

Traditional versus sprinkler irrigation of mountain hay meadows in the Valais: Consequences for biodiversity

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Semi-natural grasslands including hay meadows belong to the most species-rich habitats in Central Europe and are therefore of high conservation value. The high biodiversity of semi-natural grasslands has been maintained for many centuries through the regular disturbance by traditional management practices such as grazing or mowing. In the Valais, an arid mountain region of Switzerland, traditional management of hay meadows includes irrigation by open water channels. In the past decades, however, the traditional irrigation technique was increasingly replaced by more efficient sprinkler-irrigation systems or irrigation was stopped on marginal, poorly accessible areas. The aim of this PhD thesis was to examine the consequences of these changes in meadow irrigation for the biodiversity of species-rich hay meadows in the Valais.

The first study examined whether land-use abandonment resulting from the cessation of irrigation influenced the biodiversity of hay meadows. For this purpose, plant and gastropod surveys were conducted in three serial stages of succession (hay meadows, early abandoned meadows and young forests). Meadow abandonment resulted in an increase in gastropod species richness and a loss of plant and gastropod species characteristic for open grassland habitats. Furthermore, functional traits of plants and gastropods were affected by abandonment.

Traditional meadow irrigation is assumed to distribute the water more heterogeneously than sprinkler irrigation, which might affect meadow biodiversity as well as the distribution of plants in a small scale. The aim of the second study was to examine whether the change from traditional to sprinkler irrigation affected the local biodiversity (plants and gastropods) of hay meadows in the Valais. The diversity and composition of plant and gastropod species did not differ between traditionally and sprinkler-irrigated meadows. However, the installation of sprinkler systems resulted in an increase in the grass-to-forb ratio and affected the leaf distribution and the start of seed shedding in plants.

The third study aimed to investigate whether the change in irrigation technique affected the small-scale distribution of plants and soil characteristics in these hay meadows. Three sampling plots consisting of 13 subplots of increasing size were installed in traditionally and sprinkler-irrigated meadows to assess plant species richness and soil characteristics within subplots. The type of irrigation technique did not affect the shape of the plant species-area relationship. Furthermore, spatial autocorrelation in the soil characteristics examined was low and their small-scale distributions were mostly not influenced by the irrigation technique. These findings indicate a pronounced small-scale heterogeneity in the distribution of plant species and soil characteristics in the hay meadows investigated. Therefore, as practiced in

our study areas, the distribution of water by sprinklers might be less homogenous than commonly assumed.

The abandonment of traditional management practices of semi-natural grasslands is suggested to result in a reduced landscape heterogeneity, which in turn might contribute to the loss of local plant diversity. The fourth study aimed to investigate whether traditionally and sprinkler-irrigated meadows differed in the landscape heterogeneity of their close surroundings and whether the type of irrigation, landscape heterogeneity and particular landscape traits influenced plant diversity of these meadows. Hay meadows irrigated with sprinklers had a reduced landscape heterogeneity in their surroundings and an increased number of generalist plant species. The total number of plant species and the number of specialists and generalists were positively influenced by landscape heterogeneity in the close surroundings of hay meadows, whereas the percentage of area covered by woodland had a negative effect.

The findings of this thesis suggest that the installation of sprinklers did not affect the local species richness of plants and gastropods in the hay meadows investigated. Nevertheless, the change in irrigation technique influenced functional aspects of plant diversity (plant traits, grass-to-forb ratio, generalist species). Furthermore, the installation of sprinkler systems was associated with a homogenization of the landscape, which indicates an intensification of land use. For the conservation of the biodiversity of these hay meadows it is recommended to maintain the relatively extensive irrigation and management practices. Furthermore, a heterogeneous landscape within the close surroundings of hay meadows should be promoted, consisting of differently managed grassland habitats and small-scale habitat structures.