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March 2019

Environmental management, land use, biodiversity

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CUMANIAN MOUNDS: FROM CLASSIFICATION THROUGH LAND REGISTRATION TO TOWN VALUE COLLECTIONS

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ABSTRACT

Common Agricultural Policy has gone through many reforms since it was established. In 2010, whether agricultural support was payable was tied to the requirement of protecting the area's characteristic elements. At this time the protection of the mounds was introduced into the requirement system of cross-compliance. I began my doctorate research in 2010 and tracked the changes to the states of 185 mounds in Békés county via field-walking and monitoring examinations until 2015. My results show that community regulation has provided the mounds with protection more effective than ever before, as at the end of my research 5 of the 185 mounds were under cultivation in 2018. In my present research I have, after three years, examined the state of the county mounds via field-walking in search of changes. In the past years, I have made recommendations to the settlement securities depository board to increase the protection of certain mounds. The county government office has begun the entry of these mounds into the land registry. It has been determined that none of the mounds that were previously left have been placed under cultivation again, and of the 8 mounds that were cultivated in 2015, 3 have ceased to be disturbed. The securities depositories of the affected settlements have accepted 10 of the municipal securities depository propositions, and in the case of 82 mounds of the 185, the mounds were entered into the real estate registry of the real estate they are contained in. On the whole, we can determine that the present measures and processes will guarantee that the mounds will be preserved for posterity.

keywords: common agricultural policy, cross compliance, nature conservation, kurgan

INTRODUCTION

The European Common Agricultural Policy (CAP) has undergone continuous transformation in the past decades. Initially, the goal was the regulation and adjustment of the internal and global market as well as the production environment. At around the turn of the millennium the regulations related to rural development and sustainable agriculture were placed into the focus, such as the formation of an ecologically correct production environment, environmental and scenery protection.

About the kurgans

Cumanian mounds are manmade formations that are the ancient cultural historical vestiges of the Carpathian Basin, which hold a great deal of valuable information (Barczi and Joó 2009). In Hungary Cumanian mound is the collective designation of various size and age prehistoric mounds that are artificial, anthropogenic formations, which are outstandingly significant from the aspect of archeology, botany, scenery and cultural history (Tóth 1999).

Their archeological and cultural historical value is shown by the fact that a significant portion of Cumanian mounds contain Copper Age and early Bronze Age burial sites, cemeteries from the Sarmatian, Germanic periods as well as the age of the Hungarian Conquest of the Carpathian Basin. There burial mounds (kurgans) hold information regarding the culture, religion and funeral customs of the Prehistoric Age and the Great Migration Age. They have preserved the cultural heritage of all people, who have settled here and have come into some kind of contact with the mounds, since the Prehistoric Age practically to this day (Csányi 2003).

The outstanding botanical value of Cumanian mounds is that in an undisturbed condition they are very rich habitats and they are the last refuge of the increasingly rare steppe-flora (Sudnik-Wójcikowska and Moysiyenko

2008, Sudnik-Wójcikowska et al. 2011). With the advent of intense agricultural cultivation, the lands with excellent quality soil (Chernozem, black fertile soil) were ploughed (Gojda and Hejcman 2012), thereby the potential flora only remained in an extremely fragmented way. Therefore, the botanical and zoological value of kurgans is represented by the fact that they are the preservers and the last refuge of ancient habitats which have survived in island-like forms.

They are also the carriers of scenery, geological and paleoecological values (Hejcman et al. 2013). They represent a part of the Hungarian Great Plain's image as scenery values (Tóth 1999). The mounds are valuable from a geological aspect as well. They contribute to the detailed examination of the soils that were buried in the past and those that have been formed in past millennia (Alexandrovskiy 2000, Khoklova et al. 2001, Barczi et al. 2006a,b, Barczi 2009), and they also assist in the evaluation of artificial soil formations (Puskás and Farsang 2008).

During recent decades their complex archeological and environmental research has broadened in Hungary. The research mostly involved the chronological classification of the mounds, as well as the lifestyles of Copper Age and early Bronze Age populations (Kalicz 1965, Ecsedy 1979, Raczky et al. 2002, Csányi 1999, Dani and M. Nepper 2006, Dani and Horváth 2012).

The prehistoric environment research started with the geo-archeological examination of Bronze Age Bodymounds (Sümegi et al. 1998). Tóth Cs. (2006, 2007) performed geomorphological, layer study research on Büte-mound. With the geomorphological, geochemical and carbon dating of 3 kurgans Csípő-mound, Lyukas-mound and Bán-mound, the reconstruction of the prehistoric environment and clarification of the circumstances of mound construction became possible as well the (Barczi et al. 2006a,b, Barczi and Joó 2009, Molnár et al. 2004). Nowadays comprehensive assessment research has been conducted by Bede (2014), while geological studies were performed by Pető (2010). The study of the species-rich loess-grass and animal varieties surviving on certain mounds, and their description is broad as well as (Tóth Cs. et al. 2008, Novák et al. 2009, Tóth Cs. et al. 2012).

The agricultural disturbance of mound bodies (ploughing, removal) is the most damaging process from the aspect of their survival. Tóth Cs. et al. (2014) have pointed out that if the disturbance ceases, favorable soil geological processes may commence on the surface of the mounds. Based on map sources it can be proven that originally tens of thousands of Cumanian mounds existed in the territory of Hungary (Virágh 1979), but by the middle of the 20th century their number considerably diminished, while their condition drastically deteriorated (Bede 2014). Nowadays, when we walk around the Hungarian Great Plain we rarely see an intact mound, where we can be proud of its condition (Rákóczi 2013).

Protection of the kurgans

According to estimates, at one time there were over 40,000 Cumanian mounds in Hungary, and there are studies that describe even larger numbers. According to the registry of the Körös-Maros National Park, of these mounds there were 1,533 in the territory of Békés County. Throughout Hungarian history, for a long period there was no protection on any kind regarding Cumanian mounds. Since a large majority of them is situated on the Hungarian Great Plain, interest in saving and preserving them was more intense in these Counties.

At the same time, a significant portion of them have always been located in areas affected by agricultural activity. Throughout the centuries their number continuously diminished, primarily as a result of agricultural use and the reduction of their religious significance (Tóth 2002). In the second half of the 20th century, as a consequence of intensive and large scale agricultural production that characterized Hungary, the mounds were destroyed in large numbers, nowadays only a fraction of them remain in their original condition.

The Curgans Conference of Békéscsaba in 1994

Upon the initiative of the Békés County Local Government, on behalf of the Directorate of Békés County Museums, the Körös-Maros National Park Association published a conference announcement for the protection and preservation of Cumanian mounds for 24 November 1994. The addressees of the conference were representatives from the Hungarian Great Plain, archeologists, museum supervisors, the experts of National Parks, historians and of course civic groups interested in the topic. The conference was held at the County Hall of Békés County with hundreds of participants. The purpose of the conference was to provide assistance for the legal regulation of Cumanian mound protection as soon as possible, and to send this as a recommendation to the Ministry of Environmental Protection and Rural Development. A further goal and expectation was that the law to be enacted at that time must clearly describe as a separate theme the legal protection of the oldest manmade cultural historical heritage in the interest of uniform management.

The closing document of the conference included the most important recommendations: to assess Cumanian mounds, classify them into categories according to their condition (classification), and to enter them into the land registries of the affected properties (Szelekovszky 1999).

Act LIII of 1996 on Environmental Protection

The association sent the recommendations of the conference to the competent Ministry at the time, they accepted and processed it. The contents of the recommendations were taken into consideration while drafting Act LIII of 1996 on Environmental Protection. The mounds were given actual protection under the law, so-called legal (Ex-lege) protection (Szelekovszky 1999). However, a deficiency of the regulation was that it lacked the applicable implementation decree, thus farmers didn't stop the cultivation of the mounds, and the authorities couldn't force them to do so either.

European Union protection and regulation

When Hungary joined the European Union numerous EU subsidies became available to agricultural producers (Somai 2014). To access the EU subsidy funds, farmers are required to comply with various rules, including the regulation system of cross compliance (Hart 2015). The range of regulations is continuously expanding with environmental and scenery protection factors (Brady et al. 2009). In 2010 the protection of scenery elements characteristic of the region became part of the above regulation, with Ministry of Agriculture and Rural Development Decree No 32/2010 (III. 30). By the efforts of the Körös-Maros National Park Association and their supporters Cumanian mounds were included in the list of scenery elements. According to the Decree, if a protected scenery element is located on the land of a farmer, he must ensure its protection and abandon the cultivation of mound bodies, if he fails to comply an amount determined by sanctions may be deducted from the subsidy amount applicable to the concerned year.

The results of my previous research, research antecedents

I studied the changes that occurred in the land use of the 185 Cumanian mounds included in the Good Agricultural and Environmental Conditions (GAEC) Decree, in Békés County, starting from the introduction of the Decree, meaning 2010, until 2015. I performed the research year after year by area surveys. The changes that occurred in the land use of the mounds as a result of the Decree are shown in Table 1.

Table 1: The condition of Békés County's kurgans between 2010 and 2015, and in 2018 (Rákóczi 2018)

num.	examined year	arable (pieces)	non-arable (pieces)
1.	2010	98	87
2.	2011	78	107
3.	2012	40	145
4.	2013	24	161
5.	2014	11	174
6.	2015	8	177
7.	2018	5	180

The Table displays that never before seen improvement could be observed in the case of the Cumanian mounds included in the GAEC Decree. At the beginning of the study the farmers disturbed the area of 98 mounds, by 2015 this number was reduced to 8. After the introduction of the sanctioning system some cultivated mounds still remained, the primary reasons for this were problems related to undivided, shared ownership land areas, and the characteristics of the selection viewpoint system of the subsidy payout agency. The empirical portion of my research concluded that the farmers are willing to work in the interest of protecting the mounds (Rákóczi and Barczi 2015).

In 2018 I inspected the condition of the mounds in the County again, and I established that in the 3 years that had passed cultivation ceased in the case an additional 3 mounds, thus the number where cultivation had been abandoned grew to 180 (Rákóczi 2018).

MATERIAL AND METHODS

In my present study I analyze how the condition of the 185 Cumanian mounds included in the Decree has changed during the years that have passed since my doctoral thesis research, also considering the results of my 2018 inspections. In summary, I was searching for an answer to the question how well the Decree serving for the protection of the mounds is functioning nowadays. I performed this study by area surveys in the autumn of 2018 and in January 2019. I studied the 180 abandoned mound base population by *representative sampling* using a 10% sample rate. The compilation of representative samples occurred with a random number generator, by means of the program Random Number Generator Pro 1.71 (version: 1.71). I listed the mounds according to their unique identifiers (FÖMI identifier) in an increasing sequence, and assigned a serial number to them. By using the generator I selected the serial numbers of the mounds included in the sample, and the sample was completed based on the unique identifiers assigned to those. In the case of the 5 mounds registered as cultivated, I performed a *complete study*.

In recent years, based on the applicable rules I made recommendations to the town value collection regarding several mounds, for the higher level protection of certain outstanding mounds. In my work I present the decisions of the town value collection.

In recent years, the works related to the land registration of the mounds in the County have also started. Based on the data reporting provided by the Békés County Government Office I present the current status of the land registration process.

RESULTS AND DISCUSSION

Results of the area surveys

Of the 180 mounds registered as abandoned during my previous studies (2010-2015 and 2018), based on the selec-

Table 2: The condition of earlier given up registered of 180 pieces kurgan

num.	result of generate	identification number	name of kurgan	status
1.	132	5 278	Jukai-halom	non-cultivated
2.	2	1 062	Vadaszán-domb	non-cultivated
3.	174	8 579	Kolerás	non-cultivated
4.	177	8 576	névtelen-halom	non-cultivated
5.	91	5 099	névtelen-halom	non-cultivated
6.	102	5 181	névtelen-halom	non-cultivated
7.	171	8 573	névtelen-halom	non-cultivated
8.	126	1 564	Vágott-halom	non-cultivated
9.	163	5 279	Velki-halom	non-cultivated
10.	93	5 106	Hármashatár-halom	non-cultivated
11.	10	1 083	Gödény-halom	non-cultivated
12.	7	1 081	Dinnyés-halom	non-cultivated
13.	58	1 448	Földvári-dombok	non-cultivated
14.	181	8 583	névtelen-halom	non-cultivated
15.	118	5 238	névtelen-halom	non-cultivated
16.	138	6 220	Hullató-halom	non-cultivated
17.	56	1 502	Szappanos-halom	non-cultivated
18.	54	1 417	Töviskes-halom	non-cultivated

tion, area surveys were conducted in the case of 18 mounds in 2019, the results of which are shown in Table 2.
It is shown that none of the previously abandoned mounds have been reintroduced into cultivation by the affected farmers.
The results of the 2019 area surveys of the mounds that were still registered as disturbed in 2018 are shown on Table 3.

Table 3: The condition of earlier given up registered of 5 pieces kurgan in 2019

num.	identition	name of kurgan	status
1.	5 003	Líviusz-halom	cultivated
2.	1 074	Bódisné halma	cultivated
3.	5 259	Vas-kapu-halom	cultivated
4.	5 264	Mécses-halom	cultivated
5.	8 572	Négyesi-domb	cultivated

The results show that the 5 mounds previously registered as cultivated were still in disturbed condition in 2019.
However, based on the results of the representative study, we can conclude that further mounds were not reintroduced into cultivation, thus the Decree and the applicable sanctioning system continually protects Békés County mounds effectively.

Decisions of the municipal collection of values

Based on the authorization included in Act XXX of 2012 on Hungarian National Values and Hungaricums, the Government issued implementation Decree No 114/2013 (VI. 16.) on the Management of Hungarian National Values and Hungaricums. According to the Decree the data of national values can be registered by various categories in Town, Regional and County value collections, in Sectoral value collections, beyond the borders Hungarian value collections, the Hungarian Collection of Values as well as the Collection of Hungaricums. The Act provides for the establishment and operation of Town, Regional and County value collection councils. By filling in the Recommendation that constitutes an Annex of the Decree anyone may initiate the registration of a value toward the Town, Regional and County value collection councils. The councils make the decisions regarding the values, this is how the recommended value is registered in the various level value collections. The registration of values in a value collection may provide extraordinary attention and protection for them, to preserve them for future generations.
During the past 4 years I have made recommendations toward the value collections of 14 towns regarding certain Cumanian mounds or groups of Cumanian mounds that have outstanding significance. The summary data of my submissions are shown in Table 4.
Of the submitted recommendations 10 have been accepted by the town councils. In 4 cases a decision has not been made yet, but the reason for this in the case of Nagykamarás, Kaszaper and Zsadány is that their town value collection councils have not been established so far.

Entering the mounds into land registries

One of the emphasized recommendations of the 1994 Békéscsaba Conference was the necessity of entering the mounds into land registries. However, even after the law took effect no steps have been taken in this regard. I also described this necessity among the recommendations of my doctoral research thesis, which I based on the interviews conducted with farmers. In the year 2017, at the Békés County Government Office the registration of the mounds recorded in the Békés County Agricultural Land Parcel Identification System (MePAR) into land registries commenced. The data reported by BMKH-BCSJH-KTF (2018) are shown in Table 5.

Table 4: The settlement value collection towards commissions the summary of proposals				
nu.	**name of minicipal board**	**name of national value**	**date of advance**	**adopted/ comment**
1.	Battonya	A battonyai Cikó-halom mondavilága	2016.08.29.	adopted
2.	Kétegyháza	Kétegyházi kurgánmező	2016.08.29.	adopted
3.	Nagykamarás	Nagykamarási Botosi-halom	2016.08.29.	decision is process
4.	Újkígyós	Az újkígyósi Sas-halom	2016.08.29.	adopted
5.	Szabadkígyós	A szabadkígyósi Keresztes-halom	2016.12.01.	adopted
6.	Biharugra	A Biharugra környéki kunhalmok	2017.01.03	adopted
7.	Dévaványa	A Dévaványai-sík, mint az emberiség, így kunhalmok bölcsője	2017.01.03	decision is process
8.	Füzesgyarmat	A Füzesgyarmat környéki kunhalmok	2017.01.03	adopted
9.	Gyomaendrőd	A Szilasok nevű gyomaendrődi halomsor	2017.01.03	adopted
10.	Kaszaper	A kaszaperi Nádas-halom	2017.01.03	decision is process
11.	Kondoros	A kondorosi Hegyes-halom	2017.01.03	adopted
12.	Orosháza	Az orosházi Mécses-halom	2017.01.03	adopted
13.	Zsadány	Zsadány-fancsikapusztai halmok	2017.01.03	decision is process
14.	Tótkomlós	A tótkomlósi Döcögő-halom	2017.01.11	adopted

Table 5: The position of registering of Békés county's kurgans in the property register		
number	**status of authority register**	**number of kurgan (piece)**
1.	under authority's administration	127
2.	under authority's design plan	31
3.	beginning of registration	27
összesen		**185**

Reviewing the data of the tables we can establish that the land registrations guaranteeing the eternal preservation of Cumanian mounds have begun, and in the case of most mounds it has been completed. With this a long awaited and the earliest declared protection measure has been implemented.

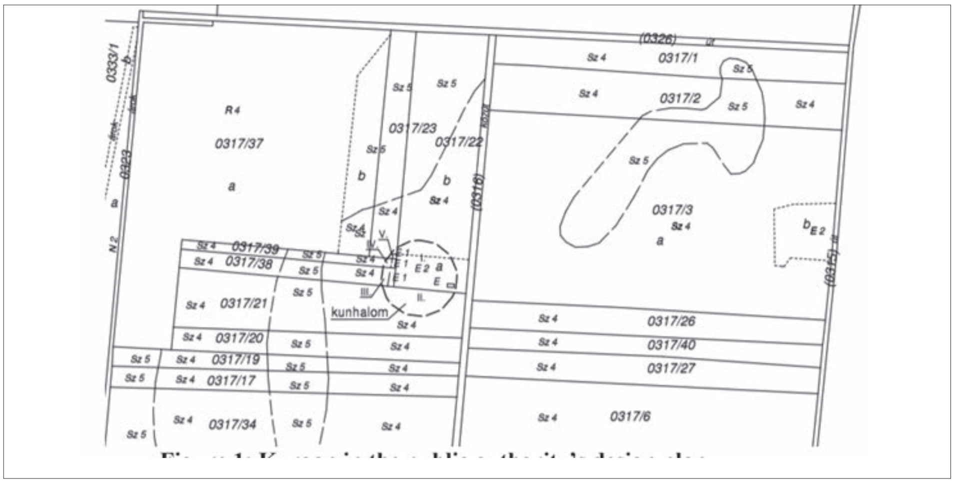

Figure 1: Kurgan in the public authority's design plan

The sketches of Cumanian mounds entered into the land registry are shown in Figure 1. Figure 2 shows the Cumanian mound data recorded on the affected land registration sheets.

CONCLUSIONS

The research shed light on the fact that the protection of Cumanian mounds is ensured for the long term by Hungarian and European Union laws. The mounds and mound groups registered in town collections of values have been placed under highlighted protection. The process of Cumanian mound area registration in land registries is in an advanced stage. In summary, it can be concluded that the measures taken and the processes ongoing in the present point in the right direction from the aspect of Cumanian mound preservation, at the same time the nationwide expansion of studies conducted by Bede (2014), more precisely the development of a nationwide database would be absolutely essential.

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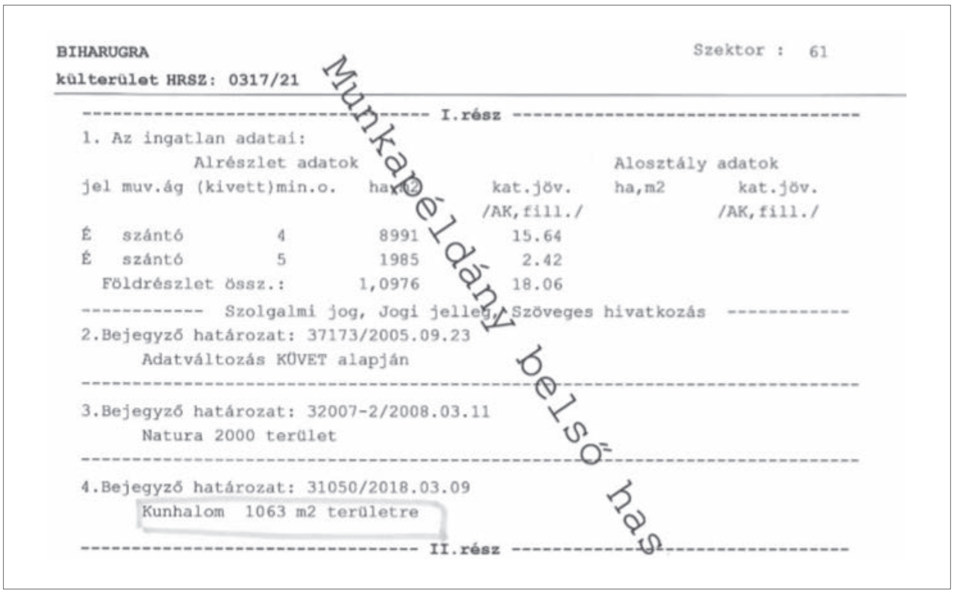
BIHARUGRA Szektor : 61
külterület HRSZ: 0317/21
------------------------------ I.rész ------------------------------
1. Az ingatlan adatai:
Alrészlet adatok Alosztály adatok
jel muv.ág (kivett)min.o. ha,m2 kat.jöv. ha,m2 kat.jöv.
/AK,fill./ /AK,fill./
É szántó 4 8991 15.64
É szántó 5 1985 2.42
Földrészlet össz.: 1,0976 18.06
------------ Szolgalmi jog, Jogi jelleg, Szöveges hivatkozás ------------
2.Bejegyző határozat: 37173/2005.09.23
Adatváltozás KÖVET alapján

3.Bejegyző határozat: 32007-2/2008.03.11
Natura 2000 terület

4.Bejegyző határozat: 31050/2018.03.09
Kunhalom 1063 m2 területre
------------------------------ II.rész ------------------------------
Munkapéldány belső has

Figure 2: Kurgan in the public authority's administration

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COUMARIN- REAL THREAT OR OVERSTATEMENT?

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ABSTRACT

Coumarin (benzo-α-pyrone) is a natural substance found in a wide variety of plants. The best-known source of this metabolite is cinnamon, sweet clover, and holy grass. Due to the unique flavor, synthetic chemical coumarin was used as a food flavoring. Its use was banned based on the researches on laboratory animals, where its hepatotoxicity was confirmed. However, recent scientific reports do not specify clearly the toxicity of this compound on the human organism. It has been also confirmed that coumarin hepatotoxicity is species-dependent. At the same time, in the laboratory and clinical studies, the health-promoting effect of coumarin has been repeatedly demonstrated.

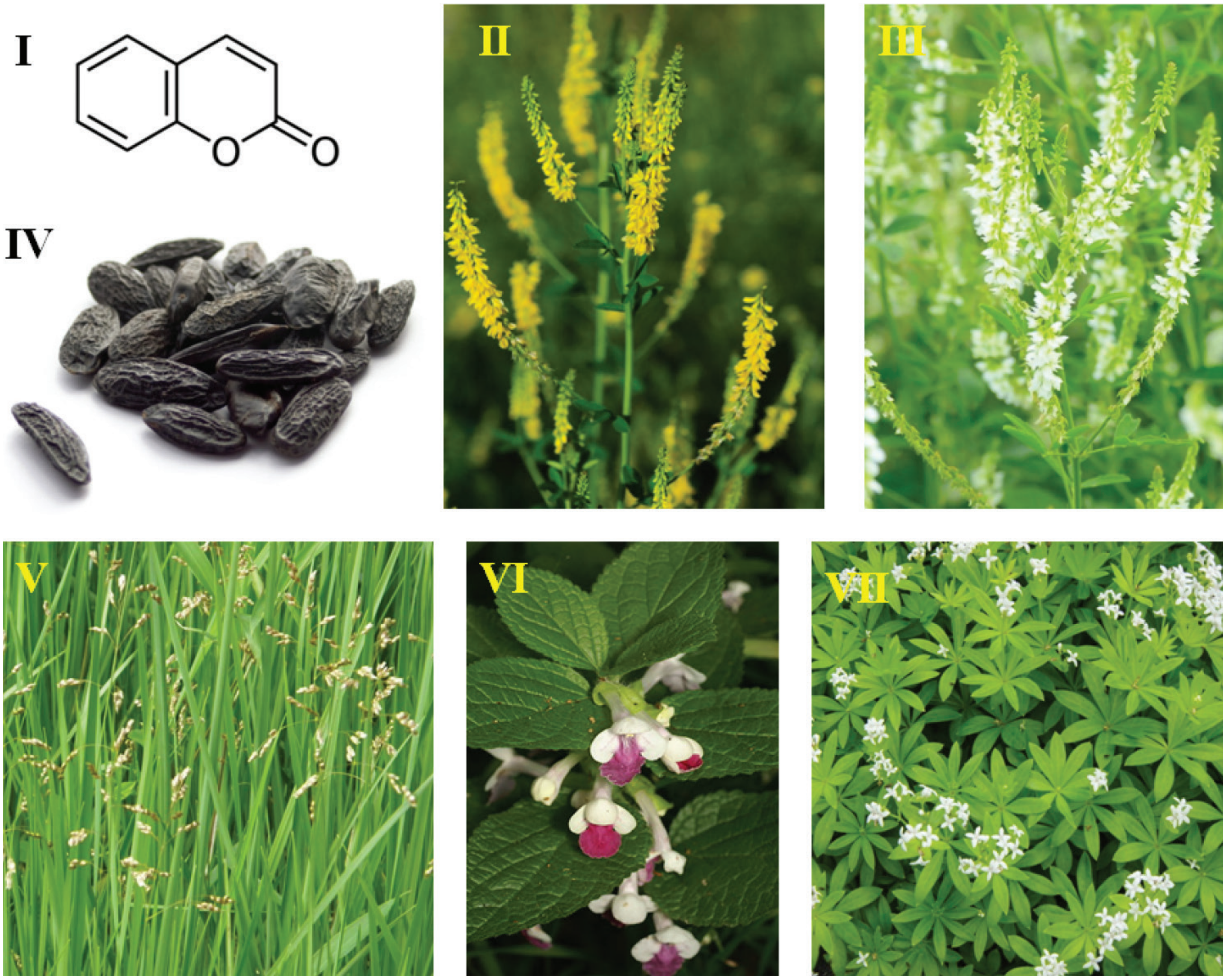

Figure 1: Structure of coumarin (I) and exemplary occurence of this compound: yellow sweet clover (II), white sweet clover (III), tonka bean (IV), sweet grass (V), bastard balm (VI), sweet woodruff (VII) (own elaboration)

It was used in the treatment of lymphoedema, venous insufficiency (CVI), and has anti-inflammatory, antithrombotic, sedative and spasmolytic activity. Tolerable Daily Intake (TDI) of 0.1 mg coumarin per kg body weight and its maximum limit in foods as 2 mg/kg were established. However, there is no legal regulation about coumarin content in plant species and herbs. In this paper, the main attention was focused on the source of coumarin in diet, the potential risk of its intake, and medicinal application. The main attention was focused on the basic source from diet-cinnamon and cinnamon-containing foods. What is important producers do not provide information about the content of this compound in food products.

Keywords: coumarin, biological activity, toxicity, medicinal usage, dietary intake

INTRODUCTION

Coumarins is an extremely diverse group of naturally occurring chemical compounds, classified as secondary plant metabolite. They are often called biologically active substances. Each plant family, genus, and species produce compounds characteristic for itself (Wink 2015). Nowadays, over 1300 coumarins have been identified, not only in the plant but also in bacteria and fungi. Coumarins have an important role in the regulation of plants growth, as well as in defense against herbivores and microbes. It has been proven that they exhibit a range of health-promoting properties and thanks to that used as pharmaceutical agents (Venugopala et al. 2013). The basic compound of this group is coumarin. Many positive effects of this compound were confirmed in clinical trials, however many scientists warn, that excessive intake of this substance in the diet can be toxic for the human body. It is also a potentially toxic compound for livestock. Anyhow, is there really anything to fear?

OCCURRENCE AND ORGANISMS EXPOSURE

Coumarin (1,2- benzopyrone; 2H-1-benzopyran-2-one, *cis*-o-coumaric acid lactone) was identified in many plant species, including sweet vernal grass (*Anthoxanthum odoratum*), tonka bean (*Dipterix odorata*), sweet grass (*Hierochloe odorata),* bastard balm (*Melittis melissophyllum)* yellow sweet clover (*Melilotus officinalis*), white sweet clover (*Melilotus albus*), lavender (*Lavandula officinalis*), as well as cinnamon, citrus fruits, bilberry, cherries, peppermint or green tea (IARC monographs 2000, (Sproll et al. 2008). Another potential source in the diet is alcoholic beverages such as vodka enriched with *H.odorata* known as Zubrowka produced for example in Poland or Maitrank (may wine) with *Asperula odorata (*sweet woodruff) traditional German alcoholic drink (Lake 1999). What is more interesting coumarin was also found in some variety of honey, especially obtained from the nectar of lavender and sweet clover (Baroni et al. 2006, (Castro-Vázquez et al. 2014), and in Mexican vanilla extracts (IARC monographs 2000). Coumarin was isolated for the first time in the 19th century from tonka bean (*Dipterix odorata* commonly known as *Coumarouna odorata*-coumarou) (Sproll et al. 2008). Synthetic coumarin, due to its specific smell, similar to vanilla, was used as a flavoring additive for food, alcoholic beverages, tobacco products, perfumes, and many other cosmetics like toiled soap, toothpaste, face creams, shampoos (IARC monographs 2000).

CONTROVERSIAL TOXICITY AND LAW REGULATIONS

The use of synthetic coumarin as a food additive was banned in 1954 by FDA (*Food and Drug Administration*), due to the suspicions that, may have genotoxic, carcinogenic and hepatotoxic activity on human organism based on laboratory tests on animals. It has been proven, that coumarin can induce liver cancer in rats and mice and lung tumor in mice, as well as can damage the internal organs (liver, kidneys) in dogs (Lake 1999, (Abraham et al. 2010). However, there are no reported data, which confirmed such an effect on the human organism. Additionally, EFSA (*European Food Safety Authority*) found in 2004, that coumarin does not covalently bind to DNA and therefore does not show genotoxic activity. Moreover, IARC (*International Agency for Research on Cancer*) cancer qualified the coumarin to group III, i.e. compounds that do not show carcinogenic effects on the human body (Felter et al. 2006, (Sproll et al. 2008). However, the toxicity of this compound, especially hepatotoxicity is strongly species-dependent. Primates metabolize coumarin mainly into 7-hydroxycoumarin, whereas rodents into coumarin 3,4-epoxide, that immediately converts to o-hydroxyphenylacetaldehyde (o-HPA), the main compound responsible for the toxic effect of coumarin. 7-Hydroxycoumarin does not exhibit hepatotoxic effect (Felter et al. 2006). However, some studies have shown, that the part of humans population is more susceptible to coumarin-induced hepatotoxicity. This resulted in a total ban on the use of coumarin as medicine in Australia and France (Wang et al. 2013). It was initially suspected that a sensitive group metabolizes coumarin in a different way. EFSA established Tolerable Daily Intake (TDI) of 0.1 mg coumarin per kg body weight (Felter et al. 2006). Meanwhile, Iwata et al. (2018) who investigate the relation between hepatotoxicity and the coumarin intake from Kampo medicines (traditional Japanese medicine containing cinnamon bark), concluded that coumarin contained in these medicines, even it exceeds the TDI, was not correlated with hepatotoxicity. Either Felter et al. (2006), based on the analysis of many studies, emphasized that no adverse liver effects have been reported in

Figure 2: Cassia cinnamon (I) vs Ceylon cinnamon ,,true cinnamon" (II) (https://stock.adobe.com)

humans following coumarin exposure via dietary sources or dermal application as well as the only negative effect was observed in patients exposed to a very high dose (often g/day). What is also important there is no evidence of coumarin and its metabolites accumulation in living organisms (Lake 1999).
Despite this maximum level of this compound in food as 2 mg/kg was evaluated by the European Parliament and Council, except for cinnamon-containing traditional and/ or seasonal baked goods containing a reference to cinnamon in the labelling and chewing gum (50 mg/ kg), breakfast cereals including muesli (20 mg/kg), other fine baked goods (15 mg/kg), alcoholic beverages and special caramels (10 mg/kg), other desserts (5 mg/kg) (Sproll et al. 2008). There is no legal regulation regarding coumarin content in species and herbs (Wang et al. 2013).

MEDICINAL USE OF COUMARIN

Coumarin was used in many clinical traits to treat lymphedema and venous insufficiency (CVI) (Felter et al. 2006). It removes protein and oedema fluid from injured tissue by stimulating phagocytosis and production of proteolytic enzymes, additionally alone or together with rutin improves lymph flow (Perrin and Ramelet 2011). Coumarin was very effective in wound healing, exhibits anti-inflammatory, antithrombotic, sedative and spasmolytic activity. (Venugopala et al. 2013). It has been reported that this compound can inhibit lipid peroxidation, lipoxygenase activity, and prevent chemically generated oxidative stress as well as inhibits the proliferation of many human cell lines, e.g., malignant prostate and kidney cancer (Kubrak et al. 2017). Coumarin also shows antidepressant activity by a different mechanism such as MAO inhibitors (Dighe et al. 2016). Pereira et al. (2009) presented the possibility of using coumarin in the treatment of neurodegenerative diseases because it affects the amino acid levels in mice prefrontal cortex and hippocampus. Furthermore, Ariza et al. (2007) concluded that coumarin is responsible for anxiolytic, anticonvulsant and sedative activity of *Hygrophila tyttha* Leonard, a medicinal plant traditionally used in Colombia.

COUMARIN DIETARY SOURCES

Due to the previously mentioned, potential hepatotoxicity, products containing coumarin are included in legal control. The used of tonka bean or tonka extract are prohibited as a food additive in the USA, but other species like cinnamon are available on the market without information on the content of coumarin (Wang et al. 2013). The average human exposure to coumarin from the diet was established as 0.02 mg/kg/day (mostly from cinnamon) compared to 0.04 mg/kg/day from cosmetic products (Felter et al. 2006). There are two types of cinnamon available on the market: Ceylon, so-called "true cinnamon" (*Cinnamomum verum*) from Sri Lanka, and cinnamon cassia with different botanical sources, derived from e.g. China (Chinese cinnamon- *Cinnamomum cassia*) or Indonesia (Indonesian cinnamon, korintje- *Cinnamomum burmanini*). True cinnamon differs from cassia mainly in the coumarin content (Ceylon –trace amount, whereas cassia is very diverse from 2 mg/kg to 9 mg/kg). Additionally, producers do not label information about the origin of the spice on the packaging (Wang et al. 2013). Furthermore, researchers warm, that high consumption of foodstuffs with cinnamon could exceed the TDI. Ballin and Sorensen (2014) analyzed the content of coumarin in cinnamon containing food products, available on the Danish market. Although most products met the acceptable limit, the content of coumarin was very diverse. For example, the content of coumarin in seasonal or traditional baked goods with cinnamon addition ranged from 3.8 mg/kg to 35 mg/kg, while in breakfast cereals from 0.9 mg/kg to 10 mg/kg. Sproll et al. (2008) based on their results confirmed, that children can eat only about 3-4 cinnamon star cookies, and adults about 10 (determined coumarin amount 88 mg/kg, the weight of cookie 5g). In many articles posted on websites, we can found the information, that coumarin is related to warfarin (also known as Coumadin) used in medicine as an oral anticoagulant. However, unmodified coumarin itself, as it occurs in plants, has no anticoagulant effect. Some authors suggested that coumarin can be converted by fungi to dicoumarol (natural, very strong anticoagulant). Dicoumarol was responsible for the bleeding disease known as "sweet clover disease" in cattle eating moldy sweet clover silage. However, the mechanism of this transformation has not been explained (Sowa et al. 2018).

CONCLUSION

In summary, coumarin has many positive effects, what is used in treating many diseases like lymphoedema, venous insufficiency, and it seems promising in neurodegenerative diseases also. However, due to potential toxicity of coumarin, the content of this compound should be monitored in product available on market.

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HUNGARIAN AGRICULTURAL PRODUCTION AND FACTORS AFFECTING THE PRODUCTION

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INTRODUCTION

In 2017 agriculture had a share of 3.3% from the gross domestic product. Although the production volume was 5.2 % lower, prices were 4.7% higher (KSH, 2017). The distribution within the production sector was the following: 58% were plant products, 34% animals and animal parts, and 7.5% belonged to agricultural services and secondary activities (KSH 2017).

Agricultural output within the EU

In 2017 the agricultural output was 5.2% higher within the EU, it summed up to altogether EUR 427 billion. The priority list for the output within the Member States is the following: Italy, France, Spain, Germany, Netherlands and U.K, which summed up to 72%. Within the agricultural sectors crop production has risen by 2%, while animal husbandry went up by 10% compared to last year (Varga 2018).

Agricultural output in Hungary

Hungary contributes to the agricultural production of the European Union by 1.9% in 2017, which shows a slight reduction compared to previous years. Within this the percentage 2.2% were plant products and 1.6% animal products. 4.3 % of the total crop production came from Hungary, most importantly maize, which adds up to 10% from the whole amount of crops. 5% of industrial crops came from Hungary with oily crops giving the bulk of this amount. Our chicken production adds up to 3.8% within the European sector (KSH 2017).

Figure 2: Dual-use hen poultry (Photo: Annamária Holes)

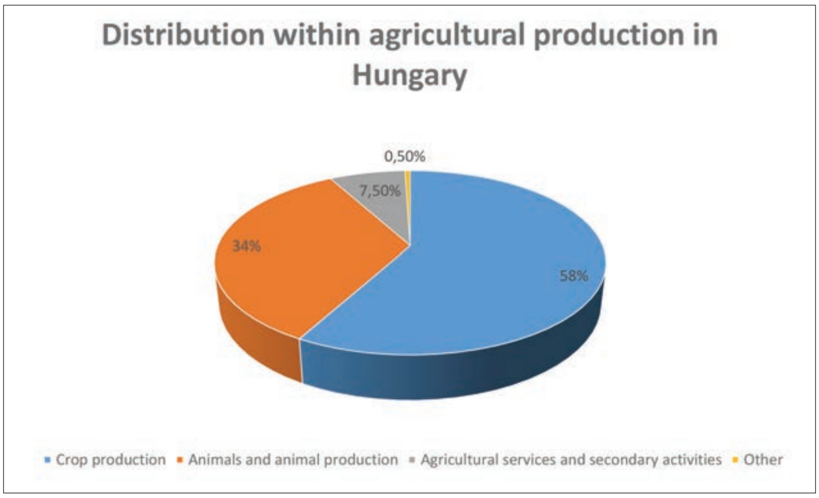

Figure 1: Agricultural production in Hungary in 2017 (Source: KSH)

Extreme weather affecting production

One of the hottest years was 2017 in terms of temperature on Earth. The effect of this was felt also in Hungary, because the average temperature was higher in 2017. The mean temperature shows the same values as for the previous year, but it is below the hottest year of 2014. In 2017 the national mean temperature was nearly 0.8 C° higher, than the 1981-2010 average temperature of years and in the past 100 years this has been the eleventh hottest one with the 11,14 C° mean temperature value. According to the data the trend shows continuous increase. In the past 117 years the national annual mean temperature has increased by 1.15 C°, and in the past 30 years it has increased by 1.22 C°. For the past 100 years, the year 2017 can be considered more rainy, but the distribution of precipitation differs from usual. Until the end of the summer, in the first half of the year there wasn't a lot of rain, but it has been compensated in the second half of the year. The average annual amount of rainfall was only a few percent higher than the 1981-2010 average value. If we look at the last 100-year interval, we see a slight decrease, but there was an increase of about 15% over the past 30 years compared to the amount of precipitation in 2017.

Extreme weather phenomena are a serious problem throughout Europe and are expected to increase in the future as a result of global climate change.

Increasing droughts and windstorms would likely cause of damages to agricultural crops. The adaptability of agriculture is good, but there is still a need for investments to increase agricultural production costs. Careful planning and the best possible prognostication of future conditions are essential to ensure the crop production programs (EASAC). Prepare for climate change, along with creating food security and generating crop surpluses, also serves the sustainable 'reproduction' of the natural resources used in the sector.

The protection of agriculture and forestry is particularly important as the above-mentioned weather anomalies cause great damage to our natural and environmental values, including loss of yield, soil degradation, quantitative and qualitative deterioration of crops, and risk to machinery, equipment, buildings and the environment. transport infrastructure. The protection of agriculture and forestry is specifically important as the above-mentioned weather anomalies cause of huge damages to our natural and environmental values, including loss of yield, soil degradation, quantitative and qualitative deterioration of crops, and furthermore it can endanger machineries, equipment, buildings and the environment. transport infrastructure.

As the atmospheric conditions are very volatile, it is necessary to prepare for big extremes, such as abundant and indigent years, creating reserves, and deduction of surpluses.

In the last hundred years, there has been around 30 very droughty years, and it is common almost in every next years, but there are years when both inland water, flood, frost damage and drought can happen, for example, 2000 was such one. These areas and places are the most endangered in point of food security in Hungary. There are some years when the price of imported products can also rise, procurement can be complicated and the country may be more vulnerable. However, if we increase the adaptability of plants, the harmful effects can be reduced, thus more predictable agricultural production increases security of supply (Mika 2011). Among other things, the most important concern is the choice of varieties, soil cultivation and adaptation to changes. There were years when most of the crop was lost due to drought, but next year the abundance was the problem. But the other important factor is the precipitation, the lack of which causes the great drought, but if it rains suddenly, in large quantities, we have to think over how we could store and utilize it. The solution can be the cultivation of the drought-tolerant and extreme weather-resistant varieties, as well as changes in the proportion of crop production and crop rotation conditions.

Effect of extreme weather on agriculture

During plant production, it must be prepared to appear of the new pathogens, pests and weeds. Typically, they are more aggressive and massive, so defending against them is an important target.

In the case of fruit cultivation, the biggest problem is caused by weather extremes, especially frost damage, summer thunderstorms associated with hail and temperature rise are the most typical risk factors. Among the adverse effects are the expected deterioration in quality and crop yield safety, yield reductions, and quantitative changes. The figures 4. and 5. show the yields harvested from the most important arable crops in Hungary in 2017 and 2018. The quantity of harvested wheat did not change significantly compared to the previous year, but the amount of barley, rye, oats and triticale decreased. Maize is cultivated in Hungary in significant quantities, mostly silage corn, which can be seen in the 2017 data. Maize is extremely sensitive

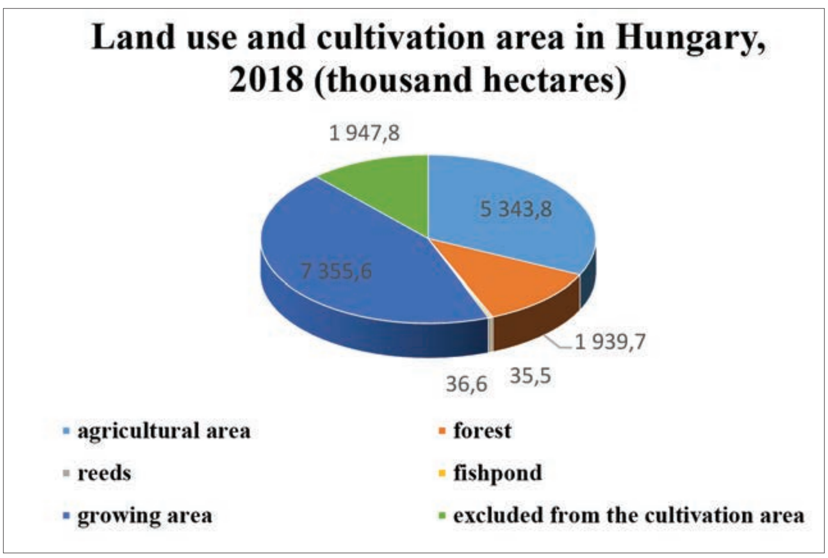

Figure 3: The land use and cultivation area in Hungary in 2018 (Source: KSH)

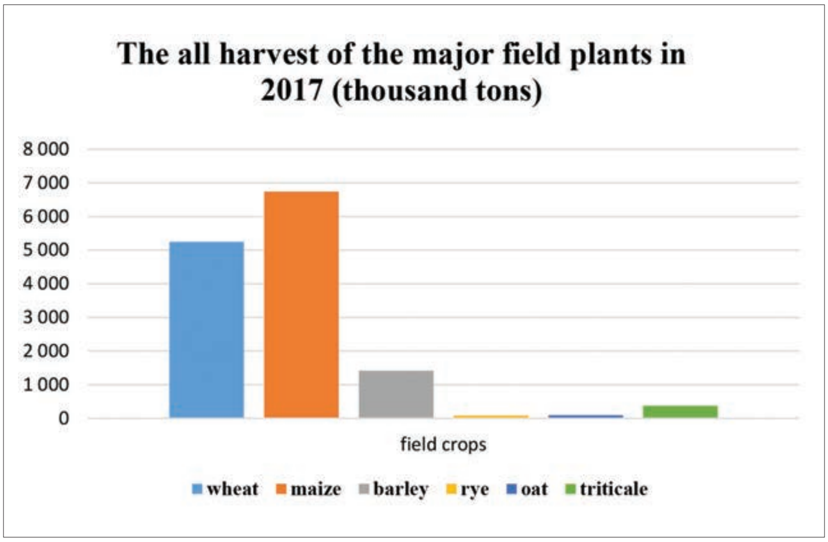

Figure 4: The all harvest of the major field plants in Hungary (2017) (Source: KSH)

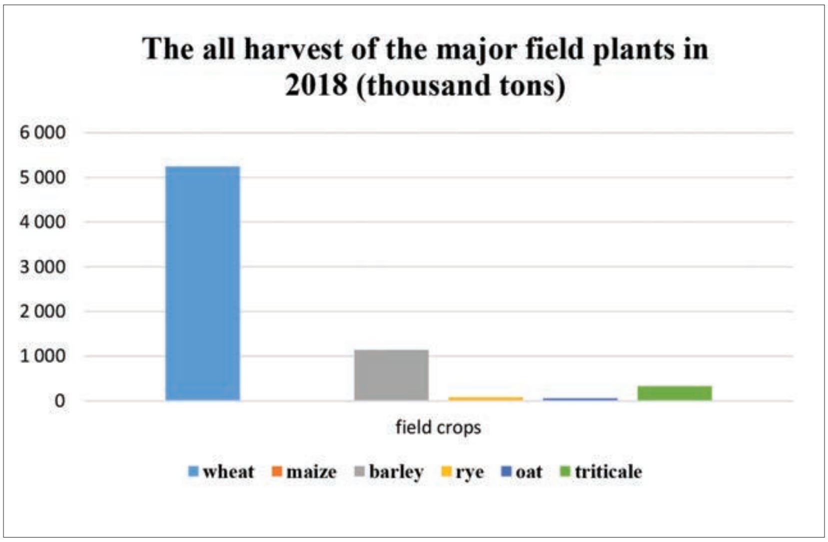

Figure 5: The all harvest of major field plants in Hungary (2018) (Source: KSH)

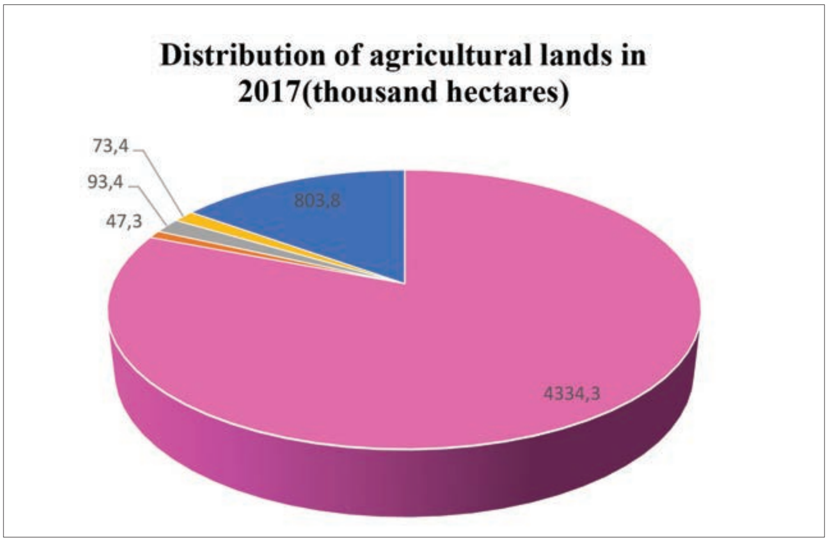

Figure 6: Distribution of the agricultural lands in Hungary (2017)(Source: KSH)

to rainfall and drought periods, so the amount of cultivation can be significantly affected by the weather. For the year 2018, data on the quantity of maize harvested is not available.

The trends and rates of animal husbandry are a big issue for farmers. The breeding of livestock kept in Hungary is based on cereals for food, which is more resistant to weather conditions than in the case of livestock consuming fibrous-juices forage. The hot-dry tendency has less impact on the grain-holding livestock, despite the possible deterioration of quality and the decrease in specific yields. In the event that the number of fodder eater animals decreases in the future, the storage, transport and sale of the accumulated grain should be resolved.

From the point of view of viticulture, the shifting of the zones to the north is expected, and due to extreme weather conditions, the life, yield and the quantity and quality of the wine may deteriorate. It is likely that the variety structure will be transformed and that the varieties of table grapes, late ripening and red wine grapes will be present in a higher proportion.

The warmer weather is favourable for some species, for example tomatoes, peppers, watermelons, cucumbers, sweet corn, which yield can be enhanced by the use of intensive technologies. Cold tolerant species – for example green peas and cabbage seeding are preferable in the early spring, as the average temperature at this time favours these plants. In areas where the number of warmer days is increasing and where there is a drier and warmer year in the given year, the cultivation of warm-demanding species is preferable.

The effects of climate change on crop production

The following factors have to be taken into account in the relationship between climate change and crop production: precipitation, temperature, CO_2 concentration and crop area (land use). One of the most important factors for plant growth is the amount and time distribution of falling precipitation. The investi-

gations are generally limited to two parameter ranges, the temperature increase and the change in atmospheric CO_2 concentration. Other factors, such as water balance, evapotranspiration, or the length of the growing season, may or may be related to this.
As temperatures rise, plant growth accelerates in the presence of sufficient precipitation and nutrients. However, above a certain level, the process may turn back, or even lead to the plant dying. The rise in temperature leads to increased evapotranspiration as the water vapour pressure increases in the leaf and the vapour pressure drop (VPD). As the VPD increases, more and more steam pressure is eliminating from the plant, resulting in a loss of moisture. More intense evaporation can lead to soil drying, which is another stress factor.
In addition to the effects mentioned above, it is very important that plants fixing CO_2 from the atmosphere during photosynthesis. Many attempts have been made by the researchers to show that there is a positive feedback between the increase in atmospheric carbon dioxide and the productivity of C3 plants. There may be large differences between species. For example, the aforementioned C3 plants are capable of absorbing the intensity of photosynthesis at a lower light intensity, whereas C4 plants often do not exhibit saturation even in the presence of full sunlight intensity. For example, the aforementioned C3 plants are capable of absorbing CO_2 in the maximum intensity of photosynthesis at a lower light intensity, whereas C4 plants often do not exhibit saturation even in the presence of full sunlight intensity (Ördög-Molnár 2011).
Changes in climatic conditions can also affect the soil. The rise in air temperature also causes an increase in the temperature of the fertile topsoil layer. Thus, the decomposition of organic matter, together with many other factors, accelerates the impact on production. This process can be counterbalanced by using more fertilizers, but this method is not only more expensive but also has an environmental impact (for soil, for water balance, for ambient air ...etc.). The process will also increase CO_2 and N_2O greenhouse gas emissions.
Warming will help the pests to proliferate, overwinter, and spread, so defending against them will be more important and cost more than before.
From the production point of view, the shifting of the zones to the north is expected, which means 150-250 km for a 1°C rise of average temperature. For example, in Hungary, a 2°C rise can bring serious changes, and the climate in the country may become Mediterranean (Zs. Harnos 2011).
In 2016, the weather was milder than average, which helps for producing. All in all, fewer areas have been damaged, but more serious damage has occurred. Almost every month was warmer than average. The figure 7. shows the deviation of the national monthly average temperatures, on the left side there are the months, first of the top is January.

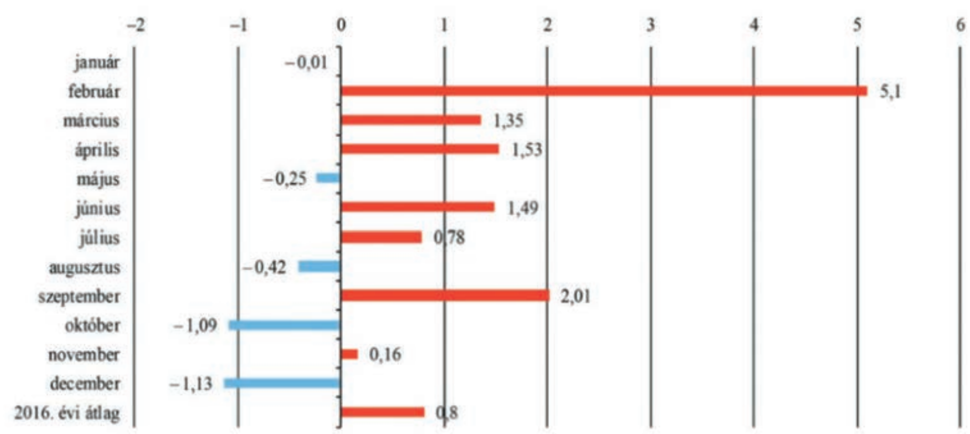

Figure 7: The deviation of the national monthly average temperature from the average of many years (1981-2010) in 2016 (Source: OMSZ)

The daily mean temperature values were also above the annual average. Due to the heavy rainfall in the winter, the rivers were flooded and the arable lands were flooded by inland water (mainly in the middle and eastern part of the Great Plain). In spring, the late frost caused great damage to many parts of the country. The biggest destruction occurred on the apple and vineyards. In the summer, there were great extremes in the amount and in the spatial distribution of rainfall, and in the suddenly falling hail. During this period, winter wheat, sunflowers, corn and apples were the ones who mostly suffered from the adverse weather conditions. In spite of the high yields, around 60-70% of the wheat has become a feed quality thanks to high rainfall.
Due to the more favourable weather conditions, the size

Table 1: Key data for the first pillar in 2015 and 2016 (Source: made by AKI (Research Institute of Agricultural Economics) Horizontal Analysis Department from data of MÁK (Hungarian State Treasury))

Megnevezés	2015	2016	2016/2015, százalék
I. pillérben tag termelők száma, fő	72 474	73 543	101,5
Befizetett kárenyhítési hozzájárulás, millió HUF	4 160	4 184	100,6
A Kárenyhítési Alap tárgyévi forrása, millió HUF	21 473	23 507	109,5
Bejelentett káresemények[a)] száma, darab	10 014	10 919	109,0
Bejelentett károsodott terület, ha	203 058	131 544	64,8
Jogosnak megítélt kárenyhítő juttatás iránti kérelmek száma, darab	3 312	3 303	99,7
Jogosan igényelt összeg, millió HUF	6 050	4 928	81,5
A kárenyhítő juttatás alapját képező károsodott terület, ha	61 824	29 143	47,1

Table 2: Number of reported damage events and size of affected areas (hectares) in Hungary in 2015 and 2016 (Source: made by AKI (Research Institute of Agricultural Economics) Horizontal Analysis Department from data of MÁK (Hungarian State Treasury))

	Bejelentett káresemények száma, darab		Bejelentett károsodott terület, ha		Az adott káreseményre kifizetett kárenyhítő juttatás összege, millió HUF	
Káresemény	2015	2016	2015	2016	2015	2016
Aszálykár	5 226	64	121 657	2 123	4 261,7	7,9
Belvízkár	299	472	12 281	17 124	77,3	341,6
Felhőszakadáskár	30	175	528	3 130	3,6	84,5
Jégesőkár	2 868	2 911	51 768	48 152	914,9	1 073,1
Mezőgazdasági árvízkár	16	7	122	97	0,0	0,0
Tavaszi fagykár	1 360	6 534	11 104	43 472	758,1	3 086,1
Téli fagykár	19	38	101	557	0,0	5,7
Őszi fagykár	1	14	7	172	0,0	36,2
Viharkár	195	704	5 491	16 718	34,2	293,0
Összesen	**10 014**	**10 919**	**203 058**	**131 544**	**6 049,9**	**4 928,0**

of the damaged areas caused by the extreme weather has reduced in 2016 compared to the previous year. This year, the spring frost and hail were the two most significant damage events. Damaged areas approx. 36% were damaged by hail and 33% by spring frost.

Figure shows more data from 2015 and 2016 (last column is the percent value). First column is the denomination: the number of the member producers (person), paid compensation contribution (million HUF), source of compensation for a given year (million HUF), number of reported damages, reported damaged area (ha), the number of claims for compensatory damages granted, number of requests, required amount (million HUF), size of supported damaged area (ha).

The figures in the figure also show that the reported damaged area is approximately it fell from 200 hectares to 130 hectares compared to last year. The total number of reported damages has increased slightly overall.

Table 2. shows more data from 2015 and 2016, first column is type of the damage, second column is number of the reported damage, third column is reported damaged area and the last column is the amount paid for the damage. The first column from above: damage of drought, -inland waters, -rainstorm, -hail, - agricultural flood, -spring hail, -win-

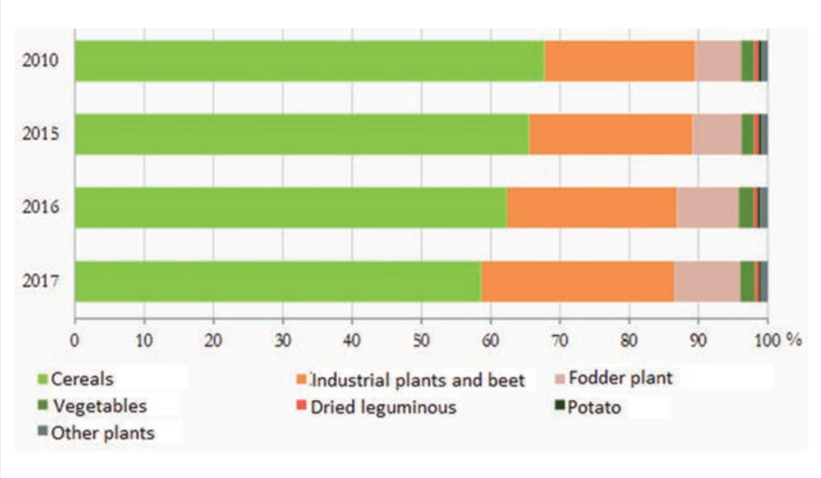

Figure 8: Crop production rates in Hungary between 2010 and 2017 (Source: KSH)

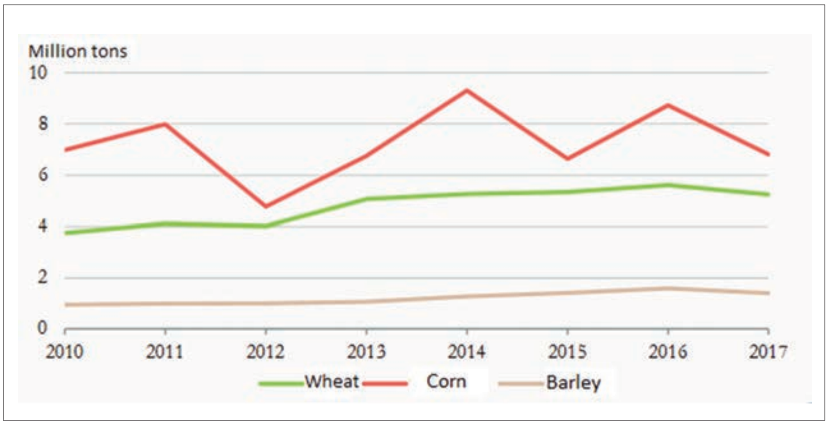

Figure 9: Wheat, maize and barley production in Hungary between 2010 and 2017 (million tons) (Source: KSH)

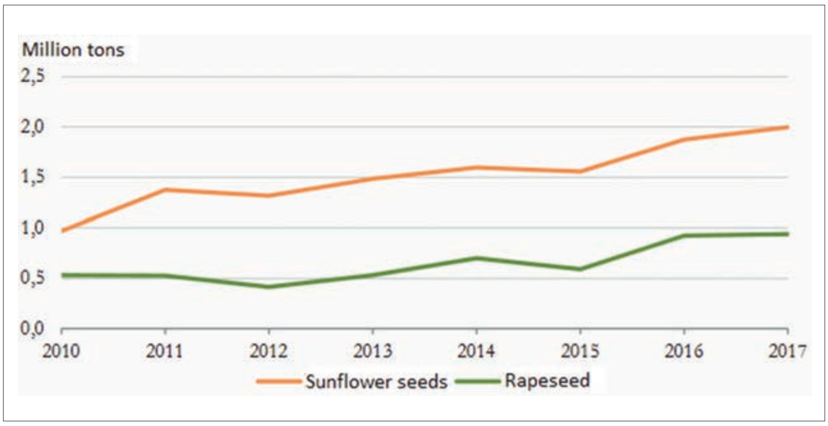

Figure 10: Sunflower seeds and rapeseeds production in Hungary between 2010 and 2017 (million tons) (Source: KSH)

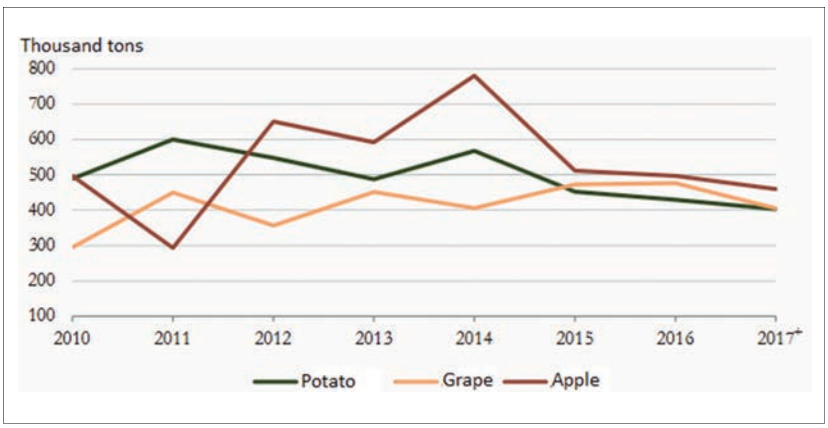

Figure 11: Potato, grape and apple production in Hungary production in Hungary between 2010 and 2017 (thousand tons) (Source: KSH)

ter hail, -autumn hail and –storm. Last line is the summary. In 2016, the number of drought damage has dropped remarkably compared to the previous year. By contrast, the number of spring frost damage rose sharply. In addition, the number of inland water damage, hail damage and storm damage increased even more compared to other factors. According to the size of the damaged area, the damage to the inland waterfall, the rainfall caused the frost damage in the spring frost damage and the storm damage area grew more (Bábáné, 2018). In case of drought damage, this value decreased significantly.

Changes in crop production in recent years

Large-scale transformations took place between 2010 and 2017 in the sowing structure. Compared to the total quantity produced, the share of cereal production is at least 9%; maize, wheat and barley have declined by one tenth. In contrast, the share of industrial crops has increased significantly, for example, by 34% for sunflower and 16% for rapeseed. For example, the crop area of sugar beet shows a positive change.

In 2017, about 16% less grain was harvested than in the year before, when crop yields showed excellent results (close to the five-year average). The cultivation of maize covered a 2.3% smaller area, and the harvested maize were 6.8 million, 22% less than compared to 2016. But the 2017 performance was still higher than the 5 years average. The amount of harvested wheat was 5.2 million tonnes, it is also 6.5% less than in 2016 and the production area was 7.9% smaller. In the case of barley, 1.4 million tons were harvested, which was 12% lower than last year, but significantly exceeded the five-year average.

In the case of oilseeds, the area of sunflower and rapeseed harvested in 2017 also increased by 10% and 18%, respectively. The amount of sunflower is 6.5% and rape rose by 1.5% compared to 2016. The amount of rapeseed harvested was never high before. The volume of sugar beet increased by 16% to 1.1 million tonnes.

The area and quantity of potatoes has been decreasing for years. In 2017, a 6.2% decrease was observed. The total amount of vegetables decreased by about 10%, the yield of vegetables was about 1.5 million tonnes in the last year under review. However, the amount of fruit production increased (788 thousand tons in 2017), but the apple was less, it decreased by 7.5%.

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PROTECTING DRINKING WATER RESOURCES ALONG THE DANUBE BEND – FINDINGS OF THE PROLINE-CE PROJECT

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ABSTRACT

The Hungarian region along the Danube Bend contains highly sensitive water resources that are the basis of drinking water supply for a large number of citizens living in the region.
The current paper provides a summary of the work of the PROLINE-CE project, with a focus on best management practices relevant to the Hungarian test areas. The aim of the project was to develop a transnational manual for the selection and application of best practices regarding sustainable land use and flood and/or drought management, with a focus on the protection of drinking water resources. Sustainable land use practices along rives such as the Danube can significantly influence related ecosystem services and through them effect drinking water resources and floods. During the project, a number of best management practices (BMPs) that are most relevant to the Danube Bend region were collected. While most of these BMPs (proper agricultural practices, improvement of sewage systems, addressing the effects of floods) are already under implementation in the region, there are a few areas with still room for improvement.

keywords: land use, drinking water, Danube, best management practices

INTODUCTION

The main objective of the PROLINE-CE project is to develop transnational guidelines for the implementation of sustainable land use and flood/drought management practices that can improve the protection of drinking water resources.
Best practice examples are tested in selected project pilot areas with different characteristics. While the project is still ongoing, there have been a few related studies.

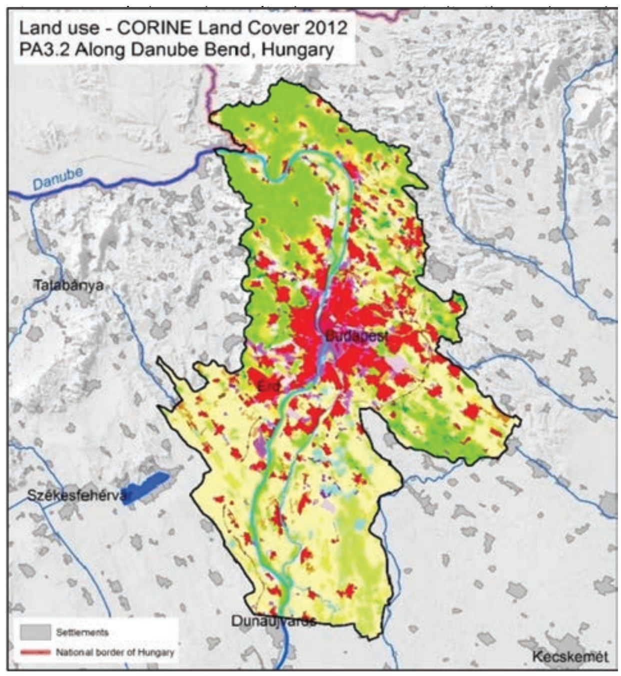

Figure 1: Project area 3.2, along the Danube Bend – outline and land cover. (green – forest/semi-natural habitat, yellow – agriculture, red – artificial surfaces, blue – water/wetland)

ECOSYSTEM SERVICES AND SUSTAINABLE LAND USE ALONG RIVERS

As sustainable land use practices can improve ecosystem services, a part of the PROLINE-CE project included the collection of a list of relevant ecosystem services, along with potential supporting measures. The project was focusing on provisioning and regulating services, forest and grassland ecosystems in mountainous areas, agricultural ecosystems and wetland ecosystems.
Wetlands are among the most important environmental resources on Earth. They are also one of the most threat-

ened and vulnerable ones. Riverine wetlands provide a significant water protection functionality, including the protection of drinking water resources and the prevention and/or mitigation of floods. (Tucker et al. 2010)

Water purification in wetlands is achieved through the removal of sediment and suspended solids by reed beds and other plants. Seepage of water from the riverbed into the groundwater can also be filtered through wetlands and thus improve the water quality in riverside wells (Heged s, 2016). Through the increase of microbial activity, wetlands can also help reduce nutrients in the water body, including the treated wastewater of sewage works. Other harmful substances (including, but not limited to heavy metals, toxic elements and pesticides) can also be absorbed by the wetland sediment, thus reducing their presence in the aquifers.

Riverine wetlands can provide a significant natural buffer against flood events. Peak flow rates can be reduced by the wetland area, while at the same time it can also delay the timing of peak flow. The proper management of such wetlands can be very important, as it can either increase or decrease the intensity of floods. The establishment of embankments separating wetland areas from their rivers – while it can reduce inundation behind the embankments – can increase flood levels and intensity in the floodway area. The establishment of drainage schemes can also negatively affect the flood reduction capacity of these wetland areas (Acreman and Holden, 2013).

While the proper maintenance of riverine wetlands is essential, the sound management of other land areas adjoining rivers can also provide significant benefits to both flood reduction and drinking water quality and quantity. As soil erosion can potentially have moderate to severe effects on 26 % of the total area of Hungary (Pásztor et al., 2016; Waltner et al. 2018), riparian strips can provide a key role in the reduction of sediments in rivers. They can reduce surface runoff and trap sediments and other suspended solids that would otherwise end up in the waterbody. Riparian forest strips can also reduce nutrient loads, potentially removing up to 90 % of nitrogen (Balestrini et al. 2016) and 74 % of phosphorus (Peterjohn and Correll 1984).

Figure 2: Wetland and riparian strip along the Danube river (Photo: István Waltner)

BEST MANAGEMENT PRACTICES IN THE DANUBE BEND AREA

A number of best management practices have already been implemented in Hungary aiming at the application of sound land use practices in order to protect drinking water resources.

While the continued improvement of sewage treatment – most notably in certain areas of Szentendre Island –, and protection against the polluting effects of flood events are key elements in reducing possible contamination of local wells, land use related measures can mostly be present through agriculture-related applications.

Considering possible founding opportunities, participation in the Hungarian Agro-Environmental Program is most likely the most straightforward way for farmers to receive financial support for the implementation of different measures influencing drinking water resources and floods, such as the application of grassed buffer strips or limitations in fertilizer use.

Stakeholder evaluation of the selected BMPs indicated that while in certain areas (particularly in and around Budapest) cooperation between waterworks companies and land users is well established, other areas could still use better coordination.

CONCLUSIONS

Results of the PROLINE-CE project indicated that the land use related ecosystem services in Danube Bend region are mostly related to the state of riparian wetlands and buffer strips. Relevant best management practices are mostly available and known to local stakeholders. However, there is still a lack of proper application of sound land use and management measures in certain regions. This lack of cooperation between waterworks and farmers is often originating in the lack of proper financial incentives. While the Agro-Environmental Program proved to be a popular driving force towards better land use application, involvement in such schemes is still often lacking.

ACKNOWLEDGEMENTS

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Figure 3: Buffer strips can help reduce sediment and nutrient load on watercourses (Photo: István Waltner)

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