, and the *vineyards* of the Alsóvárosi-szőlők, Subasa and the Öreghegy were inserted in. This area is part of the *Dorozsma-Majsaian Sandlands*. Kiskundorozsma

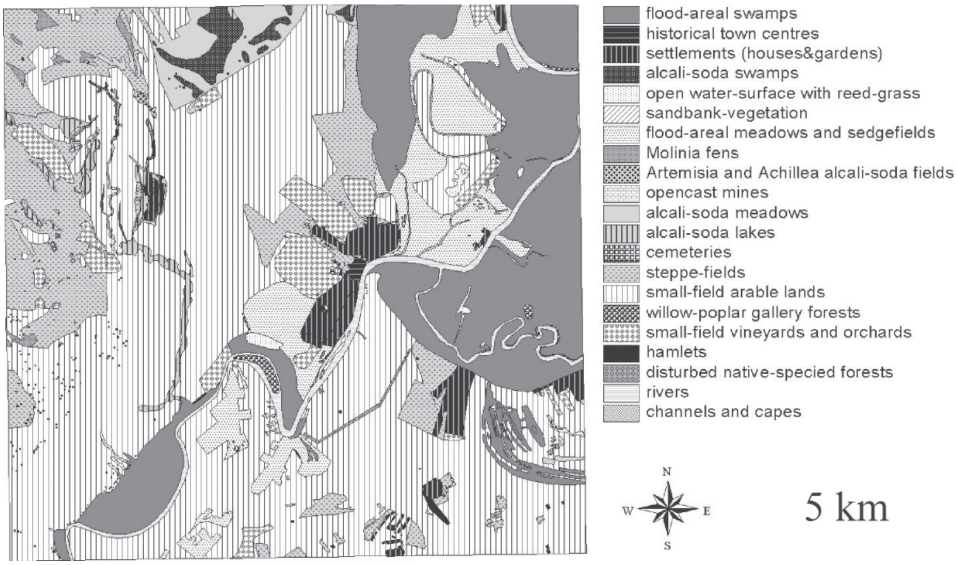

Fig. 1. CLC-CÉT biotop map of Szeged at the and of the 18^{th} century (Deák, 2003).

belonged not to Csongrád county, but to the Kiskunság District. This Kiskunság District with its Kumanian population had special privilege in those times. The *main landscape use* was here the *sheep and cow-farming*. This extensive landscape use preserved many natural areas. So in those times the Kiskundorozsmaian landscape showed the *last natural vegetation cover* of the *Dorozsma-Majsaian Sandlands* whereas the southern part of the same microregion in Csongrád County became mainly arable lands. By the way in the agriculturally intensively used landscapes the most valuable natural areas remain at the borders nowadays too! Probably because it's no-man's-land, is far from the settlements (there were no settlements between Kiskundorozsma and Kiskunmajsa in those times for 40 kms).

What was the **last natural vegetation of the Dorozsma-Majsaian Sandlands** like? The higher elevated areas were covered by closed *sandy-steppe-fields* (*Festuca pseudovina*, *Dactylis glomerata*, *Holoschoenus romanus*, *Crysopogon gryllus* dominated grasslands), where the overgrazed areas - especially where higher sand-dunes existed - could become dry *open sandy grasslands* (mainly *Festucetum vaginatae*).

The most interesting places of this sandland are the depressions situated in sand-furrows. Their vergency and sloping show typical northwest-southeast direction according to the most common wind-direction.

Our recent research pointed out that in one depression both the alcali-sodic and the fen (partly moor) vegetation can appear! Our observation shows that the northwest side of the wind-furrow is mainly dominated by moors or *Molinia fens* (non-alcali sodic vegetation), whereas the southeastern part of the same depression is covered by *alcali sodic vegetation*. Moors were rare in those times too, as the natural forest cover was lost and they began to dry out and just for the fens were the conditions ideal, but during the weter and cooler periods of the past (small ice ages) the moors could be more frequent in such geographical positions. This unique vegetation appearence of the moor and Molinia fen vegetation is named by Deák: **fen-head,** while the alcali-sodic part of the same depression is called: **alcali-sodic foot.**

The vegetation changes according to the Na-content gradient: the fen-head contains less Natrium whereas the alcali-sodic foot has more Na. So the Molinia fens changes first at the alcali-sodic foot to an *Agrostis stalonifera*, *Festuca pratensis* or *F. arundinacea* dominated *alcali-soda meadow*, then to a more alcali-sodic *Puccinellia limosa alcali-sodic-cape-vegetation* in the most sodic parts. As these sand-furrows slope from the northwest to the southeast the water migrates to the southeastern part of the depressions, where it's collected, as these depressions are mainly unoutflowable. As a result of it alcali-soda lakes are formed on the deepest part of the depressions (usually in the SE part). If the water remains for a longer time (regulary until May or June) in the depressions *Bolboschoenus maritimus dominated alcali-soda swamps* are formed on the shore, but if it dries out soon (by the end of the spring) only the *Puccinellia limosa* dominated alcali-sodic-cape-vegetation can appear.

According to our oppinion the groundwater is a mixed water. It appears on the surface or near-to the surface at the fen-heads (upper part of the depressions) because of the sloping of the deposit-layers (NW-SE). After then the water flows further according to the sloping slowly to the somewhat lower elevated southeastern part of the depressions. During this time the evapotranspiration affects this solution and it becomes concentrated, its pH increases. Until the boundary of its solution-capacity it can dissolve more salt from the near-to-surface layers and transport them further to the southeast. The salt-content is unloaded when the water is completely evapotranspirated. This could be the reason for the Na-gradient between the low-Na contented fen-head and the more alcali-sodic foot regions.

In this Dorozsma-Majsaian Sandland area significantly more *alcali-soda lakes* existed in the 18^{th} century. There was very little water in the Fehér-tó (one of the biggest alcali-sodic lake in the Great Hungarian Plain in that time). As it was an intermitting lake its shape was changing according to the water-level determined by precipitation. As there were no draining-channels established, more water could remain. This higher groundwater level helped the surviving of the weter plant communities (not just alcali-soda swamps but *Molinia* fens too). However the bogs and moors began to dry out. The majority of the moor-forests have disappeared except one patch: the Zsombóian ancient-bog (nature reserve). By this time the *steppe-forests* (open sandy poplar and oak forests) have completely disappeared.

An ancient picture of that time showed the flood-area of the river Tisza. The rivers of Tisza and Maros curved freely which were bordered by huge *flood-areal swamps*. The rivers built sandbanks and there were 2 islands in this Tisza river-section too: one at Hattyas,

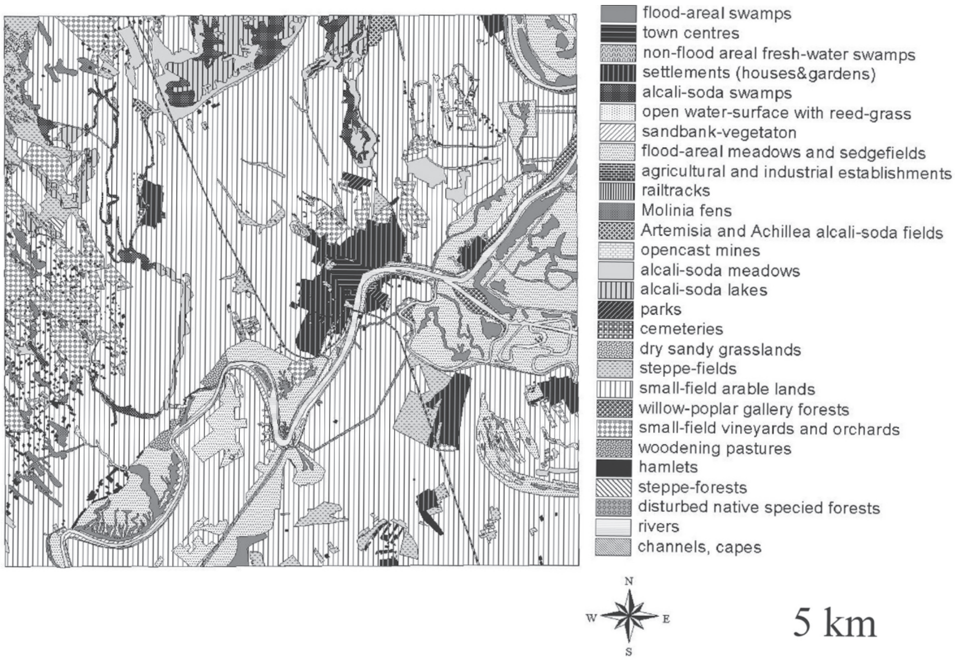

Fig. 2. CLC-CÉT biotop map of Szeged in the midle of the 19th century (Deák, 2003).

the other is the famous Boszorkány-island. There were not many willow-poplar forests, because the river-sides were kept tree-less because of the ship-towing. Almost all of them concentrated on the sandbanks and islands. Between Tápé and Algyő the *flood-areal meadows* were the place of the extensive cow-raising connected to the cape-economy, but some high-elevated areas (Kuruc-ér köze) were used as arable lands.

By the **mid-19th century** (Fig. 2) *the human impact became stronger* in the surroundings of Szeged. The position of the city was strengthened further by the building of the the Budapest-Szeged-Temesvár (Timişoara) railway (1854–1857), and the first houses appeared on the left river-side too (Újszeged). After the 1879 flood the centre of the city was rebuilt quickly with a typical new avenue-boulevard structure (Somorjai, 1984).

More lands were broken up mainly in the flood-area, but in the Dorozsma-Majsaian Sandlands too. The broken-up of the flood-area is due to the beginn of the regulation of the river Tisza and Maros. Alongside the river Tisza and Maros new dams were built, and the curve-cut of Gyálarét was also ready (1855–1887). The so created Gyáláréti Holt-Tisza (backwater) is the longest backwater in the South-Tisza-Valley (18.6 km) (Pálfai, 2001). For the Maros a new straight bed was digged out in 1860, but the dyke was built several kilometers southwards, so the river Maros could use its former beds. As the dyke hindered the floods in spreading out on the former flood-area, the *swamps* have begun to be transformed to *flood-areal meadows*, but still extended wetlands were in the deepest places. The landlords of the Palaviccini's established new farmyards with arable lands on the new flood-free areas of Tápé and Algyő. The ploughs working for them built there *hamlets*. These were the first permanent settlements in the flood-area of Szeged. The *willow-poplar forests* increased a little bit, as they were planted before the dyke alongside the navvy-holes to protect the dyke against the waves of the flood. The continuos forest-cutting were decreased on the sandbanks of the rivers because of the introduction of the steam-ships, so the willow-poplar forests could regenerate easier.

The human impact on the Dorozsma-Majsaian Sandlands became stronger on the southern parts. Next to the arable lands many hamlets and extended vineyards appeared. The group of the hamlets were called: Kapitányság (District), like Kászonyi, Bojárhalmi, Domaszéki, Fehértói, Fekete széli, Kancsal, Nagyszék sósi Kapitányság. Even Kiskundorozsma was connected to Csongrád county in 1886. Though the extensive cow and sheep-farming continued there, some sand-steppe-grasslands were broken up. The area of the *Molinia* fens and alcali-soda lakes remained the same however the first draining channels were built (Kenyérvári-tó-Nagy-szék-Matyi-ér-Tisza channel). In the Fehér-tó there were such high water levels in those times, so the Szegedian decided to build the Channel of Fehér-tó in 1872 leading the extra water to the Matyi-ér, then to the river Tisza (Somorjai, 1984).

It's interesting that even bigger spontaneous steppe-forests appeared at Vereshomoki-tó. These forests could have been at the beginning of the succession: white poplar dominated sandy forests could be there (similar as nowadays the Ásotthalom Memory Forest Nature Reserve).

The **beginning of the 20th century** (Fig. 3) is the golden ages for Szeged in the Austrian-Hungarian Monarchy. The city was expanding further especially in Újszeged. Szeged became a real railway centre as lines were connected the city towards Budapest, Szabadka (Subotica) (1864 Great Hungarian Plain-Rieka railway) (Somorjai, 1984), Arad, Temesvár (Timisoara), Békéscsaba, Nagybecskerek (Zrenjanin)-Beograd (western Banat railway). This central position, the increasing population, the food-export possibilities all encouraged the people to break more lands.

The so called Southern Sandland Railway gave a further possibility for the people living in the hamlets, so the number of hamlets increased further as their product could be put to the market easily by the railway. *The Phyloxera disease caused heavy demages in the vineyards* of the Sandlands. The 3rd military survey shows sometimes *woodening*, or *grassing abandoned vineyards*. Some of these vineyards were cut out and on their place orchards were established (like peach in Szatymaz). During this time the *intensive cultures of vegetable production* (famous Szegedian red pepper) became prefered too. All these processes reduced almost to nill the area of the sandy steppe-fields. But *Molinia* fens, and alcali-sodic meadows and swamps existed further.

The major of Szeged - to the initiation of Péter Beretzk - founded the first nature reserve of Hungary in the Fehér-tó (White lake) in 1939 (in that year the Fehér-tó became the 2nd

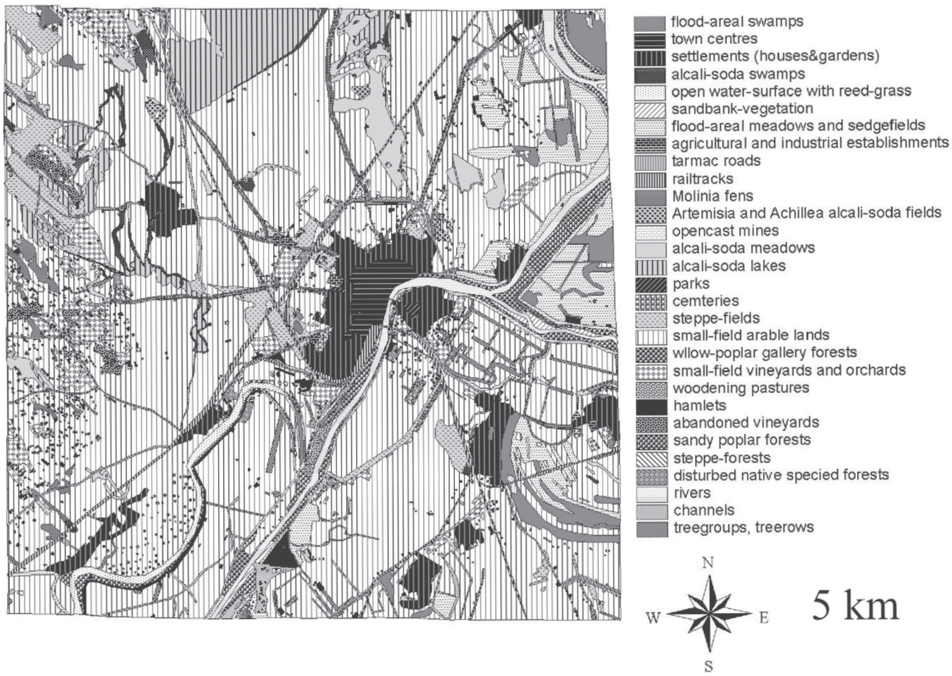

Fig. 3. CLC-CÉT biotop map of Szeged at beginning of the 20th century (Deák, 2003).

national nature reserve after the Great Forest of Debrecen) (Kopasz, 1978). But this alcali-sodic lake was begun to transform into a fishing lake since 1932.

In the Palaviccini farmyard the lower elevated arable lands became secondary flood-areal meadows because of the permanent inland-waters even though draining channels were established to recapture these lands. The Maros estuary and the right side of the river was still covered by flood-areal meadows and swamps, with a lot of regenerated willow-poplar forests. In contrast on the left side of the river Maros the former flood area became cultivated. The former Maros curves were filled up and were divided into 2 backwaters: the Újszegedian and the Deszkian Holt-Maros. The bed of the latter backwater was used as arable land. In the Marosszög almost just the Szőregian pastures remained as a flood-areal wetland.

The 2002 map shows **the results of the landscape changes of the last 100 years** (Fig. 4). During the socialism the authority tried everything to demolish the hamlets. First they stopped the Southern Sandland Railway, then new settlements were established (Domaszék, Bordány, Üllés, Zsombó) with more comfort. Even though this hasn’t attracted everybody, and later it’s become clear that fruits and vegetables can be produced in hamlets effectively. During the last 20 years new recreation settlements (dominated by houses, gardens, orchards or vineyards) grew up (Subasa, Öreghegy, Neszürjhegy, Sziksóstó) which mean more environmental risk, as the sewage and waste problems are unsolved. The pattern of

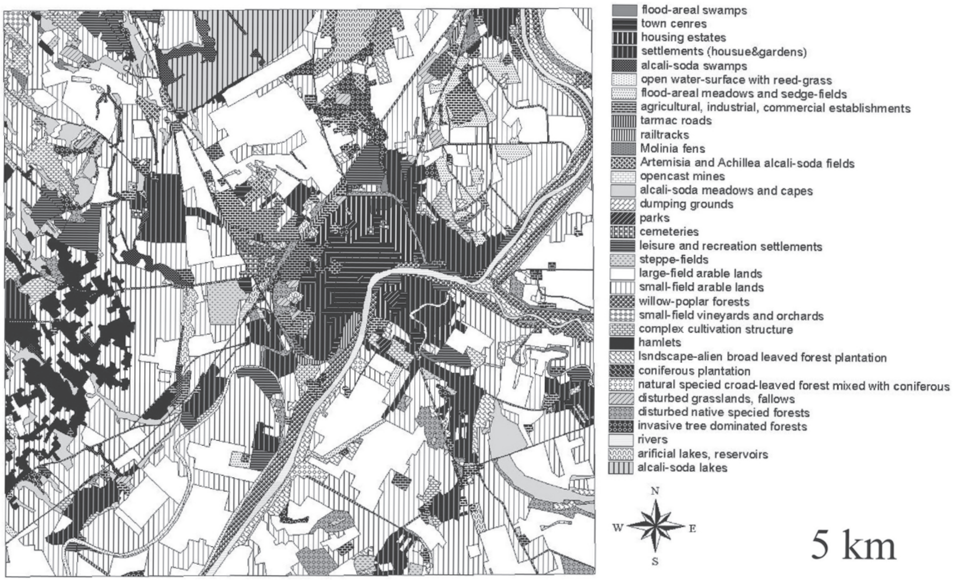

Fig. 4. CLC-CÉT biotop map of Szeged in 2003 (Deák, 2003).

the arable land shows the situation after the compensation of the 1990s. It can be seen that there is a lot of small scale arable lands, while the majority of the large-scale arable lands still belongs to the successors of the former co-operatives.

During the last 50 years Szeged became industrialized, and a huge industrial district was established on the western side of the city. Oil were discovered in Tápé in 1965 (Somorjai, 1984). Since then the area between Szeged and Algyő is the biggest oil-mining area of Hungary with a lot of mining and storing establishments, which lead to the decrease of some of the flood-areal meadows. New housing-estates were established in the northern part of the town (Tarján, Újrókus), but the suburb areas increased too (Petőfitelep, Újszeged). It meant that Szeged has grown together with some former independent settlements (Szőreg, Tápé, Kiskundorozsma).

During the socialist time the fishing lake building continued on the Fehér-tó (White Lake) – now it's 3500 hectare. The regular intermittation of the water-level was substituted by a permanent water-level, and fresh water was led to the lake from the river Tisza (Somorjai, 1984). So the alcali-soda meadows, *Puccinellia* grasslands have extincted, just the alcali-sodic reeds survived, which could stand this permanent standing water.

Nowadays the biggest problem of the Dorozsma-Majsaian Sandland is the decreasing groundwater level. The decrease is of 2–6 meters. There are 3 resons for it:

1. During the socialism many *draining channels* were built to reduce the risk of inland water and gain more arable lands. It meant that the former depressions with fen or alcali

sodic vegetation became to dry out to a steppe-field as all the standing-water is led away quickly. Many local inhabitants said that they were swimming in these depressions 30 years before!

2. There is *less precipitation*, and we had the 8 hottest year in the last 10 years during the last 100 years period here in Szeged.
3. The *landscape use*: after the privatisation the intensive vegetable cultures became popular, but they require much water. So the farmers dig huge ponds, which are all evaporation windows decreasing the groundwater level further. These watering-holes make more alcali-sodic their surroundings.

The **process of the degradation of the vegetation in the sandland** is the following: the *moors* first became *Molinia fens*. After then if there is no sodification it's transformed into a *sandy steppe-grassland*. If there is sodification it is transformed to an *alcali-sodic meadows*. If the alcali-sodic meadow is leached later the *Festuca pseudovina* appears and is transformed to *degradated steppe-field*. If there is plus accumulation of organic materials the alcali-soda field becomes to an *Agropyron repens-Festuca pseudovina grassland*. If the accumulation of organic material happens on the *Molinia* fen, it changes into *reeds*. This accumulation is due to the loss of mowing, or to the infiltration of manure. The sandy steppe-grasslands, and the alcali-sodic biotopes are attacked by an agressive introduced invasive tree: the *Eleagnus angustifolia*. North from Szeged very huge forest of them exists. This tree was introduced to plant forests on sodic soils, but it has broken out. In this area the *Asclepias syriaca* is not as big problem as at other sandlands of Hungary, but it can spread easily if a grassland is broken up.

The area of the *willow-poplar forests* increased during the last 100 years. They are naturally regenerated populations many times. The most worrying thing in the flood-area is the agressive expansion of the American origin invasive trees. The *Amorpha fruticosa,* the *Fraxinus pennsylvanica,* the *Acer negundo* cause not just nature-conservational damages as they hinder the natural grow up of the willow-poplar forests, but these species (mainly the *A. fruticosa*) are responsible partly for the high floods. The quantity of the water passed in the river Tisza hasn't grown significantly, but the height of the water-level broke records between 1999–2002. The reason is that these trees swell the river. Continuous cutting is needed to reduce these agressive species. Many times cultivated forest plantations were placed to the flood-area. It's a problem because the biodiversity is very low in these forests: many typical flood areal species are missing; the poplar species can be hybridized with each other easily, so the genome of the ancient poplar-trees spoils; and their undergrowth contains many *A. fruticosa* which causes the above mentioned nature conservation and hydrological problems.

We studied **the connection between soils and biotopes** according to Géczy's map of genetical soil-types published by Bárány-Kevei (1988).

According to this map the flood-areal forests, swamps and grasslands are typical on alluvial soils, soil deposits and meadow soils of alluvial deposits.

Steppe-grasslands can be found on different kinds of chernozem soils (formed on loesses, on alluvium, on sand or on meadow soil). The majority of the steppe-vegetation remained mainly on such places where the chernozem soils are inclosed in alkali-sodic or boggy areas.

The Dorozsma-Majsaian Sandlands around Szeged is dominated by chernozem formed on slightly humic sands. The majority of these slightly humic sand dominated areas are forested with Scotch and Austrian Black Pine, Locust Tree, cultivated and native poplar species or became the place of fruit- and vegetable-production, so the open dry sandy grasslands disappeared. The chernozem soils formed on sands are mainly arable lands dominated by cereal production, the sandy-steppe-grasslands became here rarer too.

The depressions of the Dorozsma-Majsaian Sanlands have either carbonated and moor-meadow soils – where the *Molinia* fens are typical – or are dominated mainly by carbonated solonchak, callous solonetz or solonetzic meadow chernozem. The alcali-sodic areas are covered with *Achillea* (*Achillea-Festucetum pseudovinae*), *Artemisia grasslands* (*Artemisio-Festucetum pseudovinae*) grasslands, alcali-sodic meadows and swamps.

Conclusion

These mapping works are useful for nature conservation and we get a full picture of the present and past features of the landscape. The presented maps can be a database for monitoring and planning the landscape and are good for purposes of rural development, forest and water management. They show the areal potential of rural ecotourism and help the environmental education. They help the scientific experts, the policy-makers and land-users to make optimal decisions and do a really sustainable landscape use (Deák, 2001; Dobrosi et al., 2002).

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Received 18. 11. 2003