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PLANNING MANAGEMENT ADAPTED TO CLIMATE CHANGE EFFECTS IN PROTECTED WETLANDS: FIRST RESULTS OF THE HABIT-CHANGE PROJECT IN HUNGARY

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ABSTRACT

Natural environment of Central and Eastern European countries is highly vulnerable to climate change. The area affected by one of the greatest extremities in precipitation in Hungary between 2010 and 2011 has been the Great Hungarian Plain. Especially wet areas suffered from the highest level of excess water and, in the consecutive year, the most extreme drought experienced since regular meteorological measurements have been launched. Exploration of user known problems is inevitable as a base to develop adaptive management of vulnerable natural areas through stakeholder dialogue. After the identification of stakeholder groups, the private landowners and land managers as being most likely affected by climate change were interviewed in person on three sample areas of the Körös-Maros National Park (SE Hungary). Major impacts that affect natural habitats are presented in case of Natura 2000 habitat types occurring in the sample areas. Nature conservation management methods, restrictions and prohibitions specified to land use are also presented. Problems reported by stakeholders are focusing on those phenomena that are considered problematic and are directly or indirectly connected with climate change. This compilation helps to identify the most important factors that already have influence on the management of protected wetlands. Considering awareness, land owners and farmers do see several problems and in many cases they connect them with weather extremities and long-term changes, but take practically no actions in favor of mitigation or adaptation, or strengthening resilience. As there is strong evidence that wet habitats are becoming more sensitive and vulnerable, land users have to adapt their objectives, strategies and measures to changing climate and be involved in the process of adapting the management measures of protected areas, especially wetlands, to probable effects of climate change.

INTRODUCTION

Various effects of climate change are among the greatest challenges that Hungarian agriculture and nature conservation has to face currently and in the near future (Pullin et al. 2009). In Central Europe, wetlands are already seriously affected by weather extremities (Erwin 2009, George 2010, UN 2009), therefore, their management needs to be adapted to the predicted changes of climate. 46% of the total grassland areas of Hungary are protected as Natura 2000 areas. A very high rate of their area needs the presence of humans by a certain type of management. This is why harmonizing the aims of agriculture and nature conservation is highly important (Ángyán et al. 2003). This may be ensured either by national park directorates (management organized by them or renting state areas with restrictions) or private owners. Stakeholders of wetlands face various problems and in parallel, play crucial role in their maintenance (Fürst et al. 2010). In favor of developing their resilience, there is an urgent need to develop adaptive management through stakeholder dialogue (Sendzimir et al. 2007, Wemers et al. 2010). As its initial phase, exploration of current user known problems is inevitable.

Adaptation of nature conservation management to climate change requires a broad integration of social science as well (Heller and Zavaleta 2009). Our initiative aims at combining ecological aspects, nature conservation and climatic adaptation with social and economic factors, with a concentrated view on sustainability of this type of protected land management. Planning climate adapted management requires the involvement of stakeholders and amongst them, land owners and users. Our aim was to collect the problems encountered with climate change and land use in protected wet areas. Complex studies on the effects of management on vegetation and forage value of wetlands in the same sample areas have been investigated previously by us and other colleagues (Penksza et al. 2009).

Adaptation activities can be classified into three groups based on their scope, perspectives and scale. Under implementation, adaptation can be divided into facilitating adaptation (developing information, raising awareness, mobilizing resources, enhancing adaptive capacity) and implementing adaptation (making the actual changes in operational practices and behavior, installing and operating new technologies) (Klein, 2004). Furthermore, adaptation activities can be divided into autonomous or spontaneous (referring to

private activities, being reactive: ex post, after the change) and planned measures (anticipatory or proactive: ex ante, before the change, driven by public authorities) (Schaller and Weigel, 2007).
The HABIT-CHANGE (Adaptive management of climate-induced changes of habitat diversity in protected areas) project evaluates, enhances and adapts existing management and conservation strategies in protected areas. This way, conservation managers can pro-actively respond to likely influences of climate change which threaten habitat integrity and diversity. During the project, cooperating partners analyze not only the changes of habitats caused by climate change, but also focus on the necessary changes of these habits in conservation management and land use in protected areas. It is built on a stakeholder dialogue about current user known problems in regard to climate change and is geared towards rising awareness on the demand for adaptive management of protected areas. The main aim of our adaptation policies is to increase the resilience and to reduce vulnerability of agricultural systems based on Iglesias et al. (2009).
The main aim of the process of planning climate change adapted management is to obtain a favorable conservation status of protected habitats (according to the Habitats Directive of the EU) even under changing climatic conditions. It is inevitable to define and describe goals and objectives, then strategies and measures in favor of obtaining them. It is also important to identify uncertainties and highlight how the observed areas can deal them. Main objectives are the improvement of resilience of selected habitat types and the assessment of existing strategies and measures for habitat management. During the process of updating existing management plans, integrating climate scenarios are necessary.

MATERIAL AND METHODS

Observed areas are situated in the Körös–Maros National Park, which is located in South-Eastern Hungary among the rivers Tisza, Körös and Maros. It is characterized by freshwater habitats, marshes and grasslands and by the areas' agricultural use. Considering the vegetation of the Hungarian Great Plain macro-region, this territory belongs to the most diverse landscapes. This various view is determined by the complex effect of several natural factors. Among them, the dominant ones are climatic and edafic characteristics. Investigation areas belong to the deepest-lying areas of the Hungarian Great Plain, having been extended swamp areas through several millennia. Deeper areas under constant water coverage are covered mainly by clay; meanwhile, slightly higher-lying patches with temporary water coverage give home for different types of sodic (alkali) habitats.
The sample areas designated for investigations as carrying natural values of high community importance are the Kisgyanté swamp, the Kisvátyon swamp and the Szõ-rét meadow, which lie in the Kis-Sárrét operational part of the Körös-Maros National Park, in the geographical micro-region called Kis-Sárrét, in close vicinity to the Romanian border. They host several (82 listed) plant and animal species of community importance and 6 types of habitats that are under protection within the Natura 2000 program of the European Union: Pannonic salt steppes and salt marshes (code 1530), Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* - type vegetation (3150), Pannonic loess steppic grasslands (6250), Alluvial meadows of river valleys of the *Cnidion dubii* (6440) and Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (91E0). This is why, besides being national park areas, they have been also designated as Natura 2000 (both SPA and SAC) sites.
Arable lands cover a high rate in the Kis-Sárrét SAC and SPA areas, however, the National Park Directorate supports their conversion onto grasslands. The rate of inhabitants living from agriculture is higher than the national average. However, most of them owns less than 5 hectares. A part of the one-time cooperatives works in the form of an economic enterprise. The national park directorate uses primarily those areas where this is necessary in favour of habitat reconstruction or rehabilitation, special management. Other state-owned protected areas are hired by farmers, with restrictions. Main crops are autumn wheat, autumn barley, oat, corn, sunflower, alfalfa. Alternative crops are oil pumpkin, oil rape, oil radish and corn. Rice had been produced between the 1930s and 1960s around Mezõgyán, Geszt and Biharugra villages, resulting in artificially created wet areas that have later been inhabited by species of natural habitat types.
The number of grazing livestock has increased during the past couple of years after a massive fall of the 1990s. The second largest artificial fishpond system of Hungary (about 1600 ha water surface) lies in their close vicinity. Most of the forested areas state owned, managed by a state forestry company. Only 12% of the forested areas is covered by indigenous species, 33% of it being oak. Touristic activities cover mainly bird-watching (mainly on the fishponds). A study-trail has been launched along the edge of the Kisvátyon swamp area, being 7 km long, with 6 information panels about the species, and a bird-watching tower where the trail edges the fishponds.

Considering historical development of the landscape, the Kis-Sárrét territory, once called Sárrét of the Körös river, has undergone severe landscape changes during the past 200 years. Extended marshes and fens had dominated the area before converting the landscape, serving the generation of a diverse landscape and different management types adapted to the ecological conditions. The original state had started to change in mid-19th century, due to severe water regulation works between 1856 and 1879. As many areas under constant or temporal water cover had disappeared, the traditional management has changed and a significant portion of local inhabitants was forced to give up traditional way of living. Dried-out areas were converted to arable lands, while wet parts have started to serve as pastures or hayfields, preserving the high importance of livestock keeping in the region.
There were significant landscape changes in the 20th century. The creation of the fishponds near Biharugra village started in 1910, currently giving place for rare bird species. There was an extended forestation in 1930, resulting in several wood patches. Despite landscape conversions, some wetlands remained in a favorable conservation state. Considering their changes in the second half of the 20th century, it is highlighted in case of the Kisgyanté swamp area that the portion of wetlands has not decreased despite the creation of canals. The Kisvátyon swamp has also not dried out severely. In case of the Szõ meadow, the recent system of water paths cannot be recognized on aerial photos of the 1950s. Marsh patches and those with constant or temporal water coverage carry nature conservation values as having been constantly part of the landscape for two centuries, preserving its traditional view and character. As a consequence of inland water regulatory works, the area of marshes has although decreased, but their state can be still considered as almost natural.

Identifying stakeholders

Stakeholders in the current paper are defined as persons, groups or institutions that have an influence on the protected wetland, manage parts of the area and implement measures, thus, influence its condition directly (based on Reed et al. 2009). Documenting their perception is important for several reasons: their knowledge permits their participation in the process of preparing management plans adapted to climate change, gives first indications of land-use interests and their experience can help to indicate climate-change induced problems.
A scoping exercise was performed in two steps to identify stakeholders. A brainstorming was held with three nature conservation guards responsible for organizing and controlling management in the sample areas and the ecologist and one representative of the agricultural office at the Körös–Maros National Park Directorate, representing extensive local knowledge on both natural values and management actors. Possible key informants were listed upon the criteria of being strongly affected by climate change impacts, have already existing problems or cooperation with management authorities, referring to all relevant sectors of land use. Farmers were identified as being most likely affected by climate change in wetlands of the study areas, either as being private landowners or users (managers) of state-owned areas according to national park regulations. As a second step these key informants were contacted in person, and data collected through interviews. The following stakeholders were listed.

Land users as direct stakeholders are:

- Colleague of the Körös-Maros National Park Directorate in its central office (Szarvas town) who is responsible for management of the sample areas,
- nature conservation guards in the observed areas,
- owners of the cattle and sheep that graze the areas hired by the National Park Directorate,
- shepherds looking after grazing livestock,
- farmers who mow the area hired by the National Park Directorate,
- and visitors of the study trail in Kisvátyon area.
- It was stated that there are no arable lands in the close vicinity of the areas and those in the distant areas do not have any significant pressure on the wetlands, nor the neighboring fishery.

Other stakeholders are:

- The Regional Environmental and Water Management Directorate,
- the Regional Environmental, Nature Conservation and Water Management Inspectorate,
- the local Water Management Association,
- the state-owned forest manager company,
- the fishing companies and hunting associations,
- the local governments,
- the local residents of surrounding villages.

- the anglers,
- and the tourists visiting the areas.

Qualitative interviews
We prepared semi-structured interviews based on open ended questions according to Leech (2002). These were focusing on (1) general problems of management, (2) experienced problems directly or indirectly connected to climate change effects, and (3) strategies and measures to cope with these challenges. All respondents were asked in person, usually on the spot, i.e. pastures and hayfields, between spring 2010 and late autumn 2011. The interviews were recorded and detailed notes were taken. Based upon them, transcripts were written, ensuring the basis for the problems listed below. The method of Ryan and Bernard (2003) was applied for identifying themes by comparing text fragments. They were structured using emerging categories. For data analysis and thus, discussion, scientific results of our previous investigations on naturalness state, livestock keeping capacity and forage value in parallel with relevant literature (if necessary for discussion of the local phenomena) were included.

RESULTS AND DISCUSSION

Major impacts affecting Natura 2000 habitat types occurring in the area

Pannonic salt steppes and salt marshes (Habitat Directive code 1530):
- abandonment of pastoral systems
- drying out
- drying out / accumulation of organic material
- eutrophication
- overgrazing
- undergrazing
- infilling of ditches, dykes, ponds, pools, marshes or pits
- improved access to site
- inundation
- management of aquatic and bank vegetation for drainage purposes
- management of water levels
- modification of hydrographic functioning, general
- modifying structures of inland water courses
- mowing / cutting
- trampling, overuse.

Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* - type vegetation (Habitat Directive code 3150):
- drying out
- infilling of ditches, dykes, ponds, pools, marshes or pits
- eutrophication
- invasion by a species
- inundation
- management of aquatic and bank vegetation for drainage purposes
- management of water levels
- modification of hydrographic functioning, general
- modifying structures of inland water courses.

Pannonic loess steppic grasslands (Habitat Directive code 6250):
- abandonment of pastoral systems
- artificial planting
- burning
- cultivation
- forest planting
- invasion by a species
- removal of hedges and copses

- undergrazing
- shrubbying (development of shrubs on grasslands).

Alluvial meadows of river valleys of the *Cnidion dubii* (Habitat Directive code 6440):
- drying out
- eutrophication
- drying out / accumulation of organic material
- infilling of ditches, dykes, ponds, pools, marshes or pits
- inundation
- invasion by a species
- management of water levels
- modification of hydrographic functioning, general
- modifying structures of inland water courses
- mowing / cutting
- trampling, overuse.

Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) (Habitat Directive code 91E0):
- drying out
- infilling of ditches, dykes, ponds, pools, marshes or pits
- invasion by a species
- management of water levels
- modification of hydrographic functioning, general
- modifying structures of inland water courses
- forest planting
- general forestry management
- removal of dead and dying trees
- overgrazing.

Nature conservation management methods, restrictions and prohibitions specified to land use

Management of arable lands should primarily focus on traditional cultures that are characteristic for the region, in line with the preservation aims of protected species. Advantage should be given for species without intensive cultivation demand. Not allowed activities are deeper ploughs, use of liquid manure, burning fallow and straw. Minimal work cultivation system should be used during management. Border of grassland and arable land must not be altered for the disadvantage of the grassland. Fertilizing should be based on organic manure and cultivation of *Fabaceae* species and green manure cultures. Crop protection should be based on prevention and mechanical or biological methods. Effective game disturber should be used during mowing and harvesting. Harvesting should be started from the center of the plot. In case of founding a nest of a strictly protected bird species, a protection zone should be designated around the nest that is suitable for ensuring successful hatching.

Hayfields and pastures have to be separated and managed suitably, but it does not exclude the possibility for mowing some parts of pastures in certain years or grazing on hayfields after mowing. Prohibited activities on hayfields and pastures are soil improvement, grassland burning, melioration, irrigation, racking, over-sowing, spreading organic manure or artificial fertilizers, use of chemicals, grazing with geese or pig, and grazing during winter. In order to prevent scrub encroachment, areas should regularly be mowed or grazed. It is necessary to cut shrubs on grasslands with scrub encroachment. Species to be grazed are sheep, cow, water buffalo, horse and donkey; goat only together with sheep flock as searcher, pig only in case of nature conservation cause, with permission may be grazed. Under- and overgrazing should be avoided. In favor of creating and maintaining conditions for species of high importance, overgrazing is needed in some designated areas. Grazing is possible by 0.2–1 animal unit per hectare (exceptions depend on exact area and regulation), between spring drying and autumn rains, usually between 24 April and 30 November, by the means of shepherding or section grazing. Besides this period, grazing may take place only in case of dry soil condition, without harming the grassland cover. Optimal time of mowing is defined by the National Park Directorate for the certain areas. The mowing of big, constant areas in one time has to be avoided. During

mowing, unmown lines and parcels should be designated in dialogue with the National Park Directorate. Mowing should start from the middle of the parcel, towards the edges and wildlife should be alarmed. In case of founding a nest of a strictly protected bird species, a protection zone should be designated around the nest that is suitable for ensuring successful hatching. Mowed hay should be transported away within 20 days of forming the bales, but the latest until 31 July. Mowing the aftermath should follow these regulations as well. Weedyness should be avoided by clearing mowing. Grazing and other activities on grasslands may be delivered only in case of dry soil state.

Reed harvest and other relevant activities may be delivered only between 1 December and 28 February, on totally frost soil, or on ice. Mosaic-like reed pattern should be created during reed harvest and unharvested parts should be left.

Problems faced by stakeholders that should be considered during planning adaptive management

A compilation of stakeholder opinions is listed, focusing on those phenomena that are considered problematic and are directly or indirectly connected with climate change and giving indirect attention to their perception of climate change. This compilation helps to identify the most important land user problems that already have an influence on the management of protected wetlands.
When facing the vegetation of pastures, we should take special attention to the amount of grass and *Fabaceae* species valuable for the livestock as these are the most important forage of grazing animals. The grass species significantly change during the vegetation period (e.g. from the aspects of phenology, morphology). This is why it is essential to find the proper time for mowing. If it cannot be organized in proper time because of climatic conditions, it may cause severe problems. Forage value of the pasture is determined by nutrient values. Among them, the most important ones are raw protein and raw fiber content and their ratio, which may also vary during the year. The ratio of protein and fiber exceeds the desirable 1:2 around mid-May in case of most grass species. Phenological and morphological changes lead to changes in nutrient content as well.
In drier years, instead of broad-leaved grass species (e.g. *Festuca arundinacea*), narrow-leaved grass species (e.g. *Festuca pseudovina*) with xeromorphic characters are becoming dominant since these have better adaptation to the drier period. Changes in vegetation of the grasslands are associated with climate changes, especially the occurred rainfall changes.
In favor of finding the suitable management method of the grasslands, profitability and nature conservation aspects are very important. The relevant Hungarian regulation (61/2009 FVM reg.) determines the minimal livestock keeping capacity to be 0.2 livestock unit per hectare. However, it does not determine the top limit of animal load on grasslands. This is why it is inevitable to study the real livestock keeping capacity of the different grasslands. Overgrazing affects whole areas or only smaller patches such as roads of livestock, surroundings of stables and drinking-troughs. The problem cannot be solved in these smaller parts according to most farmers. However, they agreed that if the whole area is affected then the load can be decreased. They agreed on the negative consequences of overgrazing, carrying economic effects as well.
According to the farmers, strong overgrazing was dominant in the dry period. This resulted in changes of vegetation such as dominant and character species (*Festuca pseudovina*, *Artemisia santonicum*) may almost disappear. They have appeared again with a greater covering rate in the autumn period. A greater part of the autumn species consisted of weeds and pioneer species.
The danger of overgrazing is high in case of wet areas of the Hungarian Great Plain. As an effect of constant disturbance, species composition of the grassland and coverage of species may change significantly on overgrazed areas. Usually the coverage of species indicating wetness and nitrogen increases. The amount of some *Fabaceae* species (e.g. *Trifolium fragiferum, T. repens)* may show a massive increase as well. Rate of natural disturbance tolerant species may also turn upwards. Degradation caused by trampling may result in barren soil surfaces, especially along roads and around the drinking-troughs and resting places.
The method of over-sowing is (or was previously) applied in favor of heightening the quality of the grassland, especially in those emerged in abandoned arable lands. It may result in the growing abundance of several species. The total number of species may decrease and some degradation tolerant ones may grow. Farmers reported us that this monoculture-type management is not viable also from an economic aspect.
Signs of drying can be detected in case of wet vegetation patches. As a result of dryness, the amount of hay to be mowed is decreasing. This causes a serious problem for every farmer, especially for those owning dry habitats. And in parallel, wet habitats (that are normally hayfields) are used in dry years as pastures, creating unsafe circumstances for winter forage production and giving place for unfavorable management of valuable

habitats. The amount of grass to be grazed was not enough in several places (but that was not so serious problem for the livestock, there was enough forage from the previous year).
The National Park Directorate had to buy water in 2009 (pumped from the Sebes-Körös River – this activity needs close cooperation with the neighboring fishery as well) to avoid drying out of the Szõ meadows. 2011 was the driest year in Hungary since launching regular meteorological measurements. In case of wet meadows, drying out results only in a temporary (annual) change of the habitat type and it appears again in a favorable year, and naturalness state may be good even in the altered habitat. However, water supply may be necessary due to other reasons, such as the threat of burning peat or dust storm, or in favor of nesting bird populations.
Extremities in the amount and rate of rainfalls (far from being balanced), resulting in excess water on the surface of areas or their drying out, might lead to the expansion of invasive species. As a consequence of stronger winds, less cold winters, hotter summers and droughts, wet habitats will probably become more sensitive and vulnerable, and their area will decrease; these are diverse thoughts of the stakeholders.
As a consequence of excess rainfalls in 2010, mowing could take place (in parallel with grazing) even in some dryer areas that previously were used for grazing. High level of inland water created unfavorable circumstances for management as several meadows, hayfields and even pastures were unreachable. Even if reachable, many pastures were not suitable for grazing because of hard moving for animals. Several hydrophyte plant species thrived.
Wet areas mean problems for every farmer as they can enter these areas by heavy mowing machines too late, when the forage value is lower. Meanwhile, these areas cannot be grazed, otherwise trampling totally degrades the soil. If the pasture is not too wet so it is grazed even in the extremely wet year (as in normal years), it may result in undergrazing (because of huge amount of biomass and the same livestock load). The Kisvátyon swamp experienced in 2010 that it was very difficult to mow and the mowed hay was not transported away from the area because of physical barrier (water on road). The Kisgyanté swamp is normally drained around end of summer (or dried naturally) and then is mowed, but in 2010, although the sluice gate was opened, the area remained wet, blocking mowing and accelerating succession. Wet years on hayfields result in a huge amount of hay, the majority of which in 2010 was not harvested by the farmers because of excess rainfall, or if harvested, they could not store that amount.
Increasing weedyness, especially the appearance and invasion of alien species are harmful not only from the aspects of nature conservation and management, but they also cause a bad landscape view. 1-2 monodominant species may create a boring view of the landscape as they overgrow (and finally extrudes) indigenous species. The farmers defend their pastures against weeds, especially stinger plants by clearing mowing. In some areas of the National Park territories (and surroundings), the archaic method of so called "*acatolás*" ("against *Cirsium* species") is still in everyday use – this means they prickle out the root of stinger weeds. This is a massive fight, but it may result in the cutback of e.g. *Carduus nutans* as it disappears after a couple of years.
Arable lands (both cultivated and abandoned ones) occur together with valuable habitats in our areas. Abandoned ones give opportunity for invasive species (and other adventives) to thrive, threatening the valuable parts; meanwhile, weeds occur also in those areas that have already been degraded to some extent.
Climate change affects also the development of the livestock. Some farmers reported us that (especially young) calves hardly tolerate extremely hot and dry summers and very strong sunshine. The extremities will have unfavorable effects on the health state of people and livestock as well. They hope that they will not be forced by the weather to change the breed of species.
In case of dry grasslands and those becoming drier we can generally state that shrubbyness, especially the growth of *Prunus spinosa*, *Rosa canina*, *Crataegus monogyna* and the invasive *Elaeagnus angustifolia* threaten them in parallel with too much dead fallen leaves. The second ones threaten the ephemeral, annual plants (basically small dicotyledonous species) that cannot grow through the thick lawn layer. A solution can be burning during winter time (out of the vegetation period) every 3 to 5 years. This also cuts back the amount of nutrients; this should be organized in strong cooperation with the national park authorities (as carrying harmful effects especially on fauna). Regular mowing could also be a solution in favor of ensuring good ecological conditions. Among invasive tree species, *Robinia pseudoacacia* causes harms and *Amorpha fruticosa* in wet areas. Shrubs may be cut back only by mechanical methods and by grazing livestock. *Amorpha fruticosa* is grazed only by the traditional cattle breed called Hungarian Grey Cattle.
The everyday practice of water management authorities is that during managing inland water, they intend to lead it away (into watercourses) without taking into consideration the aspects of wet habitats and retaining water on them. (Respect for the exceptions.) These activities may lead to general drying of the wet habitats.

A significant part of our interviews contains the need for water retention on areas and improvement of landscape water supply in favor of ensuring basic supply for wetlands. Temperature and precipitation data gained for the area show that summer months (May to August) were drier and warmer during the recent decades (data between 1987 and 2001) compared to previous ones (data between 1960 and 1974), resulting in decreasing average monthly total values of the Climatic Water Balance. This means that the difference between precipitation and the potential evapo-transpiration of vegetation is higher during the summer months, i.e. the most critical for livestock and thus, needs management measures on the pastures. Most of the listed user known problems may have negative effects on the landscapes' attractiveness and thus, on tourism as well.

CONCLUSION

As climate literacy is just in its initial phase in Hungarian rural areas, it was presumed that stakeholders are not much concerned about climate change topics. However, land owners and farmers do see several problems and in many cases they connect them with weather extremities and long-term changes. Our interviews have broadened this belief and hopefully strengthened their consciousness and willingness to decrease carbon footprint and adapt management to these challenges.
There is strong evidence that existing problems and conflicts in protected areas will turn even worse under changing climatic conditions. Wet habitats will become more sensitive and vulnerable. The results show that land users of protected areas have to adapt their objectives, strategies and measures to changing climate. To avoid escalating conflicts, these stakeholders have to be involved in the process of adapting the management measures of protected areas, especially wetlands, to probable effects of climate change. Their active participation, integrating their interests and needs in the development of climate adapted management plans may ensure chances for adaptation and mitigation measures and practices. This process should establish "win-win-solutions" that help stakeholders and the management authorities to obtain their goals. The management of most protected areas strongly relies on the cooperation between different stakeholders, therefore, both nature conservation and economic and social interest should benefit from this process. The desirable adaptive management highly depends on the conservation aims and on their priority. Planning management should be determined by what species or habitat to preserve first and foremost and what are less important in the area (e.g. birds, butterflies, orchids, other plant species, landscape view etc.). A general guideline is that management planning should be based on actual (current), exact, relevant ecological and social circumstances and historical land uses.

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