MANAGEMENT OF SEASONALLY FLOODED GRASSLANDS

Heike Brenken
University of Hanover, Germany

Ilona Leyer
University Halle-Wittenberg, Halle/Saale, Germany

Mathias Scholz
Centre for Environmental Research Leipzig-Halle, Leipzig, Germany

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Summary
Seasonally flooded grasslands can be found in areas with periodic, but not permanent, flooding with fresh or brackish water or a seasonally high water table. The article is focused on seminatural grasslands, which can be found in natural forested landscapes in Europe. Seasonally flooded grasslands originated in Europe from centuries of grazing livestock and mowing in lowland floodplains. Therefore, seasonally flooded grassland in the late twentieth century is considered to be a human-made biotope. The biodiversity value of this biome strongly depends on a natural hydrodynamic with floods, nutrition import, and dynamic watertables. Many species can only be found here.

In industrialized countries like those in Europe, traditional ways of mowing and grazing have nearly disappeared. With the impact of farmland amelioration and waterway construction for shipping and other land uses, the seasonally flooded grassland biome has become endangered. Because of usually tight budgets, conservation objectives have to be derived to optimize the required measures. Different methods of management were tested in the late twentieth century and are presented at the end of this article. In conclusion, we want to emphasize that management is needed for seasonally flooded grasslands in industrialized countries, which includes not only adopted methods of

grazing and cutting, but also, in many cases, the restoration of the natural floodplain hydrodynamic.

1. Introduction

Seasonally flooded grasslands are characterized by an abundance of grasses, are periodically but not permanently flooded with fresh or brackish water or have a seasonally high water table, and have regular management, usually cutting or grazing. Most seasonally flooded grasslands are located in floodplains at lake margins and in the coastal zone.

This article provides an overview about the management of seasonally flooded grasslands in riverine floodplains in temperate climate zones with examples from Middle Europe.

In Europe, grasslands are a result of extensive preindustrial land use and formed the landscape for centuries. Many plants and animals can be found only in these human-made habitats. With industrialization, these habitats disappeared through flood protection, drainage, and intensive agriculture or settlement. Today, seasonally flooded grasslands of high ecological value are becoming more and more endangered. So grassland management and restoration of the hydrology is needed for conservation and to keep the regional biodiversity.

2. The History of Seasonally Flooded Grassland

2.1. Natural Grassland in River Floodplains

Natural grasslands can be found in the northern and southern hemisphere in regions with relatively cold winter temperatures like South Africa, Argentina, Uruguay, Russia, and North America. These grasslands are not invaded by woody shrubs and trees because of seasonal drought, occasional fires, and grazing by large mammals. This article is focused on seasonally flooded grasslands in riverine floodplains in temperate climate zones were forest is the dominant natural vegetation. In Europe and on the east coast of Northern America they are classified as a human-made habitat—so-called seminatural grasslands.

Since the ice age in Europe (Holocene), the natural vegetation in lowland areas is deciduous forest. Only a few grasslands in these areas are natural. If there were no grazing or mowing, the natural vegetation would be forest. Only on rocks, salt marshes, and in floodplains are grasslands considered to be natural. But even these floodplains were mostly forested. These riparian forests can tolerate flooding even in the growing season. Due to the dynamic of the rivers, open areas can always occur. Since 1990, more and more scientists are of the opinion that natural grassland can also occur in natural forested areas. Combined with large grazers like aurochs (*Bos primigenus*), wild horse, deer, or beaver, these grasslands can be maintained for longer periods. But natural grasslands in the temperate climate of Western Europe covered probably only very small areas in the forested landscape.

Studies in Northern America show that the beaver can change its environment substantially. Beaver are clear riverine forests and construct dams with ponds (so-called beaver ponds). Beaver activity over generations leads to a patchwork of different open habitats. Abandoned beaver ponds can change into grassland, and, combined with moose, deer, or other large grazing herbivores, this grassland can resist a new invasion of trees and shrubs for a long time.

The influence of herbivores on the natural vegetation after the last ice age in landscapes such as Europe is still the subject of an extensive scientific discussion between botanists and zoologists.

2.2 Today's Seasonally Flooded Grassland—A Human-Made Biotope

The management and cultivation of river floodplains has a long tradition in Europe. Pollen analyses show that with the activities of Bronze-age settlers the percentage of graminea pollen, indicating the development of the first seminatural grasslands, was increasing. For long periods, the floodplains were used very extensively for livestock feeding. Population growth and better knowledge of flood protection lead to more intensive grazing and farming activities in floodplains in the middle ages. Forests were more and more degraded and open grassland took over. Because of a high microrelief in riverine margins and a high risk of floods, the riverine grasslands had a very high diversity of plant communities and animals.

This changed during the seventeenth and eighteenth centuries. Each of the rulers of the different nations and periods had their own ideas about "new land" for further cultivation, meaning more rural taxpayers and more grazing land for cavalier horses. Along with the colonization of overseas colonies, each country in Europe tried to enhance its own production resources by land-gaining operations within its own boundaries. In Europe, new land for agricultural purposes was at hand mainly along the shore of the north sea in the vast bogs of northwest Germany and the Netherlands, on the northern fringe of the Alpine mountains, in the moor lands of Ireland, Wales, and Scotland, and in the extensive river floodplains of the major European rivers.

After some small achievements in land gaining in some parts of Europe made by roman conquerors and minor activities in colonization during medieval times (for example, by Cistercian monasteries and in the Netherlands), the "golden age" of the so-called "inner colonization" started with the period of the Enlightenment. Rulers like Napoleon in France (and the rest of Europe) or Friedrich the Great in Prussia started large colonization projects. The most noticeable in Germany, for example, was the colonization of the *Oderbruch*—the former floodplain of the Oder River—now the border between Germany and Poland. The former wild and freely running river was straightened and a system of dykes and drainage canals, so-called *polders*, was created. Work on this river, as on many others in Europe, was carried out mostly by Dutch engineers, the most sought-after experts in the business of cultivation work.

After the cultivation of the Oder River, other projects followed; for example, the straightening of the Rhine River, the border river between Germany and France by the engineer Tulla during the nineteenth century. The inner colonization was again focused

upon during fascist times in Germany when the outcry for “blood and soil” for the German Nation put engineers back to work. Work was then carried out particularly on the large northwest German bogs and the smaller rivers , which had to function as new drainage systems. This colonization work was enforced even after the war to provide new agricultural land for the millions of war refugees coming into western Germany from eastern provinces. Hundreds of thousands of refugees were settled along the Oder and Elbe rivers, in the bog lands along the Dutch border, or in other less favorable, little-cultivated, agricultural areas.

Right into the 1950s, all this artificially gained agricultural area in the floodplains was farmed in the traditional way. With some differences due to climatic and pedographic matters, most of the river floodplains in central Europe were used as grasslands for rearing horses, grazing cattle, and producing hay. Dykes protected the inlands at nearly all the rivers during the mid-twentieth century, but the protection concentrated only on the most important areas like settlements. Large parts of the river floodplains were still regularly flooded. Means for more effective flood protection and an intensive land use were still limited until the beginning of the "economic wonder period" of the 1960s.

During the 1960s, new efforts in land cultivation started, now enforced by "unlimited" access to energy and machinery. The development of the European Union and its Common Agricultural Policy, with a guarantee of high prices for cereals, milk, and meat, also enhanced the colonization and intensification strategies. Also, in the former communist countries in east middle Europe, consolidation of farming and drainage projects in floodplains and other wetland areas took place.

Unlimited energy, the general introduction of synthetic fertilizers, and weed sprays enabled farmers to turn grasslands into arable land and cultivate sensitive crops like wheat and sugar beets on former flooded grassland. With the surplus water removed by deep dykes, canals, and pump stations in the lowlands, the former grasslands provided rich soil in most of the areas. At the beginning of the twenty-first century, the arable land on the fringe of the Elbe River floodplain, for example, is one of the best agricultural areas in Germany with wheat yields up to 80 dt ha^{-1} and higher.

In those areas where the groundwater table still remained too high or floods could not be dealt with completely, grasslands remained, but they are intensively used. The traditional management of seasonally flooded grasslands comprised grazing during the summer period on the wetter parts of the floodplain and hay cutting on the drier and more level ground. This system changed with the decline of heavy horses and the old breeds of multipurpose cattle, which thrived happily on a diet consisting mainly of hay. The introduction of tractors and American breeds of cattle caused a major change in grassland forage techniques. High yielding dairy cows demand a sophisticated diet of protein-rich fodder. Hay-making was mostly abandoned and early and multicut silage production was introduced.

The vegetation of the historic grasslands, therefore, was lost, either due to gradual changes during the intensification process or by means of sowing new high-yielding cultivars of grass.

Synthetic fertilizers allowed farmers to increase the productivity of the grasslands in the river floodplains. Traditionally these areas got very little of the valuable manure because the floodplain grasslands usually where a long way away from the villages. And manure was in too short a supply to use on flood plains, where it might be washed away by an unexpected flood. Also, most of the floodplains received a natural fertilizing through the mud that was deposited during the flood periods. This was often enough to sustain good hay meadows and grazing plots for horses and low-yielding cows.

Another change in the vegetation of the floodplain grasslands occurred with the introduction of new stable buildings and the change from manure to slurry systems on most farmsteads. The slurry systems increased the amount of fast and highly effective nitrogen fertilizers and therefore meant another pressure on the traditionally rather mesophile species of historic floodplain grasslands. Also the spreading of slurry introduced or increased (together with other aspects) so-called "troublesome grassland weeds" like rumex, thistle, and nettle species. To overcome some of these problems, farmers started using synthetic weed sprays, which caused further changes to the seminatural vegetation of the flood plains.

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Biographical Sketches

Heike Brenken is a landscape planner, research assistant at the University of Hanover, Department of Landscape Architecture and Environmental Development and freelance member of staff at Arbeitsgemeinschaft Umweltplanung, Hanover—Consulting Engineers and Landscape Architects. He has several research projects concerning socio-economic aspects of nature conservation strategies: socio-economic scenarios for the proposed Biosphere Reserve Elbe River in Lower Saxony, multifunctional land-use strategies for the urban fringe of Hanover-Kronsberg, and multilateral cooperation and groundwater protection in Fuhrberger Feld catchments area.

Ilona Leyer, biologist, has extensively worked on the relationship between swamp/floodplain vegetation and major ecological factors as hydrology, soil, and land use. Her research focuses on the responses of plants species and plant communities to ecological impacts and on the integration of landscape protection and land use in floodplain environments.

Mathias Scholz is a landscape planner with excellent knowledge about riverine wetlands. He has experience in management planing and research about evaluation and integration of land uses in highly protected areas in the Elbe valley. Currently he is working about indication systems in riverine wetlands, gravel mining in floodplains and the evaluation of ecological impact.