Vegetation of Canals Constructed in Semi-arid Environment with Special Attention on Soils, Hungary

Eszter Falusi[1], Károly Penksza[1], Virág Katalin Sipos[1], Alexander Kohler[2]

[1]*Szent István University, Institute of Environment and Landscape Management, Dept. of Landscape Ecology, 2100-Gödöllő, Páter K. u. 1., Hungary*
Tel: 06-28-522-000/1833, E-mail: falueci@freemail.hu
[2]*University Hohenheim, Institute of Landscape- and Plantecology (320), August-von-Hartmann-Str. 3., 70593 Stuttgart, Germany*
E-mail: kohleral@uni-hohenheim.de

Abstract

The macrophyte vegetation was characterized in the canal system in the Danube-Tisza lowland. Dry meadows or arable lands are situated in the environment of the canals. There is intensive grazing on the meadows. The intensive use causes nitrate load on the area that leaks to surface and underground waters through the soils. In the canals we found abundance of species that reflects nitrate load and degradation (e.g. *Elodea ssp.*). Arable farming on salty soils has similar effects since big amount of fertilizer is needed for profitable farming that leads to nitrate leaching as well. The overuse of semi-arid areas where soils are low in nutrition must be avoided because it has negative effects not only on terrestrial but on aquatic vegetation too.

Introduction

We examined an irrigation and drainage canal system which has its watersource from the River Danube and extends into the area of Kiskunság. This countryside composed the Kiskunság National Park, which is an UNESCO Biosphere Reservation since 1979. Consequently, judging the values of this canal is hard, because, in the first place, it drives away excess water from the agriculturally cultivated lands, but also from swamp land areas close to the nature. Nowadays in Europe as well it is important to determine the conditions of both natural and artificial watercourses and to restore them in near-natural state. During our research we used a method relatively new in Hungary, which was already proven to be suitable to explore and characterize aquatic vegetation. Our research started in the Kiskunság creates a basis for further monitoring examinations, so it is possible to compare watercourses surveyed with the same method, and to reveal tendencies with help of long term repetitive observation in accordance with the regulations of the Water Framework Directive. The goal of our research is to assess the macrophyte vegetation, and to evaluate their conditions and changes based on quantitative indicators. One aspect of the study was to prove that the method, which is in use in all Danube countries today, is also suitable for characterising the aquatic vegetation of anthropogenic canals. The soil types of the cultivated areas and grasslands were also determined and examined. The connection between land use and soil erosion is investigated (Centeri 2002). Our first machrophyte surveying carried out by the Kohler method was made in 1998 in a segment of the Dunavölgyi Main Canal which is the elemental part of the extended canal system. Those examination findings are eked out in 2002, with additional segments of Main canal and 4 further canals.

Materials and Methods

Soil examinations were done by the Pürckhauer type soil core sampler (Finnern 1994) and by full soil profile descriptions (Stefanovits 1992). The core sampling gave possibility to take several samples and examine the depth of layers, pH, colour, soil physical type, carbonate content, soil type. It gives possibility to draw coarse borders of soil types. We examined soil parameters that might be connected to vegetation.
Contrary to the classic vegetation surveying method the vegetation is not examined regarding homogenous areas, but a whole unit is regarded uniformly. The survey technique followed the Kohler-method (Kohler 1978; Kohler–Janauer 1995), which is in accordance with the respective European Standard (EN 14184) and the regulations of the Water Framework Directive. The borders of the continuous survey units were determined by approximately equal ecological conditions, so the length of the units is different. Artificial structures, waterworks for example sluices, bridges sharply indicate the unit borders. Units were shortly characterized based on shadedness, the parameters of the riverbed, the riverside vegetation, and landuse type. After creating a new survey unit we registered every plant, moss and alga visible to the naked eye. During the unit survey we registered the species found, and recorded their amount on a scale from 1 to 5, giving a quantitative basis. After processing the data we calculated indicators listed below (Kohler–Janauer 1995**): Relative spreading length, average mass indexes and relative plant mass.**
Danube–Tisza–Canal (DTC) was designed to connect the two rivers. The construction was ended in 1947 and further construction, due to environmental concerns, is not very likely. The Harmincas-Canal and the Dunavölgyi-Main Canal (DMC) is connected to the River Danube only by the Danube–Tisza–Canal. The other two investigated canals belong to the smaller canals which collecting inland water. The Apaji-Canal is quite narrow and cleaned waste-water is streamed into it. Sós-ér carries water with relatively high salt content, which is oozing from the nearby saline groundwater and soil. Although the canals are different in size and salinity, their water flow is slow, rich in nutrients but usually clear. The standardised field survey, and data processing, methodology guarantees that results are comparable between various locations. Also the change in the aquatic flora between the earlier mappings can be documented and the reasons of changes would be described.

Results

In the Hungarian Classification System they belong to he canals are surrounded dominant by brackish soils, especially by saline soil and featureless sandy soil type, calcareous subtype and low humus version (Stefanovits 1992).
Floristical point of view is interesting that the *Cabomba caroliniana* was first found in the Main canal in 1998. This aquarium dweller originating from North-America, is characteristic for the greater canals (DTC, DMC, Harmincas). Water with a high salt content block its spread. Another neophyte *Elodea nutallii* was found in any of the examined canals. This species likes angling- and watering places with shallow water, and is adjusted well to disturbing. *Typha laxmanii* this salt durable plant belonging to the helophytes appears to be first of all as a component in the bank vegetation of inland water agglomerative canals.
Although antropogenic influence is characteristic to the whole system also rare and protected species like *Nymphaea alba* and *Nuphar lutea* appear in large marshes, their contribution is connected to slow water dynamic and widening river-bed. In places similar to this the protected *Trapa natans* appeared in great masses too. The *Lemna gibba* was spotted only in Apaji-Canal where treated waste water flows into it. In summer the water temperature is very high, one reason: there's no shading on the bigger part of the watersurface. This warm condition is beneficial for *Cabomba caroliniana, Najas marina, Ceratophyllum demersum.*

Print

Proceedings

While doing our calculations, we were only measuring hydrophytes and amphiphytes. When comparing canals it can be concluded that DTC has the smallest number of species (9). DTCS is the only canal which is navigable. Species poorness in it can be contributed to its relatively large depth. It is followed by Apaji-Canal with 11 species, there are 14 in Sós-ér which is the smallest canal. DMC and Harmincas-Canal's measures are 15 each.
In each canal, except for the Apapji-Canal *Ceratophyllum demersum* is the predominant nation. In DTC which is the poorest, concerning the variety of species, *Ceratophyllum demersum* is present in over 36% of the vegetation. This rate of occurrence is only 18% in DMC. In DMC the dominant race is followed by *Cabomba caroliniana* (13%). *Hydrocharis morsus-ranae*, *Sparganium erectum* and *Lemna minor* are grouped together with 7-9%. Other amphiphytes like *Myosotis palustris*, *Berula erecta* and *Butomus umbellatus* appear with measures between 2 and 3%. In the Harmincas-Canal, *Ceratophyllum demersum*, *Hydrocharis morsus-ranae* and *Spirodella polyrhiza* are rampant. *Myriophyllum spicatum* and *Cabomba caroliniana* are close to a 10% range, while the other races are present in quite low percent. In the Apaji-Canal there 6 nations reaching measures close to or over 10% of occurrence. It is the only canal where not *Ceratophyllum demersum* is the predominant race.
During our research, we found that the Sós-ér is characterized by low species count, with the obvious dominance of hydrophytes. This can be explained with the steep river walls, and wide belts of reed, which makes the settling of amphiphytes more difficult. In the Sós-ér the relative plant mass of the *Ceratophyllum demersum* was 32%, which means that 1/3 of the entire vegetation consists of only one species. The dominant *Ceratophyllum demersum* is followed by three hydrophytes reaching measures over 10% (*Myripophyllum spicatum, Potamogeton nodosus and Hydrocharis morsus-ranae*).
The simple reason for the low percentage rate of amphiphytes lies in the simple structure of the canals. These monotonous canals with sedgy banks - which are with the exception of bridges and flood-gates barely concreted, are not efficient for the amphiphytes. This may be a good reason why is in each canal every of the first three dominant species a hydrophyte.

Discussion and conclusions

The five canals concerning biological aspects have been scarcely examined. But their streamlines flowing right ahead, and many times free from any structure, but canals are characteristic landscape features and play an important role as landscape elements. Due to they drive away inland water and have irrigative and flood prevention role they became a vital tool of agricultural cultivation in the area.
Our findings include information on species richness and composition, rareness, danger of extinction, and characteristic pattern of dominance. The accessibility of the method for man-made watercourses is now confirmed. Altogether can be stated that the canals measured can be divided into two types according to their vegetation:

1. The first one, which carries its discharge from the River Danube directly.
2. The second, which collect inland water and are not connected directly to the River Danube.

In the course of the examination of the physical habitat parameters was stated that the structure of the canals is almost straight with few bends. All the canals are bordered by dams close to the banks. It is characteristic to all of the canals that the inner areas of their dams on both sides are covered continuously by *Phragmites australis*, *Typha* species and *Glyceria maxima*. The reed extends as far as 2 metres wide except for fishing-places and watering places.

Other additional features which have influence on local vegetation: landuse type; management - dredging, mowing; surrounding soil types - alkali, sand, etc.; usage - shipping, irrigation, inland water drainage, flood release. Cleansing is only regular in the larger canals. After the mowing process the plant remains are usually left in the water. Mowing the stems is the reason for the further and quick spread of vegetatively reproducing macrophytes for example *Cabomba caroliniana*. Soils with a high salt content block the spread of salt sensitive plants like *Cabomba caroliniana* while they favour populations that can bare salt like *Najas marina*. *Ceratophyllum demersum* occurs with closely 100% arealong, which means almost in all of the survey units was presented. In Apaji-Canal the receiving of run-off from waste water rich in valuable nutrients effected appearance of *Lemna gibba* in large masses. The lack of gently sloping banks puts the amphiphytes in disadvantage, so the amphiphytes reach only 1-7 % from the whole Plant Mass of each canal.
Despite their antropogenic origin the canals are valuable and speciesrich biotopes. In the examined streams can be also found protected and rare species as the *Nymphea alba* and *Trapa natans, Cyperus longus, Acorus calamus*; unfortunately their mass is not too much.

Acknowledgements

The part of the vegetational investigation is part of the MIDCC (www.midcc.at) project, which is funded by the Austrian Federal Ministry of Education, Science and Culture. The program is co-ordinated by Prof. Dr. Georg Janauer (georg.janauer@univie.ac.at), Department of Limnology and Hydrobotany, University of Vienna.

Literature cited

Kohler A. (1978): Methoden der Kartierung von Flora und Vegetation von Süßwasserbiotopen. – Landschaft+Stadt 10: 73-85.

Kohler,A.–Janauer, G. A. (1995): Zur Methodik der Untersuchung von aquatischen Makrophyten in Fließgewässern.- In: Ch. Steinberg– H. Bernhardt– H. Klapper (Hrsg.)

Finnern, H. (ed.) (1994): Bodenkundliche Kartieranleitung. 4. verbesserte und erweiterte Auflage. - Hannover, pp. 392

Stefanovits P. (1992): Talajtan. Mezőgazda Kiadó, Budapest, pp. 380.

Centeri, Cs. (2002): A talajerodálhatóság terepi mérése és hatása a talajvédő vetésforgó kiválasztására. Növénytermelés. 51(2) Budapest: 211-222.