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Grasslands, their Threats and Management in Eastern Europe

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Introduction

The Eastern European region covers the post-socialist countries of central and eastern Europe (excluding East Germany and the European part of Russia) and the Balkan countries (excluding Greece and Turkey) (Fig. 4.1). The total area of the region is 2,154,005 km^2, characterized mostly by extensive lowland regions to the north and north-east and with considerable mountainous regions in the central (Carpathians) and the southern (Balkan mountains, Crimean mountains) parts of the region. The region experiences a cool continental climate with increasing Mediterranean influence to the south (Peel et al., 2007). Based on the European Environmental Stratification system provided by Metzger et al. (2005), most of the Eastern European plains and lowlands and the uplands and low mountains of the Balkan Peninsula are situated in the Continental Environmental Zone (CON), naturally dominated by deciduous, mixed and coniferous forests. In the lowland regions, grasslands were formed on fine or coarse-grained alluvial and fluvial deposits and are characterized by the high influence of large rivers and their tributaries. The

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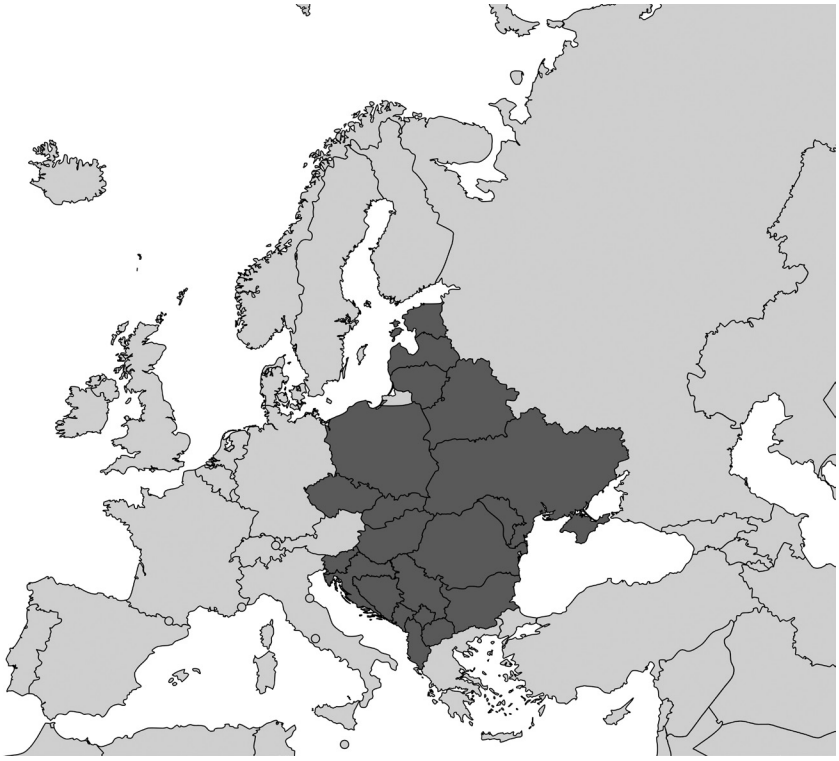

Fig. 4.1 Delimitation of the Eastern European socio-economic region as used in this chapter. The map was created by using MapChart (https://mapchart.net/).

northern part of the Baltic countries in the Boreal zone (BOR) is covered with coniferous forests (taiga). Most parts of the Baltic countries, some regions of Poland, Ukraine and Belarus falls into the Nemoral zone (NEM) with primary deciduous and mixed forests, wetlands and bog mosaics. The lowland and foothill regions of the Carpathian basin, the Middle and Lower-Danube Plains and the Black-Sea Lowland is within the Pannonian-Pontic environmental zone (PAN) and characterized by natural forest-steppe and steppe vegetation. The highest altitudes of the Carpathian and the Balkan mountains are in the Alpine South Environmental Zone (ALS) and home to heathland and alpine grassland vegetation. The low and medium mountains of the northern Balkans with an increased Mediterranean influence form the Mediterranean Mountains Environmental Zone (MDM), where the potential vegetation is Mediterranean evergreen forests and beech forests, but which are now mostly covered with overgrazed pastures and grasslands.

The region harbors a high proportion of grassland habitats; the permanent grassland area in the region based on the available literature and statistics, is higher than 300,000 km² out of which at least 10–30 per cent are High Nature Value natural or semi natural grasslands (see Appendix). The marked difference in the grasslands cover between the Western and Eastern European regions is that although the proportion of highly valuable grasslands is quite similar, in most countries of Eastern Europe there are large areas covered with partly degraded grasslands (fallows, semi-improved grassland, abandoned grasslands), which can be turned with appropriate restoration and conservation measures

to diverse semi-natural grasslands. Most Western European countries do not have such a resource; instead, they have a high proportion of very intensively managed grasslands. In Eastern Europe, there is the western border of Palaearctic steppe zone in Europe, with high cover of steppe and steppe-like grasslands in Bulgaria, Hungary, Moldova and Ukraine (Wesche et al., 2016).

Origin of Grasslands and their Types in the Region

The historical development of grasslands in Eastern Europe follows several pathways, which are linked to the biogeographical division of the area and origin of grassland ecosystems. The majority of grasslands of the boreal and nemoral zonobiome (Walter and Breckle, 1991) are secondary or semi-natural grasslands of anthropozoogenic origin. When at the end of the Ice Age (14,400–12,000 BP) the glaciers retreated, the landscape remained open for several millennia and enabled long distance dispersal of plant species, which had survived in the more southern regions. In the Atlantic (8,500–6,800 BP), woodland returned and suppressed open grassland vegetation (Ložek, 2008). However, at the same time, the human population increased and due to its activities (this so-called Neolithic Revolution included deforestation and import of various domesticated plants and animal species) the open landscape was maintained and gradually spread in the region. The first Neolithic settlements were build in 8,500 BP in Macedonia and Romania, 7,700–7,600 BP in Transdanubia (Poschlod, 2015), and during the next 2,000 years the lifestyle of settled communities spread from these parts of the Eastern Europe further to northeast (eastern part of Romania, Ukraine) and northwest (Pannonia, Carpathian and Hercynian mountains). There are notes on the first human settlements in the Balkans dating from about 6,000 BC, known as 'Vinča culture', also known as the oldest European copper metallurgy and technologically the most advanced pre-historical world civilization, primarily focusing on livestock and crop production, such as wheat, lens, barley and flax (Barker, 1985).

So, between 8,500 and 6,500 BP the first semi-natural and anthropogenic grasslands might have been created. However, the vast majority of grasslands were established much later, during the Middle Ages and reached their largest spatial extensions during the last two centuries (Ružičková and Kalivoda, 2007). Pasture ecosystems are generally older than meadows, especially in the boreal part of the region where the scythe appeared only in 3rd–4th century AD (Anon, 1974; Rabinovič et al., 1985), while farming and livestock herding appeared 6,000 years ago. The continuously increasing age of grasslands toward the south is due to a longer-lasting period of climatic conditions favorable for grassland development and a longer history of agriculture. The time of farming establishment, as the main source of food, could be attributed to semi-natural grassland age, generally dated back to 3,000–6,500 BP (Melluma, 1994; Price, 2000).

The extraordinary variability of European grasslands is reflected in the huge number of distinguished phytosociological classes and alliances. Rodwell et al. (2002) listed 19 grassland classes with 326 alliances, while Mucina et al. (2016) recently proposed 27 classes with 365 alliances. The primary or natural grasslands of Eastern Europe can be grouped into three major types: (1) steppes (in areas too dry for forests); (2) alpine grasslands (in areas too cold for forests); (3) azonal and extrazonal grasslands (where hydrology, soil conditions, relief or natural disturbances within the forest biomes prevent tree growth locally). Some of these grasslands need human intervention by grazing and mowing to maintain their continuity and prevent the forest regeneration or reed bed development (Emanuelsson, 2009). Primary grasslands of climatogenic origin belonging to Palaearctic

steppe biome cover large areas in south-eastern part of Eastern Europe and in natural conditions are maintained by drought, wildfire and wild herbivores (Wesche et al., 2016). Alpine grasslands of the region are distributed above the tree line (about 1,800 m a.s.l. in the Carpathians and generally above 1,950–2,150 m a.s.l. on the Balkan Peninsula). Semi-natural grasslands of secondary origin (4) were created mostly by tree cutting and are maintained by extensive management of mowing and/or grazing. These grasslands, ranging from semi-dry to wet conditions, are situated from lowlands to mountainous regions, in which in lack of management the shrub and tree encroachment is typical (see types 4a–4c below). The most important grassland types and subtypes of Eastern Europe are as follows (nomenclature of syntaxa follows Mucina et al., 2016):

1. Steppe grasslands (*Festuco-Brometea*: *Festucetalia valesiacae*) are primary grasslands in the Eastern European region associated with the steppe and forest steppe zones typically distributed in lowlands and at the foothills. In the Eastern European region, at least fragments of such vegetation are present in Romania, Ukraine, Poland, Moldova, Hungary, Slovakia, Slovenia, Czech Republic, Croatia, Bosnia and Herzegovina, Montenegro, Albania, Serbia and Bulgaria. Steppe grasslands are characterized by the dominance of *Festuca* and *Stipa* species and are rich in forbs, including multiple genera (among the most typical genera are *Astragalus*, *Artemisia*, *Aster*, *Salvia* and *Linum*).

2. Alpine grasslands are predominantly natural species-rich grasslands, which may be formed both on base-rich (*Elyno-Seslerietea*) and siliceous (*Caricetea curvulae*, *Carici rupestris-Kobresietea*, *Juncetea trifidi*, *Nardetea strictae*) bedrocks, occurring in the subalpine to subnival belts of the European boreal and nemoral mountain ranges in Slovakia, the Czech Republic, Romania, Ukraine, Poland and all Balkan countries. They are mostly dominated by tussock-forming graminoids of the genera *Festuca*, *Calamagrostis*, *Sesleria*, *Carex* and *Juncus* (Fig. 4.2).

3a. Rocky grasslands (*Sedo-Scleranthetea; Festuco-Brometea: Stipo pulcherrimae-Festucetalia pallentis*) include pioneer vegetation and xeric open steppic grasslands on shallow skeletal soils on rocky calcareous and siliceous substrates. Although they are often primary, their spread was supported in the past by intensive human deforestation activities and grazing. Some of them represent relic vegetation of Pleistocene periglacial steppes. These grasslands occur in all countries of the region, having larger distribution in Ukraine, Czech Republic, Slovakia, Poland, Hungary, Romania, Bulgaria, Moldova, Balkan countries and being rare in the Baltic countries. Quite often the dominants are succulents (*Sedum* spp., *Sempervivum* spp., *Jovibarba* spp.), therophytes (*Spergula* spp., *Cerastium* spp., *Veronica* spp.) or tussock-forming grasses (*Festuca* spp., *Stipa* spp., *Poa* spp.), while cryptogams (mosses and lichens) are also abundant (Fig. 4.2-3a).

3b. Sandy grasslands (*Koelerio-Corynephoretea*) are tussock grasslands and sandy steppes on acidic to alkaline sandy soils on inland sand dunes and plains. They are most common in the boreal zone on acidic sands of glaciofluvial deposits and weekly acidic to neutral sands of coastal dunes (calcium-rich sands with a local supply of calcium from crushed shells) and alluvial sands in floodplains (Latvia, Lithuania, Belarus, northern Poland, the Czech Republic and Ukraine) as well as on base-rich to alkaline sands of alluvial deposits in the Pannonian (Hungary, Slovakia, Serbia, Slovenia, Croatia) and Pontic (southern Ukraine) regions. In these communities, tussock grasses, such as closely related *Festuca* species (*F. psammophila, F. polesica, F. vaginata, F. beckeri*), *Corynephorus canescens*, *Koeleria glauca* and *Stipa borysthenica*, as well as mosses and lichens play a significant role (Fig. 4.2-3b).

3c. Coastal and inland halophytic grasslands (*Festuco-Puccinellietea*; *Juncetea maritimi*) are azonal and intrazonal grasslands occurring on soils with moderate to high salt content and generally astatic or semi-static water regime in the lowlands. Most typical stands of inland halophytic grasslands occur in Hungary and in Ukraine, but fragments are present also in Slovakia, Serbia, Bulgaria, and Macedonia. Estonia and Latvia possess large areas of coastal grasslands in the geolittoral zone of the Baltic Sea where soil salinity is lower and semi-halophytic vegetation develops under the periodic flooding with brackish sea water. This type of vegetation is dominated by stress-tolerant graminoids (e.g., *Festuca pseudovina*, *F. regeliana*, *Puccinellia* spp., *Juncus* spp.), *Plantago* spp. and several other halophytic forbs of the genera *Salicornia*, *Suaeda*, *Aster*, *Podospermum*, *Artemisia*, *Salsola*, *Spergularia* or *Limonium* (Fig. 4.2-3c).

4a. Dry and semi-dry semi-natural grasslands (*Festuco-Brometea: Brachypodietalia pinnati; Molinio-Arrhenatheretea: Galietalia veri*) are meso-xerophytic secondary grasslands occurring predominantly on moderate or deeper calcareous soils. They are distributed from lowlands to the mountain belt throughout the region; in the Czech Republic, Slovakia, Ukraine, Moldova, Poland, Hungary, Romania Serbia, Bulgaria, Montenegro, Bosnia and Herzegovina, Macedonia, Latvia, Lithuania, Poland, as well as on *alvars* (species-rich grasslands on shallow soils over flat limestone bedrock) along the eastern coast of the Baltic Sea in Estonia. In Latvia and Estonia, some of the most-species rich wooded grasslands occur in dry and semi-dry conditions. Many of these grasslands harbor steppe elements and are extraordinarily species-rich in both vascular plants and cryptogams including many rare and endangered taxa (Fig. 4.2-4a).

4b. Mesic and moist semi-natural grasslands (*Molinio-Arrhenatheretea: Arrhenatheretalia; Molinietalia*) include anthropogenic managed pastures, meadows and secondary mat-grass swards on well-drained mineral fertile deep soil or nutrient-poor soil. These grasslands represent the most widespread type of semi-natural grasslands distributed from lowlands to the mountain and rarely to subalpine belts occurring in all countries in the region. Dominants are mainly the loose tussock-forming and rhizomatous grasses (e.g., *Festuca pratensis, F. rubra, Poa pratensis, P. trivialis, Phleum pratense, Arrhenatherum elatius, Trisetum flavescens, Agrostis tenuis, Alopecurus pratensis, Cynosurus cristatus,* and *Anthoxanthum odoratum*) and representatives of the *Fabaceae* (*Trifolium* spp., and *Medicago* spp.), Cyperaceae, and Juncaceae. Various species of the genera *Plantago*, *Veronica*, *Ranunculus* and *Rhinanthus* are common as well (Fig. 4.2-4b).

4c. Wet (semi-) natural grasslands (*Phragmito-Magnocaricetea; Scheuchzerio-Caricetea fuscae*) include herb-rich temporarily wet meadows, sedge-bed marsh vegetation and sedge-moss vegetation on mineral and peaty temporarily wet, heavy soil, on oligo- to eutrophic organic sediments, calcareous and extremely mineral-rich brown-moss fens or moderate to low calcium-rich slightly acidic fens at low altitudes of temperate and boreal regions as well as the sub-Mediterranean precipitation-rich regions of the Balkan. This type of vegetation is common in all countries in the region, mostly in lowland regions. Typical dominants are tall sedges (e.g., *Carex acuta, C. acutiformis, C. elata,* and *C. cespitosa*) and/or grasses (e.g., *Phalaris arundinacea, Glyceria* spp.) or tall forbs (e.g., *Lysimachia vulgaris, Lythrum salicaria, Filipendula ulmaria,* and *Cirsium* spp.; Fig. 4.2-4c).

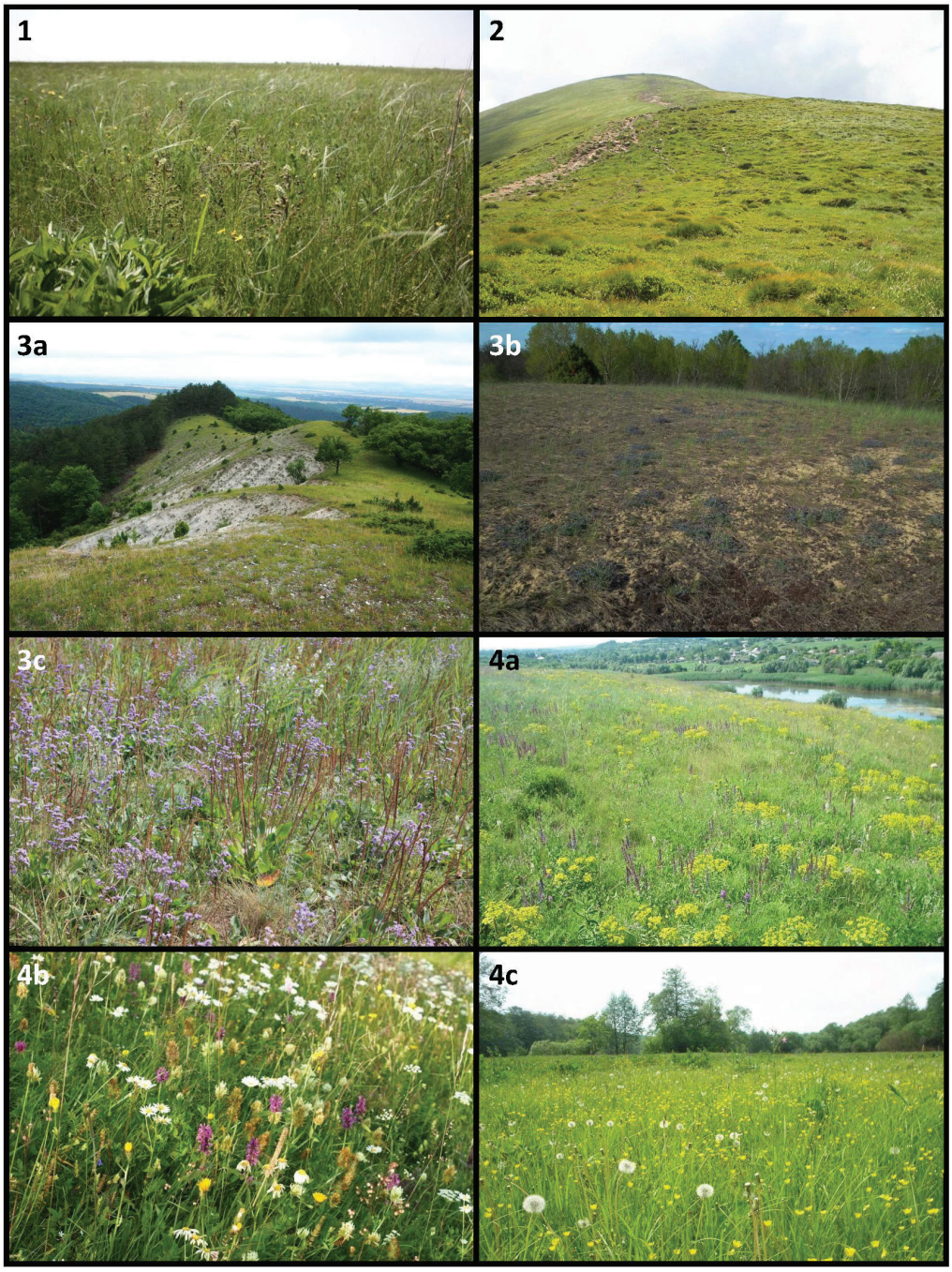

Fig. 4.2 Grassland types of Eastern Europe. 1. Steppe grassland (Askania-Nova, Ukraine), 2. Alpine grassland (Hoverla Mt., Ukraine), 3a. Rocky dry grassland in the Považský Inovec Mountains (Lúka nad Váhom, Slovakia), 3b. Sandy grassland (Fülöpháza, Hungary), 3c. Inland halophytic grassland (Oril River valley, Ukraine), 4a. Semi-dry semi-natural grassland (Synytsia River valley, Ukraine), 4b. Mesic semi-natural grassland in the Chywchyny Mountains (Sarata, Ukraine), 4c. Wet grassland (South Bug River valley, Ukraine). Photos by A. Kuzemko (1, 2, 3c, 4a, 4b and 4c), M. Janišová (3a and 4b) and P. Török (3b).

Trends of Agronomic Use of Grasslands

Most of Europe in ancient times was covered by forests but from Renaissance era onwards, a high proportion of forests were cut and the lands were transformed to extensively-managed agricultural areas and secondary habitats, like extensively-managed grasslands. In the area of the steppe biome (i.e., Ukraine, Moldova, some parts of Hungary, Croatia and Serbia) the natural and semi-natural grasslands reached their maximum extension before crop cultivation expanded, starting from the beginning of the 19th century (Wesche et al., 2016). In the northernmost countries of the region, this happened at the end of the 19th and the beginning of 20th century up to the 1920s. The 19th century could be a turning point in the history of grassland management throughout Eastern Europe. Intensification became necessary for feeding a growing urban population with increased demands for food quality and security (Hopkins and Holz, 2006). The main driver of changes in lowland natural grasslands (i.e., steppes) was the high demand of arable fields at the expense of grasslands. Decreasing areas of pastures provoked overgrazing especially because animal (draft) power was demanded for crop production. Thus, the countries in the region experienced rapid decline in grassland biodiversity because of conversion of grasslands to arable land and overexploitation of residual grassland areas. These grassland transformations resulted in massive soil erosion and habitat degradation. Humus loss, damage of secondary soil structure and compaction are interdependent factors of soil degradation (Leah, 2016).

While a high level of agricultural industrialization occurred in Western European countries from the first half of the 20th century onwards and resulted in a massive decrease in the area of extensively managed land, fragmentation and decline in biodiversity, in most parts of the Eastern Europe these negative trends were not so marked until the switch to communist economy (Pullin et al., 2009). After the First World War, the socio-economic settings in the eastern part of the region were influenced by the Soviet Union. Ukraine and Belarus became members of the Soviet Union in 1922, Moldova in 1924 (as part of Ukrainian SSR and from 1940 as Moldavian SSR) and the Baltic countries were annexed in 1940. After the Second World War, the Soviet communist influence became strong in the other central European and Balkan countries of the region. This meant forced collectivization in agriculture and, adaptation to socialist centrally-planned economy (Bogovin, 2006) in the industry.

In the last few decades two simultaneous processes either intensification or marginalization of agriculture (Vanwambeke et al., 2012; Jepsen et al., 2015) were seen. These processes were common for all Eastern European countries but with different rates of change. While intensification (collectivization) was a common process in the whole of Eastern Europe from the 1950s through 1970s to 1990s, but starting about 2000, countries diverged in land-management regimes. The northernmost countries of the region experienced two simultaneous processes. Industrialization (larger farms and fields, specialization in production) occurred in the agriculturally most-productive regions. Abandonment of agricultural lands was common throughout these countries. The dominant process in nemoral and continental countries was de-intensification (Jepsen et al., 2015). After the collapse of socialist economy in all the countries, most state-owned land became privatized and/or returned to the former owners of advanced age. Because of a lack of resources and funding, most of these lands were abandoned. With the access to various constructions of support in EU agri-environmental schemes, re-utilization of a high proportion of formerly abandoned land was enabled in some countries.

Ecosystem Services

Natural and semi-natural grasslands are key contributors to several ecosystem services, like food, genetic resources, pollination, invasion resistance and many cultural services. Potential provisioning of several services are still poorly known and not evaluated; for example, the provisioning service of natural medicines and regulating services of seed dispersal and disease regulation (Harrison et al., 2010). Natural and semi-natural extensively-managed grasslands provide more diverse and much higher quality ecosystem services than sown and intensively-managed grasslands. They are better CO_2 sinks, provide more effective water infiltration and storage; extensive management ensures less pollution, and provide extensive cultural and intangible services (Benayas et al., 2009; Bullock et al., 2011). Nevertheless, human use of semi-natural grassland services has been mostly subsided in recent decades in Eastern Europe because of high levels of decline in semi-natural grassland area. The monetary value of ecosystem services of semi-natural grasslands has been calculated only in a few countries of Eastern Europe. The best example is the Czech Republic (Hönigová et al., 2012) with the calculated amount of 11,000 to 103,000 EUR (13,000 to 120,000 US$) per hectare depending on the habitat type.

Potential of semi-natural grasslands for biogas and biofuel production has been evaluated in the Baltic countries (Heinsoo et al., 2010; Hensgen et al., 2007; Melts, 2014; Strazdiņa et al., 2015). In Latvia, the energetic potential of biomass from permanent grassland was estimated as 4,407–6,661 kWh ha^{-1} yr^{-1}, the methane potential from grassland biomass as 441–666 normal m^3 ha^{-1} yr^{-1} and the economic potential of biomass resources calculated as income from biogas production as 139–220 EUR (161–256 US$) ha^{-1} yr^{-1} (Strazdiņa et al., 2015). Energy production from semi-natural grassland is most profitable in alluvial grasslands, followed by dry to mesic meadows. Methane production yield is highest in grasses and sedges/rushes and lowest in forbs. Energy yield through combustion is higher than from methane production. The energy yield from semi-natural grasslands can be comparable with that of energy crops in the boreal region (Melts, 2014).

Only a few attempts have been made to evaluate the cultural services of semi-natural grasslands in Eastern Europe. A contingent valuation study was carried out for Estonian semi-natural grasslands to evaluate them as a non-market environmental good. Based on 1,061 respondents, the total annual demand for semi-natural grasslands was evaluated to be 17.9 million EUR (20.8 million US$; Lepasaar and Ehrlich, 2015). In Slovakia, local residents prioritized provisioning and regulating services, and did not evaluate grasslands as important providers of cultural services (Bezák and Bezáková, 2014). In Hungary, aesthetics and social values were more appreciated by organic farmers, while the conventional farmers stressed the economical values (Kelemen et al., 2013). There are some indications that Eastern European farmers are less aware of biodiversity values and more sceptic to conservation policy if compared to Scandinavian and central European countries. Comparison of Finnish and Estonian farmers showed that Estonian farmers were less sceptic to undesirable effects of intensification to farmland wildlife. Hungarian farmers were more sceptic to nature conservation than French and Italian farmers (Kelemen et al., 2013). The possible reason is a long history of top-down nature conservation policy in Eastern Europe but without a tradition to involve the general public in environmental decision making (Young et al., 2007).

Grassland Biodiversity

Temperate and hemi-boreal grasslands are known for their high and, in some cases, extraordinary, small-scale diversity of vascular plants (Wilson et al., 2012) as well as bryophytes and lichens (Löbel et al., 2006). Comparative studies of species richness of different grassland types, carried out in Eastern Europe, showed that semi-dry basophilous grasslands are characterized by the greatest richness of vascular and non-vascular plants (Dengler et al., 2016). The extraordinary plant species richness was revealed for semi-dry grasslands of White Carpathians, Czech Republic and Slovakia (Chytrý et al., 2015), foothills of the Eastern Carpathians, Ukraine (Roleček et al., 2014), and Transylvania, Romania (Turtureanu et al., 2014) (Table 4.1).

Along with high phytodiversity, grassland ecosystems provide refuge to a large number of rare and endangered animal and plant species and they can be considered as one of the global biodiversity hotspots (Habel et al., 2013). Mesic and wet grasslands of Eastern Europe are habitats of many species of *Orchidaceae* (*Orchis*, *Anacamptis*, *Dactylorhiza*,

Table 4.1 Total plant and vascular plant species richness for some grasslands in Eastern Europe. BG = Bulgaria, CZ = Czech Republic, EE = Estonia, LV = Latvia, RO = Romania, SK = Slovakia, UA = Ukraine.

Country	Study Area	Grassland Type	Total Plant Richness (max.)			Vascular Plants Richness (max.)			Source
			1 m^2	10 m^2	100 m^2	1 m^2	10 m^2	100 m^2	
BG	NW Bulgarian Mountains	dry	41	62	89	36	60	87	Dengler et al. (2016)
CZ	White Carpathians	semi-dry	65	88	117	58	79	105	Dengler et al. (2016)
CZ	White Carpathians	semi-dry	–	–	133	82	–	119	Chytrý et al. (2015)
CZ	Bošovice (S Moravia)	semi-dry	–	–	–	57	–	107	Chytrý et al. (2015)
EE	Saaremaa	semi-dry	49	72	100	35	49	70	Dengler et al. (2016)
LV	Northern Latvia, Gauja River Valley	semi-dry	51	–	–	50	–	–	Rūsiņa (2008)
LV	Western Latvia, Sventaja River Valley	moist calcareous (*Molinion*)	–	–	–	47	–	–	S. Rūsiņa (unpubl.)
RO	Transylvania	dry	82	101	134	79	98	127	Dengler et al. (2016)
SK	Strážovské Vrchy Mts	semi-dry	–	–	–	–	–	97	Chytrý et al. (2015)
UA	Central Podolia	dry	48	67	108	42	64	86	Dengler et al. (2016)
UA	Foothills of the Eastern Carpathians, Dziurkac	semi-dry	–	–	–	–	92.8*	–	Roleček et al. (2014)

*standardized to 10 m^2.

Ophrys, Traunsteinera, etc.) as well as *Liliaceae* (*Lilium, Fritillaria*), *Iridaceae* (*Iris, Gladiolus*) and some other rare forbs as well as *Cyperaceae* and *Juncaceae*. All these taxa are particularly vulnerable to changes in management regime. However, rare and endangered species occur in the highest number in dry grasslands. Moreover, their rarity is driven by habitat destruction and fragmentation. For example, in Ukraine steppe ecosystems occupying only about one per cent of the territory are habitats for almost 30 per cent of all species of flora and fauna listed in the *Red Book of Ukraine* (Burkovsky et al., 2013). A similar situation was reported from Latvia—semi-natural grasslands cover 0.7 per cent of the area of the country, but they host 30 per cent of the total number of red-listed vascular plant species (Gavrilova, 2003).

Many representatives of the grassland flora are endemic (narrow-ranged) species or relict species. There are particularly many narrow-ranged species among the steppe and forest steppe flora: *Colchicum fominii*, *Hyacinthella pallasiana, Ornithogalum amphibolum, Elytrigia stipifolia, Stipa syreistschikowii, Rumia crithmifolia, Artemisia hololeuca*, *Carlina onopordifolia*, *Gymnospermium odessanum*, *Crambe aspera*, *Cerastium biebersteinii*, *Dianthus pseudoserotinus*, *Eremogone cephalotes*, *Euphorbia volhynica, Astracantha arnacantha*, *Calophaca wolgarica*, *Chamaecytisus graniticus, Erodium beketowii, Hyssopus cretaceus, Cymbochasma borysthenica*, *Androsace koso-poljanskii*, *Pulsatilla taurica* and *Viola oreades*.

However, there are also narrow-ranged species in mesic and wet grasslands (*Nigritella carpatica*, *Pinguicula bicolor*) as well as in saline (*Allium regelianum*, *Phlomis scythica*) and sandy grasslands (*Allium savranicum, Centaurea breviceps*, *Alyssum borzaeanum*, *Astragalus tanaiticus*, *Goniolimon graminifolium*). Although the majority of grasslands in the region are semi-natural, they serve as refugia for some relict species. The primary steppe habitats are the richest in relicts: *Allium obliquum*, *Sternbergia colchiciflora, Carex pediformis*, *Psathyrostachys juncea*, *Schivereckia podolica*, *Globularia trichosantha*, *Dracocephalum austriacum*, *Thalictrum foetidum,* etc. (Didukh et al., 2009).

Natural and semi-natural grasslands are the main nesting habitat for several tens of bird species. From 200 bird species that regularly nest in Latvia, one-fourth nest in grasslands on a regular basis, while for 15 of them the grassland is the only or almost the only nesting habitat in Latvia. Coastal grasslands of the Baltic Sea are directly related to the critically-endangered Baltic subspecies of the Dunlin—*Calidris alpina schinzii*. Three of six globally endangered bird species—the Aquatic warbler (*Acrocephalus paludicola*; 'vulnerable' status according to IUCN criteria), the Great snipe (*Gallinago media*) and the Black-tailed godwit (*Limosa limosa*; 'near threatened' status for both) depend on wet floodplain grasslands. Another two globally endangered bird species are the Eurasian curlew (*Numenius arquata*) and the European roller (*Coracias garrulus*; 'near threatened' status for both). The Corn crake (*Crex crex*) also had this status until recently, but thanks to the species protection and grassland habitat restoration measures in recent decades, especially in Western Europe, its population has increased and its status has been changed (Rūsiņa and Auniņš, 2017).

Conservation of Grassland Biodiversity

The most valuable grasslands have traditionally been preserved in protected areas, mainly in nature reserves and national parks. For example, almost all large areas of watershed steppes in Ukraine that survived until now are part of protected areas, such as the Biosphere Reserve 'Askania Nova', Ukrainian steppe reserve branches, some nature reserves and national parks, with a total area of over 700 km^2. In the Carpathian

region, a whole network of protected areas was established, including those created in the framework of international cooperation, such as the 'Eastern Carpathians' trans-boundary Biosphere Reserve, which includes parts of Poland, Slovakia and Ukraine, or the bilateral Polish-Slovak 'Tatra' National Park, which protects the most valuable areas of mountain grasslands, including natural alpine grasslands.

Conservation policy has changed in post-Soviet countries substantially after the break-down of the Soviet regime. In boreal countries, conservation of semi-natural grasslands was not given due consideration until the late 20th century. In general, the active protection of semi-natural grasslands only began in the late 20th century when the approach of nature conservation changed from absolute non-intervention to active nature conservation. Until then, the emphasis was mainly placed on species conservation, sometimes not even considering or misunderstanding habitat ecology and the requirements of the species. Entire nature conservation was mainly based on the reserve principles, described as absolute *zapovednost* (protection status) by Boreiko et al. (2013). For example, Decision No. 421 by the Latvian SSR Council of Ministers of 1977 mandated that hay must not be harvested during the entire year in ornithological reserves with substantial grassland areas. Such grassland management bans in ornithological reserves resulted in reduction of bird species for which these bans were established. These practices contributed to a significant reduction in semi-natural grassland area in protected nature areas (Kaltenborn et al., 2002; Klein, (ed.) 2008; Rūsiņa, (ed.) 2017). The approach of absolute 'zapovednost' in Ukraine is still popular and even reflected in some of the laws that prohibit regulatory measures in reserves and protected areas of national natural parks; this prevent implementation of proper protection of grasslands in these areas.

Until the late 20th century, due to the prevailing non-intervention nature conservation approach, there were very few grasslands in the protected nature areas, many of which formed in the Soviet era. In Latvia, only half of the 153 Natura 2000[1] areas containing protected grassland habitats had been established before 1990. From 1999 to 2004, new Natura 2000 areas for the conservation of protected grasslands were established. These were mostly for floodplain bird habitats and EU habitat, '6450 Floodplain grasslands'. Other protected grassland habitats mostly occur in the mosaic of agricultural land and forests and are heavily fragmented; therefore, it is administratively complicated to establish protected areas for them. Thus, only half of the total area of protected grassland habitats are situated inside the Natura 2000 network in several countries (see Appendix).

The main legislative instrument that regulates protection of ecosystems in Europe, including grasslands, is the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention). It was adopted in Bern, Switzerland in 1979, and came into force in 1982. Signatories of the Bern Convention include, among others, the central and eastern European countries and the EU Member States. The principal aims of the Convention are to ensure conservation and protection of wild plant and animal species and their natural habitats (listed in Resolutions 4 and 6 of the Convention). This Convention provides the basis for development of the Emerald network of areas of special conservation interest (ASCIs). For EU Member States, Emerald network sites are those of the Natura 2000 network. Natura 2000 is based on the 1979 Birds Directive and the 1992 Habitats Directive. Now there are more than 4,100 sites that comprise certain types

[1] The Natura 2000 network is designated to protect core breeding and resting sites for rare and threatened species, and some rare natural habitat types in the European Union. The aim of the network is to ensure long-term survival of the most valuable and threatened species and habitats in Europe.

of grasslands (Table 4.2). Also in the post-Soviet countries, the process of establishing the Emerald network is ongoing. Today, the network has 821 sites that include certain types of grasslands (Table 4.3).

Another legal instrument for grasslands protection in some post-Soviet countries was the publication of so-called *Green Books*, which list plant communities that need protection. The first *Green Book* was published in Ukraine in 1987. The *Green Book of Ukraine* is a public document in accordance with the *Regulations on the Green Book of Ukraine*, approved by the Cabinet of Ministers of Ukraine in 2002. The current edition of the *Green Book of Ukraine* includes 24 types of herbaceous and shrub steppe communities, eight types of herbaceous and shrub communities of xeric type on outcrops and sands and six types of meadow communities (Didukh, 2009). The *Lithuanian Red Data Book* includes several endangered plant communities of grassland vegetation (Balevičiene et al., 2000). A list of rare and threatened plant communities of Estonia has been published in 1998 (Paal, 1998). Latvia does not have a published list of threatened plant communities.

While in the EU, national laws should be harmonized with the EU regulations for habitat protection, outside the EU, the protection of grasslands is exclusively regulated by national laws. For example there are laws *On Environmental Protection* (Belarus, Moldova, Ukraine), *The Law on the National Ecological Network* (Moldova, Ukraine), or *The Law on Plant World* (Ukraine). In Belarus, in 2012 a draft of a normative legal act says: "Compensation

Table 4.2 Number of Natura 2000 sites, comprising a habitat type of the group '6. Natural and semi-natural grassland formations' from the Habitats Directive Annex I and its subtypes (Source: http://www.eea.europa.eu/data-and-maps/data/natura-7). BG = Bulgaria, CZ = Czech Republic, EE = Estonia, HR = Croatia, HU = Hungary, LV = Latvia, LT = Lithuania, PL = Poland, RO = Romania, SI = Slovenia, SK = Slovakia.

Habitat Type	BG	CZ	EE	HR	HU	LV	LT	PL	RO	SI	SK
61 Natural grasslands (6110, 6120, 6150, 6170, 6190)	125	58	0	21	78	24	20	136	52	21	136
62 Semi-natural dry grasslands and scrubland facies (6210, 6220, 6230, 6240, 6250, 6260, 6270, 6280, 62A0, 62C0, 62D0)	167	194	250	92	430	105	45	44	95	29	183
64 Semi-natural tall-herb humid meadows (6410, 6420, 6430, 6440, 6450)	8	81	191	4	376	56	54	59	124	27	49
65 Mesophile grasslands (6510, 6520, 6530, 6540)	23	108	163	13	157	17	10	31	85	23	174

Table 4.3 Number of Emerald sites, comprising a habitat type of the group 'E Grasslands and lands dominated by forbs, mosses or lichens' from the Resolution 4 of the Bern Convention and its subtypes (Source: http://www.coe.int/en/web/bern-convention/ecological-networks-meetings-2016).

Habitat Type	Belarus	Moldova	Ukraine
E1 Dry grasslands (incl. E1.11, E1.12, E1.13, E1.2, E1.3, E1.71, E1.9)	19	2	255
E2 Mesic grasslands (E2.2, E2.3)	6	11	102
E3 Seasonally wet and wet grasslands (E3.4, E3.5)	24	6	176
E4 Alpine and subalpine grasslands (E4.11, E4.12, E4.3, E4.4)	0	0	16
E5 Woodland fringes and clearings and tall forb stands (E5.4, E5.5)	26	0	135
E6 Inland salt steppes (E6.2)	0	0	43

system for users of land plots and (or) water bodies for the introduction of restrictions on economic and other activities in natural areas under special protection (habitats of wild animals and plants species included in the *Red Book of the Republic of Belarus* passed under the protection of users of land plots and (or) bodies of water)" has been developed and submitted to the Ministry of Environment. Article 82 of the Law *On Environmental Protection* provides economic incentives for environmental protection by establishing (for legal and physical entities) tax and other benefits in respect of the protection and use of regime of protected areas, areas subject to special protection and rational (sustainable) use of their natural resources in the transition zones of biosphere reserves (CBD National Report of Belarus, 2014).

Threats

Land use change (land conversion, intensification and abandonment of management), eutrophication caused by industry and nutrient runoff from neighboring agricultural systems and climate change are the main direct drivers of ecosystem change listed in *Millennium Ecosystem Assessment* (World Resources Institute, 2005). The influence of the mentioned direct drivers of biodiversity in semi-natural and natural grasslands in Eastern Europe are accelerated by demographic, economic and socio-political changes.

Land conversion into arable land, forest (through encroachment following abandonment or active forest planting) and to a lesser degree also into urban areas was the main driving force leading to decrease in semi-natural and natural grassland area in the region in the last century and is still continuing at a high rate. In Latvia, only 28–44 per cent of the area of rare grassland habitat type (predominantly hard management conditions, e.g., wet, steep slopes) and 60 per cent of the more common habitat types (predominantly with easy management conditions) were still managed in 2007–2013. Moreover, 1.8 per cent of the total area was destroyed in this period by turning it into arable land (Rūsiņa, 2016). In Belarus, the area of grasslands has decreased by 1,219 km² or 3.86 per cent in recent years (Bogovin, 2006; CBD National Report of Belarus, 2014). In Poland, during 2009–2012 the total amount of farmland—most importantly, pastures and grasslands—decreased by 1,600 km². This decrease was caused by the conversion of farmland to non-agricultural uses and changing its classification. Many farms, especially small ones, abandoned production in the recent years (CBD National Report of Poland, 2014). It is predicted that depopulation and severe ageing will continue in Eastern Europe (Gavrilova and Gavrilov, 2009; Davoudi et al., 2010), leading to more empty rural areas and polarization of the landscape. Still, there are also reverse trends in grassland area dynamics. Thus, for example, in Moldova in the last 25 years, the area of grasslands has increased at the expense of arable land left fallow or abandoned. The area of pastures and hay meadows is growing while the area of intensively used arable land and cropland decreases. This increase of grasslands resulted from a failure of the agrarian reform after 1990 (Leah, 2016). In Estonia, 80 km² of semi-natural grasslands have been restored in the last decade and more than 30 km² are planned to be restored in the ongoing restoration projects (Helm et al., 2016).

Grassland abandonment and cessation of former extensive management by mowing or grazing was identified as one of the most crucial drivers of grassland biodiversity, especially in the mountain areas of Europe (Valkó et al., 2012). The increasing rate of abandonment was in parallel with the decrease of livestock in the region, typical for most countries in Eastern Europe (see Appendix). This resulted, in most cases, in shrub and tree encroachment and the decrease of grassland biodiversity.

Climate change has been identified as one of the major drivers of grassland biodiversity in the near future. It is forecast for Eastern European region that (i) the temperature will rise by 1–3°C with considerable sub-regional differences until the middle of the century. The highest increase is projected for the summer, while a lower increase in temperature is expected for the winter. For most sub-regions, the projection is, however highly uncertain (Anders et al., 2014). (ii) There will be complicated changes in precipitation with marked sub-regional differences, but likely there will be a precipitation shift from summer to winter. (iii) The frequency of extreme climatic events and the likeliness of summer arsons (in line with the decreased precipitation) will also increase (Anders et al., 2014; Wesche et al., 2016). In line with these changes, a high species turnover is expected: the cover of drought-tolerant species and the proportion of Mediterranean species are supposed to increase, especially in the Carpathian Basin (Thuiller et al., 2005). Further, the decreased precipitation and increased temperature (with increased rate of arsons) will suppress forest vegetation in many places and increase the area of open habitats, including drought-tolerant grasslands communities (IPCC, 2014).

In addition to the three main drivers listed above, the spread of invasive species forms a fourth threat for grassland biodiversity. In general, grassland habitats are characterized by intermediate levels of invasion and low invasion risk (Pyšek et al., 2010). However, considering grassland types separately, we can see that there are some grassland types of low invasibility (i.e., saline and dry grassland types, rocky grasslands), while others can be characterized by a high risk of invasion (sand grasslands) (Botta-Dukát, 2008). High-intensity management or other forms of disturbance, which cause the degradation of grasslands, can also enhance the risk of invasion. The most dangerous invasive species that can completely change the composition and structure of grasslands are invasive woody species, such as *Robinia pseudoacacia*, *Ailanthus altissima*, *Elaeagnus angustifolia*, *Hippophaë rhamnoides, Amorpha fruticosa* and *Acer negundo*. Among herbaceous plants, most dangerous for grasslands are *Asclepias syriaca, Heracleum sosnowskyi* (incl. *H. mantegazzianum*), *Phalacroloma annuum, Solidago canadensis, Conyza canadensis, Ambrosia artemisiifolia, Grindelia squarrosa, Impatiens glandulifera* and *Centaurea diffusa* (Protopopova et al., 2006; GISD, 2017).

Fifth, eutrophication caused by (i) the deposition of aerial nitrogen or (ii) the increase of nutrients by cropland run-off strongly affects the diversity and biomass production in semi-natural grasslands. Nutrient enrichment favors generally the dominant graminoids and increases their cover and biomass production, leading to the decrease of biodiversity and suppression to subordinated species (Bobbink, 1991). The nutrient enrichment also reduces the positive effects of grassland management on biodiversity, especially in nutrient poor grassland types (Habel et al., 2013).

Grassland Management and Restoration

Most grasslands in the Eastern European socio-economic region, similarly to other regions of Europe, were created and/or their biodiversity is maintained by an extensive form of management (Fischer and Wipf, 2002; Dengler et al., 2014). This entails, in most cases, grazing or mowing management. As discussed above, because of intensive agriculture a high proportion of grassland areas in the lowland regions has been converted to croplands; thus, the remaining grasslands have become fragmented and were degraded by the generally intensified use. By contrast, in mountain and foothill areas grasslands with low accessibility or productivity were subject to abandonment, which resulted in a

strong shrub and tree encroachment. To conserve grassland biodiversity, it is crucial to maintain extensive management regimes (best represented by a traditional agricultural regimes) to avoid both abandonment and too high land-use intensity. In case of already degraded grassland stands, the change of management intensity is also suggested, but in case of completely destroyed grasslands, recovery by spontaneous succession or technical reclamation methods is recommended.

Eastern Europe belongs to the European regions with the best preserved remnants of the traditional rural culture based on traditional agricultural practices (Oppermann et al., 2012). The positive effects of re-introduction of traditional management by mowing or grazing have been demonstrated in several experiments reported from the region (Galvánek and Lepš, 2008; Valkó et al., 2011, 2012). For pastures, low intensity grazing (i.e., < 0.5 animal units per hectare) is recommended with a strong preference for traditional herding of local cattle breeds or free grazing by wild horses and cattle (Török et al., 2016a,b; Tóth et al., 2017). As re-introduction of traditional management practices is often not feasible or economically sustainable, conservation authorities are seeking alternative management practices, like prescribed burning during the dormant season. Valkó et al. (2013) suggest that prescribed burning with long fire-return periods (i.e., at least three consecutive years without burning) might be a cost-effective and appropriate tool in eliminating accumulated litter and sustaining grassland biodiversity. It was found that for recovery and sustainability of high biodiversity of various taxonomic groups of organisms, a mosaic management (i.e., a spatially and temporally dynamic combination of mown and abandoned grassland patches) would be most appropriate and cost effective. It became evident that not only performance of a single management activity, such as mowing or grazing, but adoption of the whole scheme of traditional management regimes is necessary to maintain the extraordinary grassland diversity of a particular region (Babai et al., 2014). The importance of small-scale, low-intensity farming in conservation of European biodiversity and the maintenance of cultural landscapes has been recognized for decades and led to the development of the High Nature Value (HNV) concept in the 1990s (Keenleyside et al., 2014). Similarly, the role of traditional ecological knowledge (TEK; multi-generational, culturally transmitted knowledge and ways of doing things) is increasingly appreciated nowadays and various recent studies (Babai and Molnár, 2014; Babai et al., 2014) have shown that there are many traditional rural cultures in Eastern Europe that use TEK in their agricultural practices. Its application in grassland conservation has a huge, still not sufficiently used, potential.

When grasslands are completely eliminated due to their transformation into croplands, forests, plantations or urban areas, their recovery can be based on spontaneous succession or technical reclamation (Prach and Hobbs, 2008). Spontaneous succession is increasingly involved in restoration and it is the most promising approach in landscapes where the proportion of target grassland communities is high. There are promising examples reported from central Europe in various grassland habitats (Ruprecht, 2006; Albert et al., 2014; Prach et al., 2015). The most frequently applied technical reclamation methods include sowing of regional seed mixtures and plant material transfer (Török et al., 2011), successfully used in large-scale grassland restoration projects in some countries in the region (Hungary: Lengyel et al., 2012; Czech Republic: Prach et al., 2015), while in the northernmost countries of the region no experience exists so far, or only the first attempts have been made in this direction (Gazenbeek, 2008; Metsoja et al., 2012, 2014; Rūsiņa, 2017).

In Poland, agri-environmental schemes are part of the EU Common Agricultural Policy (CAP) and provide payments to farmers for protecting the environment on their

farmland by adopting environment-friendly farming practices or for maintaining habitats and species with certain management practices. Total financial expenditure on agri-environment payments in the EU during 2007–2013 was over 33 billion EUR (38 billion US$; Żmihorski et al., 2016). The effect of CAP payments on biodiversity in Eastern Europe is, however, ambiguous. On the one hand, the CAP-related payments together with other direct payments that are at least partly used for nature conservation (LIFE, LIFE+, structural and rural development funds) increased the available budget for activities related to sustainable grassland management and restoration in Eastern European countries (Mihók et al., 2017). On the other hand, CAP payments enabled in many regions increased intensification of agriculture, leading to a decrease in farmland biodiversity even in the short run (Tryjanowsky et al., 2011; Pe'er et al., 2014; Sutcliffe et al., 2015). One solution would be the extension and refinement of agri-environmental schemes, fine-tuned by considering local perquisites and differences in land management (Wegener et al., 2011; Báldi et al., 2013; Sutcliffe et al., 2015).

Résumé and Future Prospects

The importance of Eastern European grassland biodiversity for the whole of Europe and even in broader context is very high, as grasslands in the region harbor many relict species of high conservation value and a high proportion of the European and Mediterranean steppes are situated there. Evaluation of the monetary value of semi-natural and natural grasslands ecosystems is rather a neglected research area in Eastern Europe. Although they are key contributors of several ecosystem services, their area is either too small and declining or still very common and too familiar for local people, so that they do not recognize the importance of semi-natural grasslands and do not value them. The EU policy is a driving force to elaborate this approach at the national level and to raise public awareness about it, so it is a growing field both in science and nature conservation policy. Restoration of grassland habitats has given a rich ground to scientific research with importance for restoration ecology of grassland habitats globally; however, in many countries the accessibility to the results of grassland restoration projects is relatively poor. Although a conservation system is well established in terms of nature protected areas, the real conservation effort gives only negligible results in several countries because of negative demographic, economic and socio-political drivers. Although there are very promising examples of good practice in conservation and sustainable management, the future trends in conservation of grassland biodiversity in semi-natural and natural grasslands are not very promising in the region.

Acknowledgements

P. Török was supported by NKFIH K 119 225 grant during manuscript preparation. S. Rūsiņa was supported by the University of Latvia grant No. AAP2016/B041. M. Janišová was supported by the grant VEGA 2/0027/15.

Abbreviations

BP = Years Before Present; CAP = Common Agricultural Policy (of the European Union); HNV = High Nature Value; IUCN = International Union for the Conservation of Nature; TEK = Traditional Ecological Knowledge

Appendix: Table showing spatial Extent of Grasslands in Eastern Europe.

Country	Total Area of Permanent Grasslands	Area of High Quality Natural and Semi-grasslands	Area of Grasslands under Protection	Main Types of High Quality Grasslands	Threats	Source
Albania	4,500 km²	No data	No data; 25 Emerald sites	No data	Overgrazing Overcutting Soil erosion Abandonment	Shundi (2006), Rupa (2013)
Belarus	29,748 km²	No data, 412 km² mapped	No data	Of the total mapped grassland area: Rocky: 0.5% Dry and semi dry: 4.4% Mesic: 24.3% Wet: 70.8%	Abandonment	Witkowski (2006), Maslovski (2007)
Bosnia and Herzegovina	14,100 km²	No data	No data; 28 Emerald sites	Most meadows are in the lowland, lower hilly area, also on flat areas in mountains regions	Lack of educated management Abandonment	Alibegovic-Grbic (2009)
Bulgaria	13,726 km²	5,513 km²	6,080 km² of all grasslands in Natura 2000	Mostly extensively managed pastures	Overgrazing near to settlements Uncontrolled burnings Decrease in livestock Abandonment	Hamnett (2006), Stefanova and Kazakova (2013)
Croatia	3,433 km²	No data	~ 3,000 km² in Natura 2000	Traditional hay making Mediterranean grasslands historically used for sheep grazing	Abandonment Overgrazing	Beneš (2013)
Czech Republic	9,800 km²	2,715 km²	No data	Alpine: 1.9% Dry and semi dry: 2.8% Mesic: 14.2% Wet: 80.6% Halophytic < 1% Other: 1%	Intensification of agriculture Abandonment Lack of educated management in protected areas Urbanization	Veselý et al. (2011), Hönigová et al. (2012)

Estonia	2,961 km²	~ 1,300 km²	~ 750 km²	Rocky: < 1% Dry and semi dry: 18.2% Mesic: 23.6% Wet: 41.3% Halophytic 16.8%	Abandonment Intensification of agriculture Change in water regime Urbanization	Heinsoo et al. (2010), Talvi and Talvi (2012), EUROSTAT (2016b)
Hungary	~ 10,000 km² (7,840 km² managed and 2,500–3,000 km²) abandoned cropland with grassland vegetation	~ 2,300 km²	~ 68% of HNV protected, 31% protected only by Natura 2000	Steppes, sand steppes and alkaline: 43.3% Rocky: 3% Mesic: 11.4% Wet: 42%	Abandonment Decrease in livestock Invasive species encroachment Change in water regime	Tasi et al. (2014), KSH (2016), Mihók et al. (2017), Z. Molnár (pers. comm.)
Latvia	6,403 km²	~ 500 km²	~ 230 km²	Rocky: 0.05% Dry and semi dry: 6.5% Sandy: 1.9% Mesic: 57.7% Wet: 34.0% Halophytic: 0.4%	Abandonment Intensification of agriculture Change in water regime Conversion to arable land	Auniņš (2013), Rūsiņa (2017)
Lithuania	6,059 km²	744 km²	~ 177 km²	Dry and semi dry: 3.8% Sandy: 0.2% Mesic: 76.1% Wet: 19.9%	Intensification of agriculture Conversion to arable land Abandonment Change in water regime Afforestation	EUROSTAT (2016a), V. Rašomavičius (pers. comm.)
Macedonia	5,900 km²	~ 650 km²	No data; 35 Emerald sites	Pastures in Macedonia are mainly natural and semi-natural, divided into summer and winter pastures of low productivity or low quality High mountain pastures in western Macedonia are traditionally used for sheep grazing in the summer	Conversion to arable land Weed infestation Lack of access roads to the sheepfolds and pens Poor water supply Pasture abandonment Soil degradation	Kratovalieva and Milcevska (2013)

Table contd. ...

...Table contd.

Country	Total Area of Permanent Grasslands	Area of High Quality Natural and Semi-grasslands	Area of Grasslands under Protection	Main Types of High Quality Grasslands	Threats	Source
Moldova	3,510 km²	No data meadows 21 km², pastures 3,489 km²	No data Steppe: 11.3% of the country	Steppes Semi-dry grasslands Mesic grasslands	Abandonment Overgrazing Conversion to arable land	Anon. (2009b), Shabanova et al. (2014)
Montenegro	4,600 km²	No data	No data, 32 Emerald sites	Traditionally, domestic production of meat and milk are far below the consumption Extensive or semi-extensive farming prevails	Abandonment Overgrazing	Dubljevic (2009)
Poland	39,390 km²	No data	~ 3,783 km² in Natura 2000	Alpine Rocky Sandy (boreal zone) Semi-dry Mesic Wet grasslands	Abandonment	CBD National Report of Poland (2014)
Romania	45,319 km²	4,991 km² mapped	No data	Mapped grasslands are Steppe: 34.7% Rocky: 0.9% Dry and semi-dry: 4.7% Mesic: 44.2% Wet: 15.4%	Abandonment Replacement of cattle grazing by sheep	Sârbu et al. (2009), Veen and Metzger (2009), EUROSTAT (2016c)
Slovakia	8,450 km² (2003)	3,200 km² (2002)	Of the HNV grasslands between 1,500 and 2,000 km² are covered	Mesic: 62% Wet: 15% Dry: 8% Alpine: 4% (11% cannot be classified in lack of characteristic species)	Intensification of agriculture Abandonment Lack of educated management in protected areas Urbanization	Šeffer et al. (2002)

Slovenia	4,000 km²	No data	~ 2,000 km² in Natura 2000	Humid, marshy grasslands grazed by cattle or mown Hay meadows and pastures typical of karst areas Extensive pastures in hilly areas grazed by cattle and sheep Shepherded summer grazing on alpine pastures	Intensification of agriculture Tourism Uncontrolled grazing Intensification of agriculture	Seliškar (1996)
Serbia (with Kosovo)	14,245 km²	No data	No data; 61 Emerald sites	Livestock-raising region includes mountain areas of semi-natural and natural grasslands: (a) Crop-farming and livestock-raising region, including lowlands and flat areas in river valleys; (b) Mixed farming region: Hilly land with different climates and soils – livestock production and grazing	Overgrazing Conversion to arable land Abandonment	Stošić and Lazarević (2009), Djordjevic-Milošević (2013)
Ukraine	78,400 km²	No data	No data	All types	Abandonment (in some regions) Overgrazing (in some regions) Conversion to arable land Afforestation	Bogovin (2006), Burkovsky et al. (2013)

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