International Journal of Earth, Energy and Environmental Sciences
ISSN: 2517-942X
Vol:6, No:11, 2012

Horizontal Aspects of Planning Climate Change Adapted Management of Wetlands

Ákos Malatinszky, and Szilvia Ádám

***Abstract*—**Climate change causes severe effects on natural habitats, especially wetlands. These challenges require the adaptation of their management to probable effects of climate change. A compilation of necessary changes in land management was collected in a Hungarian area being both national park and Natura 2000 SAC and SCI site in favor of increasing the resilience and reducing vulnerability. Several factors, such as ecological aspects, nature conservation and climatic adaptation should be combined with social and economic factors during the process of developing climate change adapted management on vulnerable wetlands. Planning adaptive management should be determined by a priority order of conservation aims and evaluation of factors at the determined planning unit. 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. Integrating landscape history and historical land development into the planning process is essential.

***Keywords*—**Adaptation, climate change, management, wetland.

I. Introduction

WETLANDS all over Central Europe are seriously affected by weather extremities [1]-[3], therefore, their management needs to be adapted to the predicted changes of climate. Most of them need a certain type of land management, harmonizing the aims of agriculture and nature conservation. Stakeholders present in these areas play crucial role in the management. In favor of strengthening resilience, there is an urgent need to develop adaptive management.

The current management plans and strategies of nature conservation do not take climate change into account in Hungary. 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. In order to reduce existing uncertainties about climate change and its impacts, the climate change adapted management plan promotes a new strategy called adaptive management. It gives recommendations for decision making under conditions of climate change, supports management and adaptation processes in those protected areas that need land management.

This study was supported by the Habit-Change project, implemented through the Central Europe program co-financed by the ERDF.

Ákos Malatinszky is with the Szent István University, Faculty of Agricultural and Environmental Sciences, Institute of Environmental and Landscape Management, Department of Nature Conservation and Landscape Ecology, Gödöllő, Páter K. 1, 2105 Hungary (phone: 3628-522-000; fax: 3628410-804; e-mail: malatinszky.akos@kti.szie.hu).

Szilvia Ádám is with the Ministry of Rural Development, Department of Nature Conservation, Budapest, Kossuth tér 11, 1055 Hungary (phone: 36-1-7952134; e-mail: szilvia.adam@vm.gov.hu).

Lowland wet habitat types are especially exposed to various pressures, especially those emerging from climate change, which may affect their conservation status negatively. In case of being effected also by land-use change, they are usually more sensitive against additional pressures from climate change [4]. Main aim of our climate change adapted management planning process was to obtain a favorable conservation status of habitats listed in the Habitats Directive of the EU (92/43/EEC) and improve their resilience. Although most management practices can not mitigate potential exposures and impacts of climate change, they may strengthen the resilience of habitats by reducing non-climate pressures [5].

II. Materials and Methods

Investigations were prepared during the vegetation season of 2010, 2011 and 2012 in the Körös–Maros National Park, which is located in South-Eastern Hungary among the rivers Tisza, Körös and Maros and is characterized by freshwater habitats, marshes and grasslands. Their diversity is determined by the complex effect of mainly climatic and edafic characteristics. Our investigation areas belong to the deepest-lying ones of the Hungarian Great Plain and have been extended swamps through several millennia. Deeper parts under constant water coverage are covered mainly by clay and in parallel, slightly higher-lying patches with temporary water coverage give home for different types of sodic (alkali) habitats. The sample wetlands belong to the A zone of the national park and thus, are under strict protection. Complex studies on the effects of management on vegetation and forage value in the sample areas have been investigated previously by Kiss et al. [6] and Balogh et al. [7]. 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. This is why these habitats are in focus of planning their management.

Considering historical development of the landscape, this territory has undergone severe landscape changes during the past 200 years. Extended marshes and fens had dominated 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 [8]. 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.

Our investigations covered, besides vegetation mapping and collecting data on climate, previous and current management, botanical and zoological values, soil and water characteristics from various forms of sources, goals and objectives, then strategies and measures were defined in parallel with identifying uncertainties, integrating climate scenarios.

III. Results and Discussion

A. Horizontal Aspects of Adaptive Management Planning

In case of management planning, short-term predictions of climate models are more relevant than long-term changes and these suggest that the number of extreme weather events will grow. This is why 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 (HD code 1530), climatic changes may lead to habitat changes, however, usually also natural, salty habitat types generate. As a nature conservation guard told in the investigation area, “any kind of weather comes, some natural habitat types will benefit from it” (Tóth ex verb.).

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 ungrazed. 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 are well maintained as horses graze deeply. Deeper lying wet areas, especially if invaded by reed or *Typha* spp. stands, 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 favor of creating and maintaining conditions for species of high importance, overgrazing may be needed in some areas. Grazing is possible by 0.2–1 animal unit per hectare (exceptions may be for some areas), 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, 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 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. 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 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 unharvested parts should be left.

2011 was the driest year in Hungary since launching regular meteorological measurements. As a result of dryness, the amount of hay to be mowed was decreasing, causing a serious problem for farmers. In parallel, some wet habitats (that are normally hayfields) could have been used 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. The National Park Directorate had to buy water in 2009 (pumped from the Sebes-Körös River) to avoid drying out of the Sző-rét swamps. On the contrary, 2010 was an extremely wet year. As a result of high level of inland water, the hayfields and even pastures were unreachable or, even if reachable, many pastures were not suitable for grazing (hard moving for animals and not the desirable forage species). Mowing could take place (in parallel with grazing) even in some dryer areas. Most farmers could enter wet areas by heavy mowing machines too late, when the forage value was already low. Meanwhile, these areas could not be grazed, otherwise trampling would have totally degraded the soil. If the pasture was not too wet and it was grazed even in the extremely wet year (as in normal years), this resulted in undergrazing because of huge amount of biomass and the same livestock load. Mowing another area (Kisvátyon) in 2010 was very difficult and the hay was not transported away from the area because of physical barrier (water on road). Another area (Kisgyanté) is normally drained around the 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 and expansion of *Typha* stands. The majority of hay was not harvested because of excess rainfall, or if harvested, farmers could not store that amount.

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 favor 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. 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 centre of the plot. In case of founding a nest of a bird, a protection zone should be designated that is suitable for ensuring successful hatching.

B. Socio-economic Factors to Consider during Adaptation Planning

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.

IV. Conclusion

There is strong evidence that existing problems and conflicts in wet habitats will turn even worse under changing climatic conditions. Wet habitats will become more sensitive and vulnerable. The results show that land users and owners 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 into the development of climate adapted management plans may ensure chances for adaptation and mitigation measures and practices. 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.

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. Habitat management should be based on a profound knowledge about the functional and structural components and the conservation status of the habitat types as well as their impacts on the conservation status. Basis for an adaptive management is an intensive stakeholder involvement, the precise definition of management objectives and the identification of different management responses that should be tested regarding their effectiveness.

References

[1] K. L. Erwin, "Wetlands and global climate change: the role of wetland restoration in a changing world," *Wetlands Ecology and Management*, vol. 17, pp. 71-84, 2009.

[2] G. George, editor, "The Impact of Climate Change on European Lakes," *Aquatic Ecology Series*, vol. 4, pp. 1-13, 2010.

[3] United Nations Economic Commission for Europe, "Guidance on water and adaptation to climate change," 2009.

[4] N. Salafsky, D. Salzer, A. J. Stattersfield, C. Hilton-Taylor, R. Neugarten, S. H. M. Butchart, B. Collen, N. Cox, L. L. Master, S. O'Connor, D. Wilkie, "A Standard Lexicon for Biodiversity Conservation: Unified Classification of Threats and Actions," *Conservation Biology*, vol. 22, pp. 897-911, 2008.

[5] R. J. Hobbs, D. N. Cole, L. Yung, E. S. Zavaleta, G. H. Aplet, P. B. Landres, D. J. Parsons, N. L. Stephenson, P. S. White, D. M. Graber, E. S. Higgs, C. I. Millar, J. M. Randall, K. A. Tonessen, S. Woodley, "Guiding concepts for park and wilderness stewardship in an era of global environmental change," *Frontiers in Ecology and the Environment*, vol. 8, pp. 483-490, 2010.

[6] T. Kiss, A. Nagy, Á. Malatinszky, Á. Balogh, K. Penksza, "Habitat mapping and map presentation of characteristic habitats in the Körös–Maros National Park, Kis-Sárrét territory," *Lucrări Ştiinţifice Management Agricol* Ser. I. vol. 10, pp. 357-364, 2008.

[7] Á. Balogh, A. Nagy, E. Herczeg, M. Vona, T. Kiss, K. Penksza, "Weedyness tendencies in grasslands near Biharugra (ES Hungary)," in *Proc. 6th Int. Conf. Anthropization and Environment of Rural Settlements, Flora and Vegetation*, Tarcal, Hungary, 2006, pp. 45-57.

[8] D. Saláta, "Landscape changes on 3 areas of the Kis-Sárrét part of Körös-Maros National Park: Kisgyanté, Kisvátyon and Sző meadow," *Crisicum*, vol. 7, pp. 129-152, 2011.