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HOMOKHÁTSÁG – A SEMI-ARID REGION FACING WITH COMPLEX PROBLEMS IN THE CARPATHIAN BASIN

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Abstract: In Hungary, the aridification primarily affects the Great Hungarian Plain, most specifically the “Homokhátság” area which is part of the Danube-Tisza Interfluve. On the basis of our experience gained in the past 15 years, we would like to give an insight into the complex problems of this rural region. Our starting point is the aridification process and water scarcity which are characteristic features of this area for the last century. We investigate the related problems in land use management such as unfavourable land use and vegetation changes and the challenges in the local economy and social sustainability. In this respect we introduce the emerging issues in agriculture, forestry and nature conservation which may be relevant in European context too. We have discovered specific factors related to the devaluation of the rural environment and found that significant part of the unfavourable phenomena can be explained by the combined effect of climatic changes, improper land use and inappropriate environmental management. Based on our findings we outline a possible regional pathway for a sustainable rural development.

Keywords: Danube-Tisza interfluve, land use change, climate change, unpredictable water balance, complex rural problems, rural development

Absztrakt: Magyarországon a szárazodás hatásai az Alföldön, és azon belül is leginkább a Duna-Tisza közi Homokhátságon érzékelhetők. Tanulmányunkban − az elmúlt másfél évtizedben szerzett kutatási tapasztalatainkra építve − szeretnénk betekintést adni e rurális térség komplex problémakörébe. A szárazodás és a vízhiány hosszú évtizedek óta a legismertebb jelenségek a térségben. Ugyanakkor érdemes szemügyre venni más kedvezőtlen folyamatokat is, pl. a tájdegradációs, területhasználati és vegetációs változásokat, amelyek egyre nagyobb kihívást jelentenek a térségben élők számára. Ebben a vonatkozásban vesszük górcső alá a mezőgazdaság, erdőgazdálkodás és természetvédelem egyes releváns kérdéseit, amelyek akár európai összehasonlításban is fontosak lehetnek. Olyan speciális tényezőket mutatunk be, amelyek az érintett térségben jól demonstrálják a környezeti- és klimatikus változások, valamint az átgondolatlan tájhasználat és környezetgazdálkodás következményeit. Mindezek mellett, reményeink szerint az elvégzett vizsgálatok, jól hasznosítható támpontokat nyújthatnak a fenntartható vidékfejlesztés számára is.

1. Introduction

The geographical situation of Hungary is quite specific. The country’s location within the Carpathian Basin has many consequences regarding to the landscape features and climate conditions. Of all the constraints the water management may be affected mostly both by the basin character (Fleischer 2002; Pálfay 1995; 200; Somlyódy 2002) and by the fact that 95% of the surface waters are arriving from abroad which creates an extreme situation in many ways. Nowadays most of the professionals warn about the unpredictability of the water balance of the country and they explain the occurring aridification processes primarily in the context of the climate change and land use management (Bartholy et al. 2005; Molnár 1995). From the landscape regions of Hungary the Great Plain is the most affected by aridification, and in particular the Homokhátság of the Danube-Tisza Interfluve (Cserni – Füleky 2008; Lóczy – Szalai 1995; Pálfay et al. 1998; Szalay et al. 2007; Völgyesi 2006; Zsákovics et al. 2009). The roots of the problem are approached by the scientific literature from several aspects such as analysing the reasons of the decreasing ground water level, the effects of climate change and human activity with the research of related social and economic processes (Buzetzky 1980; Major 1994; Bíró et al. 2007; Csatári – Farkas 2010, Csatári et al. 2016; Dóka et al. 2006; Dóka 2009; Farkas – Kovács AD. 2014; Hoyk 2005; Hoyk et al. 2011; Kovács 2006; Kovács – Farkas 2007, 2011; Ladányi 2010; Mika et al. 1995; Molnár – Balázs 2009; Molnár. 2003; Pálfai 1995, 2003; Pálfay et al. 1997; Rakonczai et al. 2008; Rakonczai 2011; Szodfridt 1994). In these researches it becomes gradually accepted that the reasons and the consequences of the aridification are complex in the case of the Homokhátság and natural, social and economic factors all play their roles in this adverse process (Csatári et al. 2004).

Therefore in this paper we would like to give a complex insight into the environmental problems and the related social and economic issues of this Eastern Central European rural region. The main themes of our analysis are land use and vegetation changes, and the conflicts in land use management which are closely related to the aridification process. We highlight the relevant concerns of the agricultural sector, forestry and nature conservation too with the discrepancies of the individual policy fields. Finally we would like to outline some possibilities and visions which can help to define the directions of the rural development process of this area.

2. Aridification and land degradation

International outlook

The analysis of climate change and its consequences are in the mainstream of geographical researches in the last decade. In these analysis researchers investigate the aridification process mainly in arid and semiarid regions of the world.

In Africa, Sahel region is the best known territory for desertification since decades. Researches focus on rainfall changes (Diallo et al. 2013; Lodoun et al. 2014) and investigation of wet periods based on vegetation (Castaneda et al. 2009) and land cover changes (Diouf – Lambin 2001). They also pay attention to social aspects because periodical changes of rainfall has a strong effect on the society. The precise forecasts might contribute to improving population's life and they can prompt farmers to adopt efficient agricultural practices (Lodoun et al. 2014). This situation is similar to the problem of the Homokhátság, where the main limiting factors of the agricultural production are the unpredictable weather conditions, especially wide variations of rainfall.

Aridification and desertification are similar, but on the basis of annual rainfall we have to distinguish them from each other. Desert means rainfall less than 200 mm per year, and we have more rainfall in all region of Europe. Semiarid regions have 200–500 mm precipitation per year, and we can find European regions with this amount of annual rainfall. These are the most vulnerable regions against climate change, but declining annual rainfall does not mean becoming a desert for these areas.

Despite the similarities in the processes, aridification is much less studied in Europe (with the exception of the Mediterranean region perhaps). The climate change models show that the mean annual precipitation will decrease in southern areas of Europe and drought periods will be more frequents (Seager et al. 2014) and there will be an increase of mean annual temperature too (Kertész – Mika 1999; Kertész et al. 2002). The situation is already very challenging for the ecosystem and the local society too. For example South-Eastern Spain is suffering from soil water balance changing (Touhami et al. 2015), similarly to the groundwater level sinking in the Danube-Tisza Interfluve.

Effects of aridification in the Mediterranean region are especially noticeable in the summer, just like in Hungary. It means increased summer drought stress affects forage properties, or inter-annual rainfall variation influences forage features in sub-Mediterranean areas (Scocco et al. 2016). Scocco and her colleagues investigated pasture lands in Italy, which are also involved by climate change and aridification. Their results show that the expected increase of summer drought stress due to climate change (Giorgi – Lionello, 2008) will present a significant challenge to cost-effective pasture management in sub-Mediterranean mountain areas (Scocco et al. 2016).

Barbero-Sierra and her colleagues had an interesting approach in the research of aridification in Spain. They investigated the role of urban sprawl as a driving force behind the process. Their results indicate that "agriculture, rather than being a desertification agent, is a victim of a set of social and economic conditions leading to its abandonment and/or transformation in urban land, becoming irreversibly degraded by soil sealing." (Barbero-Sierra et al. 2013). Urban sprawl in the Homokhátság region is a real threat also, especially around Kecskemét, which is the biggest settlement of the area.

Hungarian overview

Hungary can be found in Central Europe, but it suffers from aridification too – which is a quite unique process in this part of the continent. The main problem is the groundwater level sinking which results in vegetation and soil changes. The current water scarcity and the wasteful water use by the local communities are originated from the river regulations which began in the middle of the 19^{th} century (Iványosi 1994). In that time the water management of the Great Plain was an economic necessity but in some regions like in the Homokhátság or Békés loess ridge variety of adverse effects have arose. These effects have been strengthened further by various human interventions and by the accelerating climate change. Nowadays this latter one is the most significant factor from all of them. The climate change of the Carpathian Basin is well reported in international and domestic scientific literature (Bartholy et al. 2008; Krüzselyi et al. 2011; EEA 2004). Investigation of climate change is based on the interpretation of international climate models in Hungary. The researchers use four models (Aladin, Remo, Precis and RegCM) which focus on temperature and precipitation changes, and extreme weather conditions like heat waves, 24-hours rainfalls or flash floods (Bartholy et al. 2011; Czirfusz et al. 2015). According to a study published by the nearly 140-year-old Hungarian Meteorological Service (HMS) an intensive heating began since the early 1980's across the country, which represents a rise of 1–1.5 °C in the southern regions of Hungary (Bartholy et al. 2011). The warming trend is detectable in the summers mostly. The temperature anomalies and extremely hot days indicate the relatively rapid climatic changes, which mostly can be observed in the Homokhátság and in the southern part of the country (fig. 1). The warming cause serious stress for the natural environment (e.g.: landscape and habitat degradation, decline of hemeroby level), for the economy (weather disasters) and for the local society too (health risks of hot days).

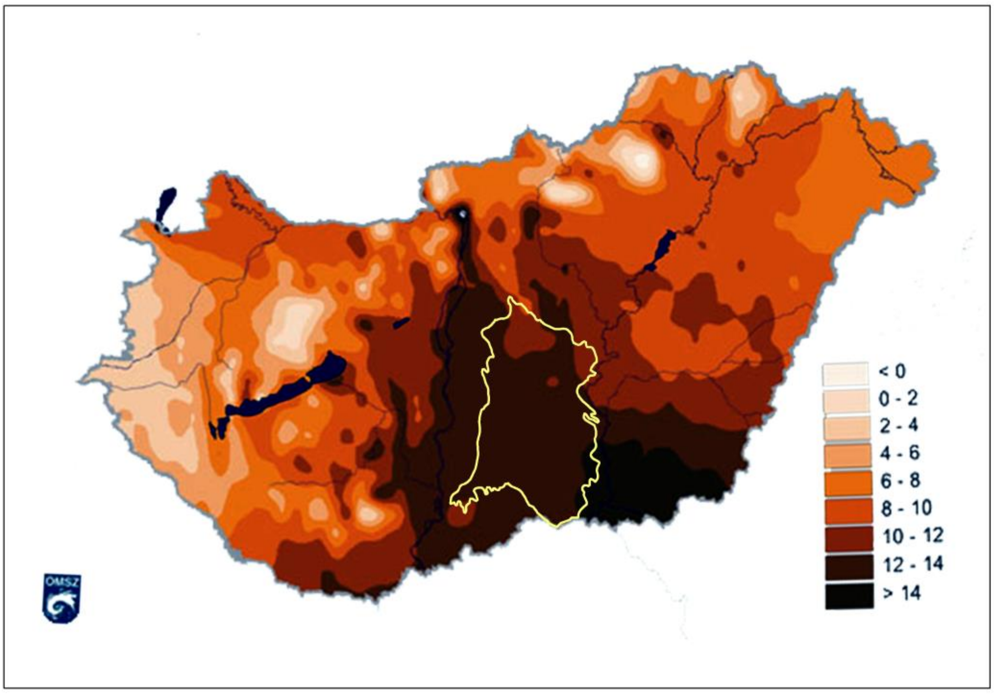

Fig 1. Heat wave number of days per year in Hungary (daily average temperature > 25°C) in period between 1980–2009, based on grid-point trend estimation. Source: Hungarian Meteorological Service

The trends of the last decades observed in the context of the precipitation are less obvious. The rainfall in the Carpathian Basin is extremely variable, so clear trends cannot be detected even in a 50-year period. Based on the measurements between 1960 and 2015, the annual rainfall haven't changed significantly in Hungary. However, it is important that the temporal distribution of the precipitation became more unpredictable. The greatest precipitation decline occurred in the spring, and the weather extremes grew (mainly rainfall) (Bartholy et al. 2011; Torma 2011).

Based on the model calculations, in the next 50–100 years significant changes will occur in Hungary's climate, which basically means the warming-aridifying trend to continue. The mean annual temperature could increase of 0.5–2 °C, and the amount of annual rainfall predicted to fall in parallel (NÉS) (NCCS/National Climate Change Strategy). The agricultural production is strongly influenced by the expected water shortage, but because of the warming other sectors will also have an increasing water demand.

3. Materials and methods

Introduction of the study area

The Homokhátság is often mentioned as a part of the Danube-Tisza Interfluve or part of the Kiskunság region, however it is not included in the taxonomic chart of the landscape regions of Hungary. The area cannot have clear administrative identification either, although it is located mainly in Bács-Kiskun county but it extends to the territory of Pest and Csongrád counties too. Therefore the Homokhátság area cannot be fit in any of the present regional classifications.

In our analysis we have merged 6 natural microregions from the geographical landscape classification used in Hungary (Dövényi 2010). This delimitation is very similar to the previous attempts (Csatári et al. 2004) but put more emphasis on the environmental factors instead of the social ones like settlement structure (area of scattered farms). Based on our calculation the exact area is 7,100 km² (fig. 2).

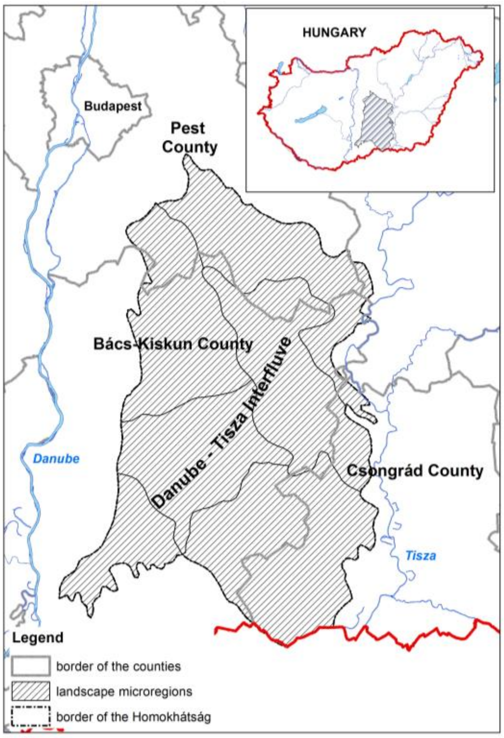

Fig 2. Geographical position of Homokhátság area. Source: by own elaboration.

The ecosystems in the area basically cover three geographic regions: sand ridge area of the Danube-Tisza Interfluve, the Danube Plain, and the Lower Tisza Region. The ridge is characterized by sand sheet plains, divided dune ridges and their forms with erosion deflationary depressions, which had been a number of transitional saline lakes and saltwater marshes before. The sand ridge areas are actually the remains of the alluvial of the Ancient Danube which form this landscape from the beginning of Upper Pliocene – Pleistocene. When the Danube left the area in the Würm period a strong Aeolian accumulation of sediment was started. The main geomorphological character is determined by the basin residues and sediments the Danube left behind. The direction of the settlement of sediments (sand, loessial sand, loess) building the Hátság (Ridge) is NW-SE, which corresponds to the prevailing wind direction. The sand dunes today are a few tens of meters high above the Danube and Tisza Valley.

Nowadays the area is a natural formation and a man-made "cultural landscape" at the same time with many natural values. The most valuable areas are located in the National Park of Kiskunság which was founded in 1975. Two-thirds of the 50 523 hectare area of the National Park was declared as Biosphere Reserve in 1979 by the UNESCO Man and the Biosphere (MAB) Programme. Some of the saline lakes in the Danube valley are considered internationally important wild wetlands according to the Ramsar Convention. We also need to pay attention the diverse habitats in the bogs, fen meadows, marshy meadows, wet meadows, sandy areas and sandy forests are under the Natura 2000 EU Regulation (circa with an area of 180 thousand hectares). The geomorphological formations, the dune formations, varied terrain and soil types have outstanding importance too (Iványosi 2015).

The population of the Homokhátság region is ca. 1 million people (2014) in 128 settlements. Since the 16th century the people living here have been playing a crucial role in shaping the landscape. The land use system and the agricultural production structure of the market towns largely contributed to the appearing of the first open sand dunes and soil erosion in the area. The reasons behind this were deforestation and overgrazing. After the river regulations (beginning in the 19th century) the changing demand of the western agricultural markets brought new directions in agriculture with afforestation, vine plantations and scattered farms in the outskirts. The above mentioned processes formed a unique cultural landscape with ethnographic values in the special settlement structure. The scattered farms are still present and have a major role in the preservation of the traditional way of living.

Homokhátság as the most affected region of adverse processes

The Danube-Tisza Interfluve was recognised as an increasingly arid zone in the FAO's long-term forecast, or even the most pessimistic assessments predict the risk of desertification (UNCCD 2006). In the Homokhátság region, not only the more frequent droughts cause problems but the decreasing groundwater level, too, which makes the situation in this region more serious than in others. Based on the hydrological studies the average decreasing of the groundwater level in the area is 1.5–2 meters in the last 55 years, however, in some places it reaches 6–7 meters (Hoyk 2008).

The researchers agree that the effects of the climate change are most visible in this area in Hungary (Iványosi 1994; Pálfai 2005; Csatári et al. 2004; Hoyk et al. 2007; Zsákovics et al. 2009). According to many experts mainly the improper land-use has led to the arisen of the phantom of desertification. Based on objective data this proved to be an exaggeration, although it is a fact that some parts of the landscape are severely homogenized and degraded.

The local society and economy has been suffering from water shortages for long decades. Primarily the agricultural activity is threatened by the aridification which is a serious problem because one third of the population has certain dependency on this sector. Over the past 20 years the safety of the agricultural production has decreased remarkably and the number of registered farms continues to decline. The scattered farms are quickly destroyed, and as a result the land use is strongly deteriorating making a negative spiral in the land management system.

The decline of the natural attractions has caused problems in the tourism which is also an important and now decreasing income source for the local economy. The competitiveness of the region has been below the Hungarian average for a long time.

In summary the region's water consumption is greater than possible; the high demand for water continues to increase which is not sustainable from environmental point of view. In addition, the population of the area is ageing, young people have been leaving the region and there are social problems such as high unemployment, marginalization and growing rural crime. The Homokhátság shows the typical symptoms of inner peripheries. Because of the environmental problems the classical way of bottom up rural development can only be used with restrictions, without external support the above mentioned problems cannot be solved.

Applied methods

In this article we summarize the result of a multi-year research affecting several topics such as the land use and vegetation changes, the status of the scattered farms, the role of agricultural subsidies and the general living condition of local society. Consequently we used different methods for different themes but we mainly used the methodological approaches of rural geography and sociology. In common we always use primary (field survey, interview, focus group interview) and secondary (EEA, CSO, HMS) data for our analysis. In the last ten years we have coordinated and executed many field surveys of the scattered farms with the help of rural development college students, and also made many interviews with local stakeholders and experts of state agencies (Ministry of Rural Development, National Park of Kiskunság).

Tab 1. Applied methods and data sources[2].

Theme	Primary data source/method	Secondary data source/method
Land use and land use change	Interviews with prominent people of the nature protection, forestry, water management, rural development and farmers, questionnaire survey	GIS analysis of EEA Corine Land Cover data 1990, 2000, 2006, 2012
	Analysis of Landsat TM and MODIS satellite data (NDVI and EVI analysis)	Analysis of agricultural subsidies system and database
Afforestation	Focus group interview with farmers and experts	GIS analysis of EEA Corine Land Cover data 1990, 2000, 2006, 2012
		Analysis of agricultural subsidies
		National Afforestation Program
Vegetation change	GPS field survey of vegetation patches	Previous results of field surveys
	Analysis of Landsat TM and MODIS satellite data (NDVI and EVI analysis)	Analysis of HMS meteorological data
	Aerial photography analysis (photo from MePAR system)	Analysis of ground water wells data
	interview with rangers of the area	
Rural development	Interviews with local stakeholders, experts and inhabitants	CSO statistical data
	Scattered farms field and questionnaire surveys	

We would like to underline our ongoing research (HSRF K109269) in which we examine the interactions of the society and its natural environment in two pilot areas within the Homokhátság. In this four year project (2013–2017) we focus on understanding how landscapes are socially constructed in different spatial contexts and how changing policies influence land-use decisions. We try to identify specific conflicts and territorial differences in the protected and non-protected areas. We'd like to present the relevant results based on 60 in-depth interviews with experts and representatives and 650 questionnaires with local inhabitants. Table 1 shows an overview of the data sources and the applied methods.

[2] Detailed information of the applied methods can be found in our previous publications (Csatári et al. 2004; Kovács 2005; Farkas – Kovács 2006; Farkas 2007; Farkas – Csatári 2011; Hoyk et al. 2011; Hoyk et al. 2012; Farkas – Hoyk 2012; Csatári et al. 2013; Hoyk et al. 2014; Farkas et al. 2014; Farkas – Kovács 2015; Farkas et al. 2015).

4. Results and discussion

The main causes and circumstances of land-use changes in Homokhátság region

The land-use changes are well demonstrated by our GIS based analysis on the time-series Corine Land Cover data published by the European Environment Agency (Meiner et al. 2010). We used the Corine Land Cover database to determine the direction and the spatial differences of the land cover changes. According to this dataset 960 000 hectares were affected between 1990 and 2012 in Hungary. The map below shows the amount of land cover changes in hectares in a 3 x 3 km reference grids (fig.3).

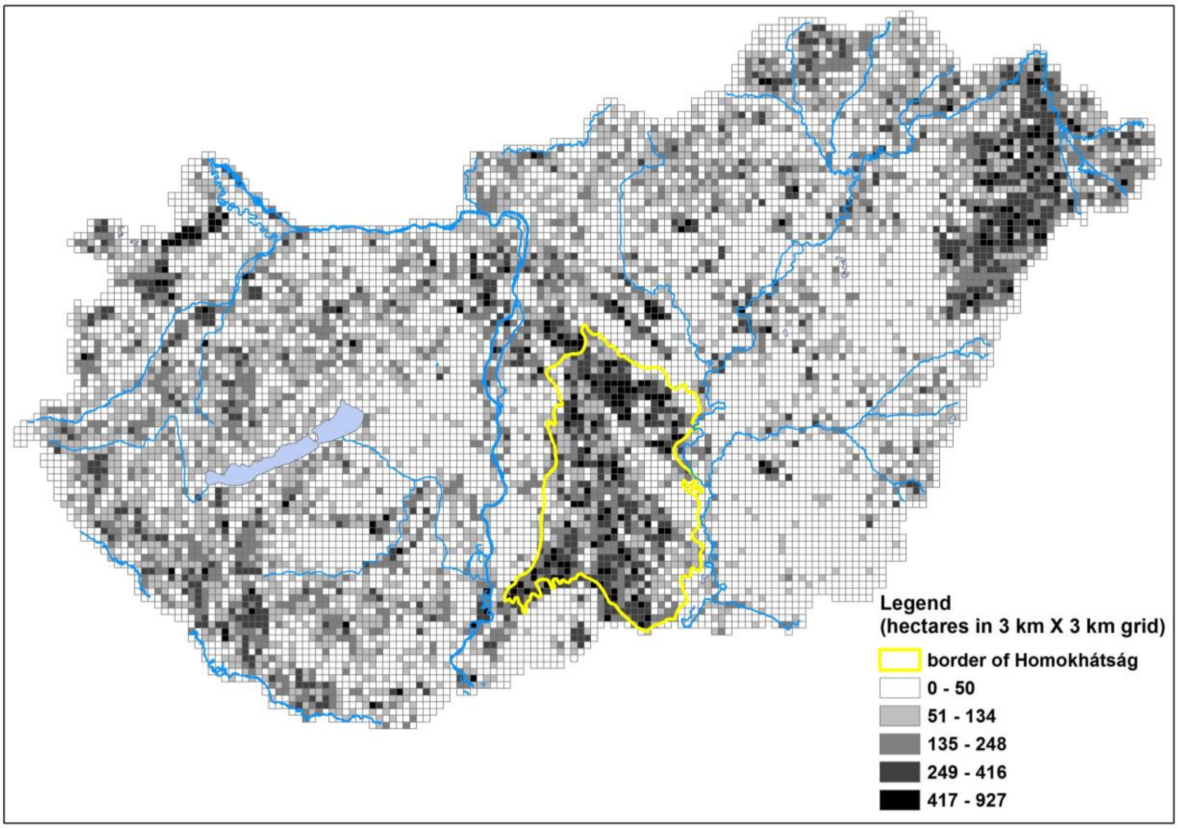

Fig 3. Land cover changes in Hungary between 1990 and 2015 by own elaboration. Data source: Corine Land Cover 1990–2000, 2000–2006, 2006–*2012, EEA, FÖMI, 2015*

According to the Corine data there were almost 114 000 hectares (= 16% of the region) affected by land cover changes in the Homokhátság area between 1990 and 2012. This is a very high rate, particularly if we compare that with annual land-use changes in European countries (EEA/ETC-LUSI, 2010, based on Corine land-cover data). In the Homokhátság region, the number of identified “overlapping hotspots of land-use change” have been over the average between 1990 and 2006 (Kuemmerle et al. 2016).

The core areas of the former large-scale agriculture have changed much less, or only minimally during the relevant period in Hungary. But in contrast, in the Danube-Tisza Interfluve, especially in Homokhátság area an "unstable land-use" was formed.

So why has been the land use change quite rapid, and why have the changes caused adverse effects in the examined region? Based on our spatial researches in the area over the past 22 years, we can determine the following observations:

After the transition in the 90’s there were several changes in cultivation. While we witnessed the dynamic reduction of close to nature meadows and vineyards, the forests and the uncultivated fallow lands have increased rapidly. The wine sector and the fruit industry have gone through a deep crisis. Large plantations remained uncultivated, and transformed into scrub-shrub areas. The vineyards have almost totally disappeared from the landscape, however it had been playing a key role for a long time in sandy soils' stabilization. This could be offset by the later vineyards reconstruction only partially. But it was only one clearly visible phenomenon in the Homokhátság region. Looking closely, the land use changes have got several causes and symptoms in the past decades:

- The former socialist cooperatives generally reduced landscape diversity and increased the water usage.
- After the political transition the individual farmers sometimes tried to increase their arable land at the expense of protected areas (grasslands and the area of the drying salt lakes).
- As an opposite process (parallel with the property acquisition of Kiskunság National Park) the agricultural production was eliminated in many zones around the protected areas, and the status of the natural landscape improved.
- The agricultural subsidy system also has an important effect in the rapid land use changes. Before the EU accession the Ministry of Agriculture has had subsidies for new or replantation for vineyards and orchards in the 1999 - 2004 period. After 2004 then there was the vineyard liquidation program by the EU, which changed in 2010 and farmers can get money for vineyards plantation again.
- The crisis and the decline of the livestock production are associated with the retreat of the grassland management.
- The depopulation of the scattered farmsteads has been accelerated and this caused homogenization in the landscape. The mosaic land use has gradually diminished or eliminated and some invasive species have spread rapidly (Robinia pseudoacacia, Amorpha fruticosa, Asclepias syriaca and scrub vegetation).
- The inland limits of the cities have changed significantly due to the economic development in the 90's, and new residential and industrial zones have been established.
- In the urban-rural fringe the suburbanization has caused negative effects. These areas were considered as a buffer area by the municipalities where certain consumer and business needs can be met. Unfortunately the building permits have been issued here without any serious concept.
- Meanwhile the recharge of water resources has become unpredictable and the signs of climate change have become noticeable. The agricultural production has limited by the prolonged dry periods, the inland waters or the occurrence of extreme rainfall or hailstorms. The saline lakes, marshes and wetlands have been declined. The municipals' green space has become more and more costly to maintain.

Moreover, the current trends of urban expansion are highly significant factors in the land-use change of this region. This is closely related to suburbanization and the transformation of the economy. The example of Kecskemét (the most populated city in the region with 112 000 inhabitants) is worth mentioning for further illustration of the process. In this traditional agro-town there was a really fast growth of urban areas in the 20th century. In the last hundred years the built-up areas has increased tenfold while the population only doubled. Today more than 10% of the population live in outskirts of the town. As a result of the expansion the city has lost valuable plantations and "recreational areas". This loss affected not only the agriculture, but the quality of life as well. The disappearance of the plantations increased the dust pollution because the surrounding green balks (functioning as natural barrier filter) have been liquidated. It was typical transformation in case of mid-size agro-towns in the region when the previous mosaic, small-scale farms and spatial structure was disrupted. The constructions (essentially the urban sprawl) have not been regulated in the areas of scattered farmstead in the past three decades. Basically the new buildings have merely provided residential function, so "the landscape is only used and not cared". As a result, the farming activities narrow down and disappear. The farmsteads are forced to give up their earlier traditional activities. Moreover, the milieu of traditional farmsteads often causes social conflicts (Csatári et al. 2016; Kovács – Farkas 2011). Obviously, the growth of urban areas and the way of life of the middle class moving out have increased the outlying residential water use requirements. All these problems do not affect only Kecskemét. Many of abuse, illegal water withdrawal and wastewater disposal are experienced in the surroundings of the affected municipalities (especially in the cities). That causes a negative impact on the water balance of the whole region and on the quality of its environment. Our empirical experiences have fully confirmed the above statements.

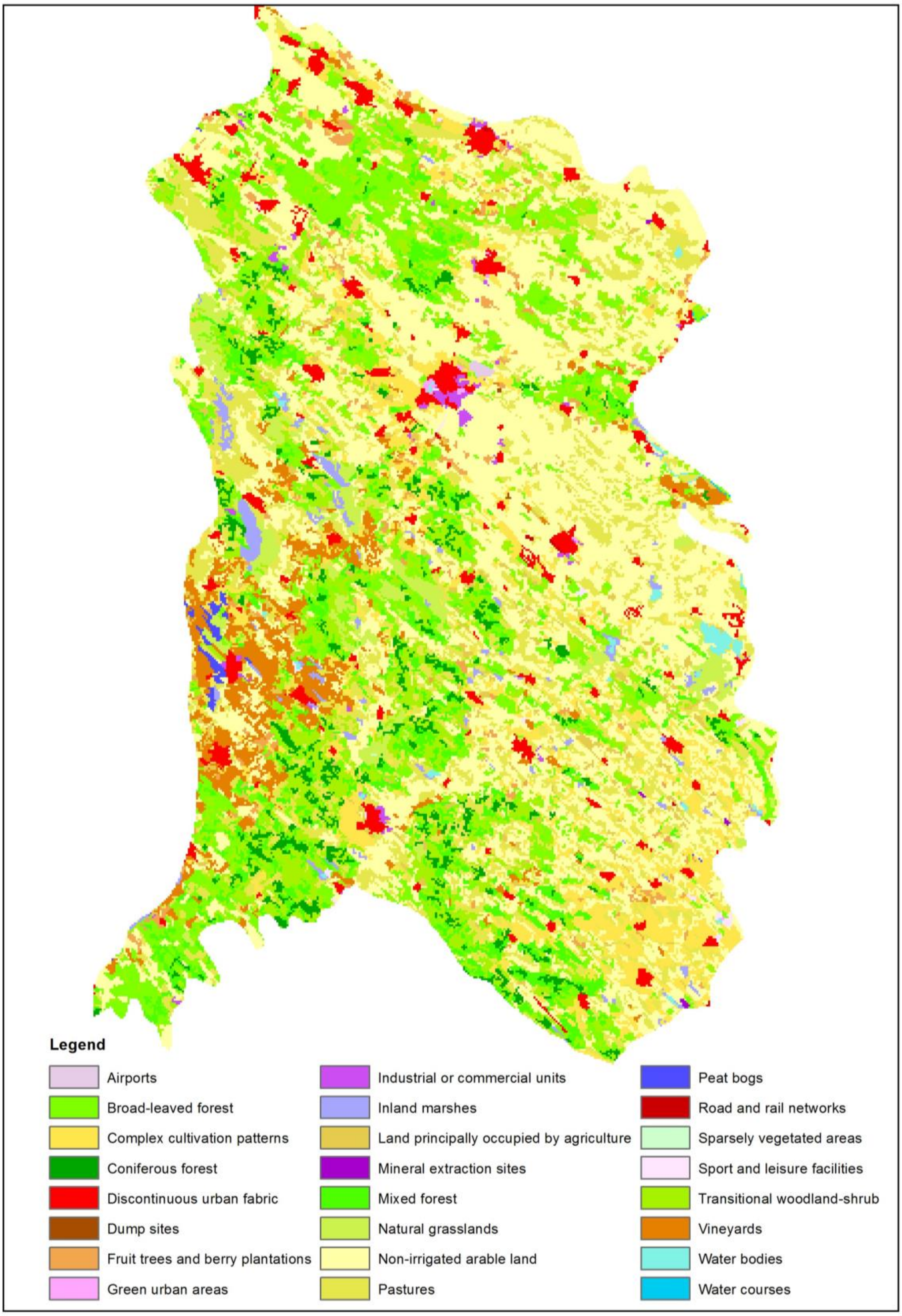

Fig 4. Recent land use in Homokhátság area. Source: by own elaboration based on CORINE Land COVER 2012, FÖMI 2015 data

Vegetation changes

In the Homokhátság region one of the most controversial vegetation changes was the afforestation. That resulted in lots of negative and positive impacts on land-use and water balance and it is still being discussed by many authors (Biró 2011; Jankó 2013; Láng et al. 2007). In the 2000's it was an important feature of the land-use conversion that Hungary undertook to withdraw 1 million hectares of arable land from production. The National Afforestation Programme envisaged 700 000 hectares for afforestation on the areas to be withdrawn from, while grassland got priority on the remaining 300 000 hectares. The agricultural subsidy schemes (agri-environmental programs, afforestation and vineyard liquidation) also support the rapid transformation of the rural landscapes in the Homokhátság region because of the "profit/income maximization thinking" of the farmers. A good example is that 16 500 hectares of new forest planted between 1990 and 2012. From all of these changes the consequences of the intensive afforestation is doubtful, especially from the ecological point of view (Dóka 2015) as the natural vegetation of the area used to be forest steppe and not deciduous forest. Therefore the forced afforestation was not associated with the original implementation of EU policy goals. Unfortunately, the plantations did not serve the spread of native species, the ecological balance and the reinforcement of local communities, but led to the dominance of alien species (because of the profitability in many cases). The plantations of native tree species are made more difficult due to the decreasing groundwater level. The non-endemic species (e.g.: Populus, Pinus sylvestris, Pinus nigra, Amorpha fruticose) are drought-tolerant and less dependent on groundwater level so they are more suitable for afforestation in the study area.

Based on studies implemented in the Homokhátság region it can be stated that the indigenous sand forest vegetation decline is related to both the climate change and the use of cultural landscapes. The proportion of forests increased on the one hand, (the forested area almost doubled from the mid-20th century to the present day, currently about 15%) on the other hand, the quality deteriorated. The increase in forest cover contributed to groundwater level sinking undoubtedly, but we also should see its benefits. Thus, for example, the uncultivated land rates have declined and have been replaced by landscape managing activities, which has benefit for the cultural landscape despite of any dispute. The forest protects against the effects of wind, the soil erosion, as well as reduces global warming; it is intended to woodworking, hunting and tourism purposes as well. It is important that a further decline in groundwater levels might occur primarily under the forests of intensive water demand species.

If we consider the species composition of the afforestation of the past decades it can be seen that the forests have shifted towards a drier, less demanding category. Plantings implemented mostly with species which have no effect on the groundwater level. Despite this, the considerations of nature conservation dictate that indigenous species plantations must be favoured and a more conscious, ecologically oriented forest management would be required (Hoyk et al. 2007).

One manifestation of the complex problems of the area is the transformation of natural plant communities. In this chapter the described changes may be associated with the changes of the groundwater level, temperature, precipitation, evaporation and soil salinity. Szappan-szék was chosen as the sample area because it is well explored by previous researches and the trends of the vegetation changes are clearly identified. The area is essentially one of the saline lakes of the Homokhátság. The lake water recharge provided by the precipitation falling on the water catchment area, but the water level is related primarily to the groundwater. Over the past 35 years the Szappan-szék regularly dried out by the end of the summer, and the last 15 years has remained dry throughout the year (Hoyk et al. 2011).

Previously, the staff of the University of Szeged made vegetation maps here, in 1987, 1994, and 2003 (Bagi 1989; Fehér, 2004). We examined the changes in 2010 when we made a field survey and mapped the vegetation patches with a handheld GPS system.[3] The maps then were

[3] Beside the GPS data we also used an aerial photography from that year which was originally the part of the MePAR system (Land Parcel Identification System which was established for the CAP management in Hungary). From these two datasets we made the vegetation map for 2010 in ArcGIS. We also digitized the maps of the previous surveys, and then calculated the areas of the associations for every sampling year. This data can be seen in Table 1.

compared to the groundwater level data and we also evaluated the water coverage of the landscape as well as the groundwater fluctuations.

For the better understanding of these changes we decided on reviewing the climatic changes of the area. For this purpose we reviewed the 10 km x 10 km grid interpolated database of the HMS between 1961 and 2010. The rainfall dataset of these 50 years shows a slight upward trend accompanied by great extremes and increasing seasonal variability. This trend is coupled with rising temperature values (fig. 5.) which – especially in the summer – increases the evaporation, while the summer season rainfall is decreasing, so an aridifying-warming trend can be observed.

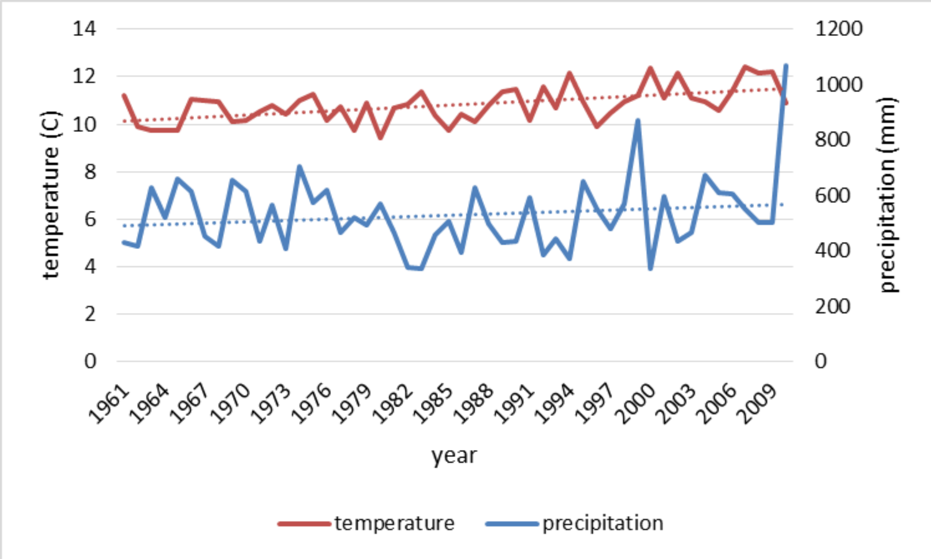

Fig 5. Annual mean temperature and precipitation (1961–2010).

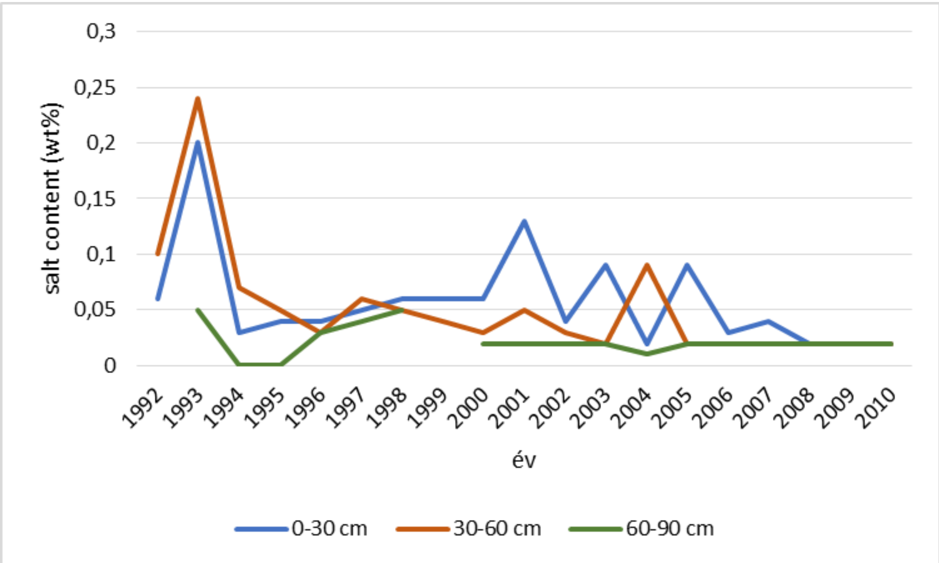

Fig 6. Changing of salt content in the 0–90 cm soil layer (1992–2010)*. Source: own elaboration based on The Plant and Soil Protection Service information*

The reduction in the salt content of the soil affects the development of the vegetation, since the vegetation of the saline areas was established by the adaptation to this environment. The salt washing out might alter the living conditions of saline associations which can lead ultimately to their disappearance. The maps show the state of the vegetation in 1987, 1994, 2003, and 2010 (fig. 7).

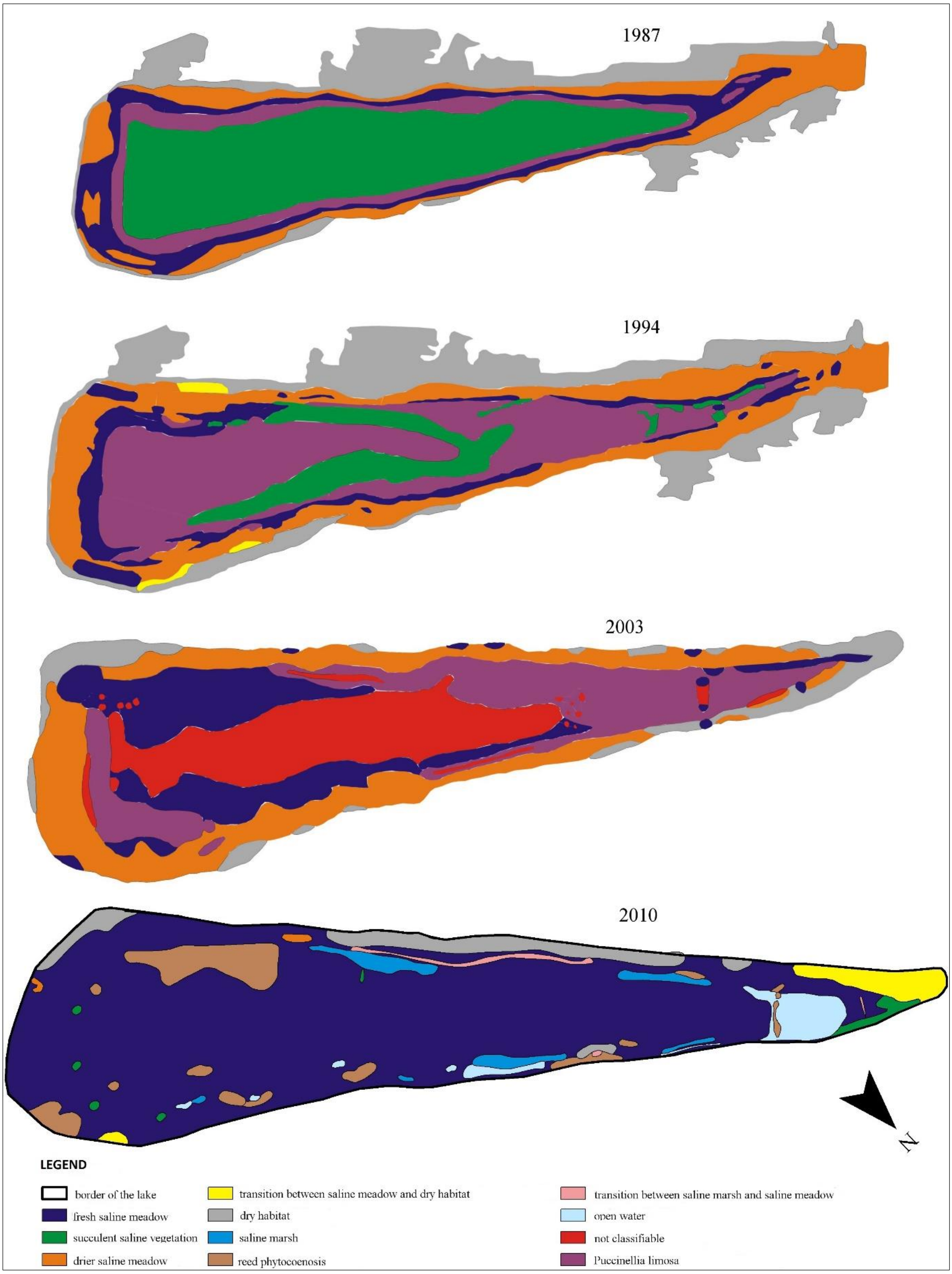

Fig 7. Changes in vegetation of Szappan-szék since 1987 to 2010. Source: Based on Bagi 1989; Fehér 2004 and own research

The Szappan-szék was an open water lake until the 1960's. For 1980's because of the low groundwater levels it has already been dried more than once. In 1987 the lake bed was covered for the most part by continental, succulent saline vegetation, which was surrounded by *Puccinellia limosa* and saline meadow in the form of narrow zones. The state of 1994 shows the spread of *Puccinellia limosa* in the lake bed which could be caused by further drying but also may be attributed to the increasing organic matter content in the bottom of the lake. Due to the droughts at summers after 2000 – when the groundwater sank deeper than one meter compared to the lake surface – the zonation of the lake bed disappeared. During this period, the vegetation in the former lake bed cannot be classified into associations. There was a short water covering in 2000, but some parts of the lake bed remained dry. Fresh and dry saline meadow occupied these parts at roughly similar proportion (21 or 26%), but the succulent saline vegetation disappeared.

Among the types of association alone the *Puccinellia limosa's* territorial share has remained robust in the north-western part of the lake (about 22%), while large areas of the lake associations were occupied by vegetation which cannot be classified (tab. 2).

Tab 2. Types of plant communities of Szappan-szék (distribution %). Source: Based on our own calculations

Vegetation	1987	1994	2003	2010
Succulent saline vegetation	37,6	9,5	0	0,9
Puccinellia limosa	10,5	31,1	21,8	0
Fresh saline meadow	12	10,2	21,2	77,6
Dry saline meadow	16,5	23,7	26,4	0,3
Dry habitat	23,4	24,6	8,5	5,6
Transition between saline meadow and dry habitat	0	0,9	0	2,8
Transition between saline marsh and saline meadow	0	0	0	0,8
Saline marsh	0	0	0	2,6
Reed phytocoenosis	0	0	0	6,1
Not classifiable	0	0	22,1	0
Open water	0	0	0	3,3

In 2010 there was a special situation in several aspects which reflected to significant changes. The annual rainfall distribution and parallel to it the groundwater level fluctuations ranged widely, so the rate of extremism increased.

Based on the 2003 survey the zonation disappeared from the vegetation cover. This status was characterized in 2010 also. The typical vegetation zones of the salt lakes were no longer possible to trace in the lake bed. As a result of the high rainfall of 2010 (1070 mm) the open water surface returned and persisted throughout the year which was a major change compared to the previous surveys. On the other hand, associations referring to wetter conditions – the Fresh saline meadow (77% in share) – almost covered the whole lake bed. An exception is the bed boundary area where there is a relatively sharp transition to a dry habitat and we can find saline marsh mainly in southern and south-western part of the lake. The succulent saline vegetation was limited to the narrowing, north-eastern part of the lake, as well as the transition between saline meadow and dry habitat.

The transformations taking place in the vegetation of the Szappan-szék demonstrate the water-related negative tendencies, the homogenisation of the landscape and the extremely rapid changes of the natural environment.

Future projections and important environmental issues related to the region

The visions and dilemmas related to the Homokhátság were important topic of in depth interviews what we have made during the past two years in the region. Hereinafter we are going to summarize the prominents' opinions. Having in mind the regional sustainability, the landscape degradation, the water management issues, and the other rural problematics, it is worth pondering what kind of future projections we can count on? Many interviewed agree that the "do nothing strategy" is the worst version. "If we let the existing negative trends prevail, the region will have to face serious irreversible problems in a few decades." Due to the aridification the regional carrying capacity might decrease in the future. Both the cultivated land and protected areas might be devalued, production is unpredictable. Because of the deteriorating living conditions the local societies will migrate and especially the youngsters leave the old and dysfunctional settlements. The total loss of perspective is still avoidable with the scenario of the "environmentally conscious landscape management". It requires efficient land use, environment-friendly technologies and water management, adaptation and mitigation from local residents and farmers as well. Finally, the third projection, “the long-debated Danube-Tisza channel and the related investments may be in the centre of the complex developments” – commented several respondent.

Regarding the future of the region it is definitely worth mentioning the Danube-Tisza channel issues. The planned channel connects Hungary's two largest rivers and its future function is an issue for centuries. Some experts envisioned a navigable, high-volume, industrial supply channel functions that would create economic stability for the whole region. Others say this investment would not be worth, because neither navigation, nor irrigation is that much needed to restrain the investment. The local ecologists believe that the flood peak-reducing effect will not sufficiently contribute to the improvement of the water balance of the region, even not through its reservoir capacity. Also it would be associated with "unacceptable level of landscape destruction" and loss of semi-natural areas (Kákonyi 2009 and the interviewed experts of Kiskunság National Park). Most engineers, ecologist and rural experts agree on the necessity of water supply, but the navigable channel would be supported by groups of industrial interest only. Nature conservation and water impact studies mention the opportunity for the development of a north-south direction channel especially designed for efficient water transport connecting to the existing inland water network. This might be achieved without serious risks, and would optimally satisfy the goals of the organic agricultural and residential water consumption. However, “before realizing such a channel, first of all we should solve the treated waste water retention”. “We should renovate the existing channels, locks, and have to support the drought-tolerant plants and the extensive grazing of livestock.” The channel might be established or not, many questions remain, for instance: Will the local residents and opinion leaders be able to recognize the problems related to long-term planning and common solutions? What will be the region's water needs? Is it possible to optimise the use of ecosystem services? Could the local community become more eco-friendly?

One thing is certain: a common element of proposals provided for the Danube-Tisza channel so far, is that their implementation could only be successful with a multi-purpose use. The crucial goal is the water recharge, and the improvement of the water balance. In our view, the channel's vision should not be completely ruled out, even perceptively might be the only solution for the region's wildlife, agriculture and local societies to maintain. In course of the human interventions intended in the future “we have to proceed more carefully than ever, when the Danube-Tisza water retention is the focus. Decision should not be made taking one or a few aspects into account when the long-term consequences doubtful.” – as several prominent people summed up their thoughts.

There was another relevant theme we discussed with prominent: the issues of protected areas and the role of Kiskunság National Park. Each mean a special study but we want to highlight some crucial findings. Everyone agree that the foundation of the national park was a key event because it strengthened the diffusion of the ecological and more environmentally conscious approach in the region. The national park in the studied area brought several important changes in land use and water management, and triggered specific social reactions and conflicts. “Typical problem was that when the farmers tried to expand their arable land on the protected salt lakes or the grasslands. Another negative process was the abandonment of the vineyards and other plantations.” – listed by respondents.

In terms of water efficient land use there was another key moment: the introduction of the agro-environmental schemes in 2003, and the Common Agricultural Policy after the EU accession in 2004. These have caused dynamic land use changes in the affected region. The experts agree that the recent subsidy schemes unable to optimize the landscape management. “We can find instable land use in several zones even along the buffers around the protected areas and NATURA 2000 territories. The short term material interests (“the fight for subsidies”) cause intensification, degradation and homogenization close to the semi natural habitats and cause instability for agriculture and finally unpredictable livelihood in Homokhátság region.” – the interviewees expressed their concerns.

Conception of multifunctional agriculture

Based on our previous studies and analysis the problems of the Homokhátság area are extremely diverse, and the region is facing environmental, economic and social challenges (fig. 8).

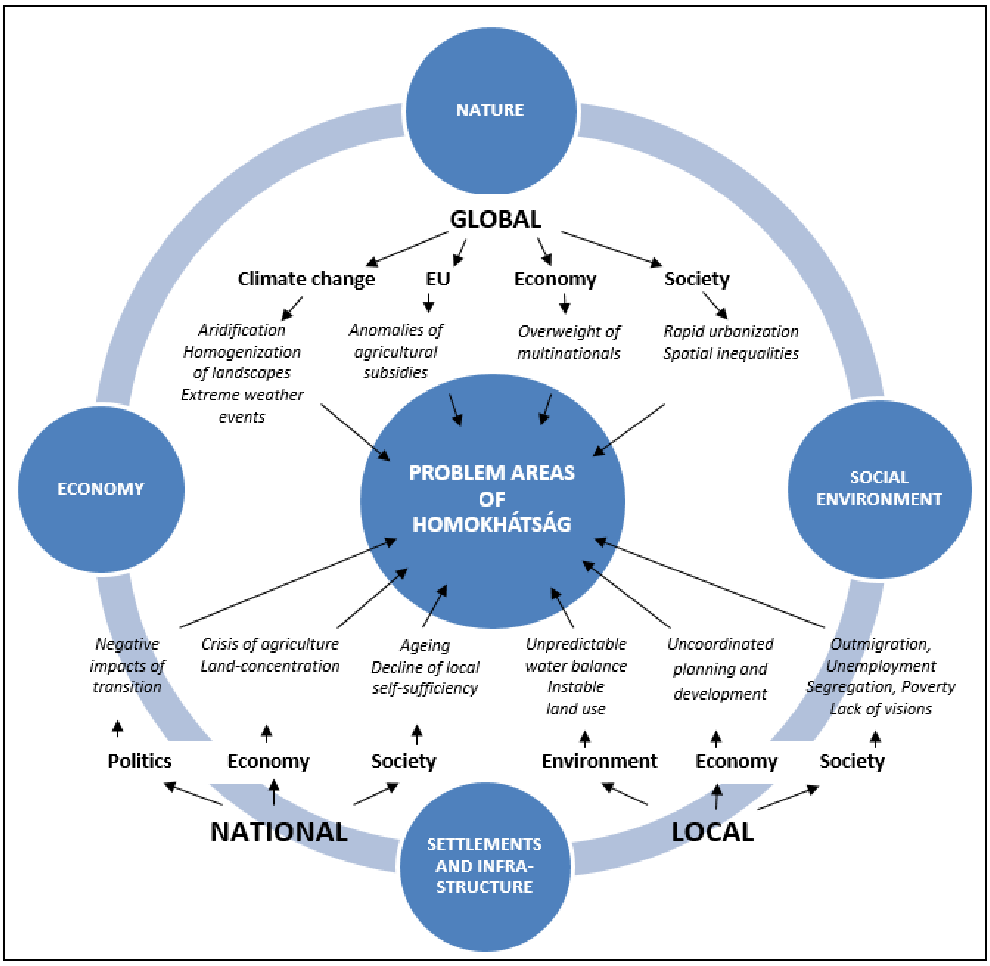

Fig 8. The main factors of the Homokhátság problematics. Source: Own elaboration based on Csatári (2009)

The above presented processes and problems of the Homokhátság region affect both the natural landscape and the social, urban, economic trends. In our view, the region's complex rural development should primarily be an adaptation strategy developed for the treatment of aridification. This, however, should integrate the responses to other arising challenges as well. On this basis, we think the most relevant development concept is the multifunctional agriculture, which is supported by the following arguments:

- The area has got strong agricultural character,
- High involvement of the agricultural society, a large number of commodity producers, traditions, and a high level of knowledge,
- The possibility of local self-sufficiency in basic foodstuffs,
- In addition to the Hungaricums (apricot brandy, red pepper etc.), existing and currently marketable agricultural products (fruits and vegetables sector, sheep and rabbit production so the production is partly already diversified),
- Potential agricultural diversification opportunities which can be produced in drier conditions (e.g. sand truffles, herbs),
- A significant part of the area is environmentally sensitive, one of the most influential factor is the water balance unpredictability
- European famous national park and protected areas, Natura 2000 habitats can be found in the region.

The development directions of the multifunctional agriculture may include additional extensification of production and the widest possible extension of agri-environmental programs. During our work we have found that the main tasks include: land use optimization (smarter afforestation, preference of the scattered farmsteads), dissemination of drought resistant species and varieties, support for precision agriculture and livestock production. In addition, the water management measures are needed to assist in the retention of water. The wastewater returning to the ridge areas, the resolution of municipal drinking water supply from river waters would be strictly necessary. The restrictions on illegal water abstractions are also inevitable.

From the economic point of view we recommend the development of three sectors: The first is the environmental industry and the associated research and development (biomass for energy purposes and industrial use, the development of applications and processes). The second is the food industry (this would base basically on processing of local products). The third is the further expansion of rural tourism. The latter should follow the local diversity of landscapes and could appear in several versions in different spaces; such as eco-tourism, wine and culinary tourism, agro-tourism, rural- and conference tourism. In addition to the main directions listed, particular emphasis should be placed on trade and marketing of the local agricultural and food products. The framework of Community-Supported Agriculture supports and makes these achievements feasible. This contains the organization of a direct marketing chain, the creation of local markets and regional product brand labelling system and finally the development and expansion of marketing activities associated with all these.

In respect of the above mentioned, there is a great importance of residents' awareness which can be the cornerstone of water saving and rational water management. Without this, the targets are less effective or not feasible at all. So the “local knowledge-based” rural development will require more rational water use and environmental management.

5. Summary and conclusions

Based on global and regional climate models, the most acute problem of the climate change for the coming decades is the expected water shortage. The most serious situation is expected in the semi-arid and Mediterranean regions, however, in the central part of Europe, in the Danube-Tisza Interfluve serious consequences must be expected too. In our work we presented a really sensitive area which is very fragile regardless of climate change. The current rural problems are already serious and will be even more critical. In national comparison, two main groups of problem-factors can be identified in the region: In one hand, the Homokhátság area is more environmentally sensitive than the other lowland areas in Hungary mainly due to the rapid anthropogenic changes in land use, the sensitivity of soils and vegetation and the unpredictable hydrological regime. On the other hand the urban sprawl, the territorial expansion of the built up areas (road network, motorway and infrastructure) caused large scale intervention and water usage. These phenomena in the outskirts were more dynamic than in other rural areas. So there are number of factors behind the land degradation and land-use conflicts in the region, and we have not even talked about the maladministration of the agricultural subsidy schemes after the EU accession. Some negative trends can be attributed to the fact that the agricultural policy kept just the goals and receipt of the assets of the EU in mind. The supports of the CAP (Common Agricultural Policy) have strongly influenced the profitability of certain agricultural activities, and thus, indirectly, the land-use. The harmful effects are exacerbated in the Homokhátság due to the changing environmental conditions.

If the aridification is similar to the previous years, consequences will be terrible and the negative processes will be irreversible both in terms of landscape and socio-economic status of the region. It is crucial that local societies have to adapt to the changes, such as inconstant climate and water scarcity, and also have to understand the long-term interests instead of short-term benefits. The adaptation requires environmental conscious decisions and activity. Therefore the solutions are not necessarily only sectoral. But also such social skills and abilities are needed, which enable the consistent implementation of the rural developments in every specific region.

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