Adaptation of agricultural and conservation management to protect biodiversity against climate change effects

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Abstract. Natural areas, especially wetlands and grasslands are already seriously affected by climate change, and a main challenge for agriculture and water management is adaptation planning. We planned the process of implementing adaptation through a stakeholder dialogue in a Hungarian area, to integrate interests into management plans, and build capacity at relevant authorities. Major impacts of climate change that affect the agricultural use of wetlands and grasslands were explored. Ecological aspects should be combined with social and economic factors during the stakeholder dialogue. Mowing techniques, frequency and exact date should be observed as well as grazing species and their breed, due to different grazing, group forming and trampling habits. The integration of landscape history and historical land development into the planning process (especially in case of water management works in the past) is also useful. Identification and engagement of key stakeholders should be followed by an informative meeting, providing information about climatic impacts on natural and human systems, discussion of objectives, community based assessment of impacts, then elaboration of adapted strategies and measures. There is strong need to differentiate between stakeholders, and customize communication strategies for different groups. The benefits of intense stakeholder involvement are enhanced awareness, willingness to taking action, inclusion of local knowledge, strengthened habitat resilience through guidance of autonomous adaptation and reduction of land use pressures, information exchange among affected parties that might help finding common solutions, the identification of win-win-solutions for land users and nature conservation, and building trust in authorities.

Keywords: adaptation, climate change, management, protected areas, stakeholder involvement, wetland.

1. Introduction

Europe's biodiversity already has to face various challenges emerging from the effects of climate change. In favour of its preserve, both agricultural and conservation management should be adapted to the probable effects. Land managers using natural habitats in any way, and authorities that control their management, play crucial role in the maintenance of their values. As these stakeholders face various problems, they should be involved in the process of adaptation to integrate their interests and needs into the management plans. In favor of strengthening resilience, there is an urgent need to develop adaptive management. A very important challenge for agriculture and nature conservation is to develop policies to adapt so as to achieve sustainability [1]. Our main objectives were to give recommendations on how to organize adaptation for protected areas through exploring the major impacts and investigating in a stakeholder dialogue.

The current management plans and strategies of nature conservation do not take climate change into account in Hungary. Habitat types, in case of being effected also by land-use change, are usually more sensitive against additional pressures from climate change [2]. Although most management practices cannot mitigate potential exposures and impacts of climate change, they may

strengthen the resilience of habitats by reducing non-climate pressures [3]. The investigations were made within the HABIT-CHANGE (Adaptive management of climate-induced changes of habitat diversity in protected areas) project, which evaluates, enhances and adapts existing management and conservation strategies in protected areas.

2. Methods

Study area has been in the Körös–Maros National Park, which is characterized by freshwater habitats, marshes and grasslands and by the areas' agricultural use, and is one of the most diverse landscapes in South-Eastern Hungary. Its various view is determined basically by climatic and edafic characteristics. It belongs 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 effects of their management on the vegetation and forage value have been studied by [4]. They host 5 types of habitats that are under protection within the Natura 2000 program of the European Union: Pannonic salt steppes and salt marshes (Habitat Directive 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. They are especially important as preservers of salt steppes and salt marshes. Investigations were prepared during 2010, 2011 and 2012.

The study area has undergone severe landscape changes during the past 200 years. It was dominated by extended marshes and fens before converting the landscape by severe water regulation works between 1856 and 1879. As many areas under constant or temporal water cover had disappeared, traditional management has changed. 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. Landscape went on changing during the 20th century with the creation of fishponds near Biharugra village (1910), currently giving place for rare bird species. Extended forestation in 1930 resulted in several wood patches. Despite these conversions, some wetlands remained in a favorable conservation state; moreover, they are last remnants of the one-time extended marshes as marshy patches [5]. 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.

3. Results

Biodiversity of the study area suffers mainly from the following impacts of climate change as reported by the stakeholders (mainly land managers and authorities): excess rainfalls during winter, extreme droughts during summer, rise of temperature and extremes, groundwater abstractions for arable lands due to decreasing rainfall, change in forage composition, abandonment of pastoral systems due to climate change effects (e.g. heat stress as reported also by [6]), changing salt characteristics due to excess rainfalls or longer spring inundation, decline of some species due to climate extremes, changing attractiveness of landscapes, changing species composition due to variations in rainfall, drying out, earlier mowing due to milder winters and warmer springs that is harmful for nesting birds, newcomer species, decreasing quality of forage due to climatic conditions, reduction of habitat connectivity due to extreme weather, and spread of invasive alien plant species due to changing abiotic conditions.

Adaptation policies should focus on weather extremities, such as extremities in the annual amount and distribution of precipitation (especially in the vegetation period) and daily maximum, higher frequency of droughts and water balance deficit. Changing water level of the Sebes-Körös River (possible reservoir for water supply in case of early drying out of wetlands) and of the canals, size of area and number of days covered by inland water, changes in water regime and groundwater level should also be taken into account. In long term, the amount of salts accumulating in upper horizons of the soil may also change, strengthening or weakening salinity. Changing winter temperature and number of frost days are also important as frozen surfaces are needed for management of invasive species. Heat waves are harmful for livestock as well, thus, climate change determines the state of a habitat type also through its maintainers.

Weather of the previous year and annual and monthly predictions for the planned year are also worth to consider. Temporary changes in species composition and habitat types due to annual effects (e.g. total drying up or constant water coverage) should be handled carefully and likely there is no need to intervene as the altered habitat type may carry important species (that is, conservation aims) as well, however, management action (e.g. water supply or deflate) may be necessary due to other reasons (e.g. threat of burning peat, dust storm, nesting birds, thriving invasive species). In case of salt steppes and marshes, climatic changes may lead to habitat changes, however, usually also natural, salty habitat types generate.

To estimate habitat changes, processes in soils driven by climate change effects should also be considered. This is especially important in case of sodic areas where salt content and movement determine the habitat type generating on the surface. We can estimate that stronger continental effects (dryness, especially during summer) will stabilize the sodic habitats with no significant changes in their coverage; solonec soils may alter towards solonchak, carrying more halophytic vegetation. In case of stronger Mediterranean effects their extent will probably increase. However, rainier climate may result in a decrease of area as heightening groundwater level leachates, especially if a colder summer decreases evapo-transpiration.

Integrating landscape history and historical land development into the management planning process is essential in case of lowland wetlands to explore one-time lines of watercourses before water regulatory works (or melioration), or original source of water (groundwater, watercourse or precipitation), historical land use (has the area been used as arable land for a period) providing base for revitalization. Management planning may be based on old traditions, for example, some areas had been common pastures of local villages previously. However, several limits have to be faced such as old historical maps are many times not accurate, should be handled with critics, were prepared for military use and not for nature sciences and management, their legend might differ in each period and studies based on literature sources and historical maps need to be combined with the examination on historical meteorological or hydrological data. As archive sources are different everywhere in Europe, they are suitable for local or regional use only.

Hayfields and pastures have to be separated and managed suitably, but this should not exclude the possibility for mowing some parts of pastures in certain years or grazing on hayfields after mowing. Not recommended activities 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, regular mowing or grazing is necessary in line with cutting shrubs on grasslands with scrub encroachment.

Grazing had been the ancient type of use on sodic areas. Its determining factors had been the extensive breeds of livestock tolerating severe ecological circumstances and the shepherds knowing their claims well and living together with the livestock year-round on the steppes. By use of the open grazing method (livestock is not controlled, may move freely), vegetation may be eroded and plant species number fall in parallel with becoming weedier on patches near the stables and drinking troughs, however, distant areas of the pasture will remain non-grazed. Using the method of

shepherded grazing (shepherd and his dogs control the livestock) may be in line with the planned management and serve nature conservation aims.

Grazing species and their breed, due to different grazing habits (selecting among plants), group forming or individual grazing and trampling habits should be considered. Species to be grazed are sheep, cow, water buffalo, horse and donkey; goat only together with sheep flock as searcher.

From the aspect of nature conservation, any dryer sodic habitat may be grazed by cattle, but trampling on wet soil and on shoulders of steppes should be avoided. Selection of the cattle breed is an important factor. The Holstein breed kept for milking does not graze enough (as receiving also fodder), moves in groups and does not graze in wetter habitats, and is more sensitive against weather extremities. This is why the breed Hungarian Grey Cattle is advised. On steppes with short grass, sheep flocks should graze. Traditional breeds such as Racka and Cigája as well as Merino breeds by shepherded grazing can be equally used, however, the former ones tolerate extremities better. Intensive milking breeds are not satisfied with forage production of sodic steppes. Most sodic habitats are suitable also for horse grazing and is well maintained as horses graze deeply. Deeper lying wet areas, especially if invaded by reed, can be used for water buffalo.

Most sodic habitats are less sensitive to grazing intensity, however, overgrazing in wet weather ruins shoulders of the salt steppes. In favour of creating and maintaining conditions for species of high importance, overgrazing may be needed in some areas. Grazing is possible 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.

Mowing techniques, frequency and exact date should be observed as well. Optimal time of mowing should be defined based on annual weather effects and conservation aims. The mowing of big, constant areas in one time should be avoided. During mowing, non-mown 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 bird, a protection zone should be designated that is suitable for ensuring successful hatching. Mowed hay should be transported away within 4 weeks of forming the bales, but the latest until 31 July. Mowing the aftermath should follow these regulations as well. Weed expansion 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 should be delivered between 1 December and 28 February, on totally frost soil, or on ice. Mosaic-like reed pattern should be created during reed harvest and non-harvested parts should be left.

Valuable wetlands are usually situated as a mosaic, therefore, it is advised to convert some arable lands between them into grasslands and mow them regularly, for example in favour of rare butterfly species. To increase their role as a buffer around sensitive habitats, management of arable lands near wetlands 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. Deeper ploughs, use of liquid manure, burning fallow and straw are not recommended. No-tillage farming or similar cultivation system should be used. Border of grasslands and arable lands must not be altered for the disadvantage of the grassland.

The vulnerability of farming in the sample area depends, besides the factors already mentioned, on socio-economic factors as well. Especially farm characteristics (production type, size, level of intensity), diversity of cropping and livestock systems and the presence of other income sources apart from agriculture, access to relevant information, available technology and infrastructure capacity, skills and knowledge about climate trends and adaptive solutions should be taken into account. We have to highlight that the farmers own limited resources and live in remote rural areas, being highly vulnerable. If the areas are state owned and maintained by the national park directorate

(such as in many patches of the sample area), main aspect is the conservation of natural values and economic factors are not considered.

In addition, this process should be cross-level and cross-sectoral, bringing together actors from different stakeholders including governments at various levels, businesses, NGOs, scientists and citizens. Measures for facilitating adaptation should include awareness raising and transfer of knowledge, support to farmers who develop adapted varieties and innovative methods, mobilizing sufficient resources and monitoring of climate change effects. Measures for implementing adaptation should include promoting efficient water management, improvement of water retention and development of alternative farming strategies.

At a landscape level, the top measures for climate change adaptation are to avoid fragmentation and increase connectivity (by designing corridors and removing barriers), reduce additional stressors in case of species with high sensitivity, and manage the matrix between protected areas to provide continuity for processes and species range shifts outside of protected areas. Strengthening the existing regional cooperation with the adjacent Romanian protected areas and harmonize conservation goals regionally, and managing for landscape asynchrony are also important steps. There is a need for re-assessing conservation goals regularly and increasing ecological resilience.

4. Conclusion

As there is strong evidence, that the habitats all over Europe 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 grasslands and terrestrial 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. Preparing a compilation of their problems together with them, focusing on those that are connected with climate change helps to identify the most important questions that should be answered during the planning of adaptive management.

We should strongly consider that the influence of respective stakeholder groups is varying. Most of the problems reported by them are related to climate change and global warming, but there are also some problems that arise due to conflicts between nature conservation objectives and the economic interests of farmers, for example.

A habitat type may be managed by various methods even within the same sample area. Thus, management cannot be uniformed and standardized. Planning land management should be based on actual, relevant ecological and social circumstances and historical land uses. During the process of updating existing management plans, integrating climate scenarios are necessary.

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