CLIMATE-ADAPTIVE GRASSLAND MANAGEMENT IN URBAN ENVIRONMENTS

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Meadow sage in a residential green space

FOREWORD

Green spaces, biologically active surfaces covered with vegetation, are essential elements in cities, playing a key role in maintaining the ecological balance of settlements, the health of city dwellers, and a healthy urban environment. In various historical periods, green spaces in urban settlements not only embody an ecological link to the peri-urban areas, but are also essential building blocks of the townscape and the aesthetic appearance of the city. Living elements resembling nature in densely built-up urban areas.

The significance of green spaces is gradually increasing with urbanisation and the recognition of harmful environmental factors affecting human health. Green spaces in urban habitats have an important role to play in protecting the human environment; their maintenance is therefore a priority. In a narrower sense, good living conditions and the sustainability of green spaces around us, while in a broader context, healthier living conditions for humans must be ensured and maintained in urban environments.

The City of Veszprém has a long tradition of maintaining and improving urban green spaces to a high standard. The results achieved have been supported by several professional partnerships in the past and continue to be supported to this day. In this city with a diverse landscape and valuable green spaces, these partnerships have helped to develop a green space system made up of elements with a good location and size, and a valuable plant population with a significant number of exotic species. The unique green character of the city, which is recognisable to the professional observer, is made special and enviable by the species and varieties of rare plants that are reminiscent of an arboretum.

In today's Veszprém, more and more innovative technologies and good practices, such as the Wildflower Veszprém Programme, are being applied in green space management, which increase sustainability, especially biodiversity. The planned management, renewal and development of green spaces is supported by the city's „Green Space Strategy", which also emphasises the broad involvement of the community. Green spaces are both the site and subject of environmental education programmes, so that interested residents can be involved in the shaping and maintenance of the urban green environment from an early age.

The aim of this publication is to enrich the knowledge and to encourage gardening, which can be done in your own garden or in our common garden in Veszprém where we welcome all helping hands in professional coordination.

"First we shape the cities
– then they shape us." / *Jan Gehl*

Mária Bránya
Vice mayor,
Municipality of Veszprem

Natural occurrence of poppies along an urban road

URBAN CLIMATE

Characteristics of urban climate

The 19th century saw an explosion of urban development. More and more people moved and still move to cities in search of a better livelihood and living conditions. Urban development results not only in an increase in population, but also that in the area occupied by buildings, infrastructure and sealed surfaces. At the same time, the area covered by vegetation and surface water is rapidly decreasing. Urbanisation is not causing a change only in the proportion of land uses. Urban life has a significant impact on the environment as well. Industry, transport and other human activities cause significant changes in the environmental processes. Due to dense populations and concentrations of activities, these modifying effects appear more pronounced in cities, placing a heavy burden on the environment for city dwellers and the remaining natural systems of the city.

The bigger a city, the more people live in it, the greater the environmental impact of urban life. In conurbations, these effects are more pronounced. One consequence of urbanisation is the development of urban climate, which is a result of the interaction amongst built-up, densely populated areas and regional climates. Let's take a closer look at urban climate!!

The Benedek Hill in Veszprém

The development of urban climate

One of the reasons for the development of urban climate is the changing land surface. The physical properties of land covered by houses and pavements are very different from those of natural surfaces. On paved streets, rainwater cannot seep into the ground, and so is diverted to subsurface drainage systems or open ditches, and used elsewhere. The materials used for paving and buildings have different heat-absorbing and heat-reflecting properties compared to natural surfaces, forests, fields, and water bodies. The pattern of buildings, streets and green spaces is also very different from that of a natural surface.

Human activities concentrated into cities have two very important effects on the development of urban climates. Industrial production and modern urban life generate a lot of heat, which is released directly into the urban environment, resulting in a significant surplus heat inside the city. This is known as the urban heat island phenomenon. The other crucial effect is the release of smoke, gases, water vapour, and other solid materials into the atmosphere from heating, industrial production and transport, which, like a blanket increase air pollution in the city

The effects of urban climate

As to how strong the effects of urban climate are depends largely on the characteristics of the city. Geographical location determines the climate. The urban climate in a Northern European, Central European or Mediterranean city has different characteristics. The size, shape, territorial extent, and number of inhabitants of the city are also important. These indicators are influenced by the activities taking place in the city: one must expect higher levels of air pollution and surplus heat in an industrial city than in a resort city with parks and green alleys. The geographical character of an area can enhance or even weaken anthropogenic effects. Wind patterns may be different if a city is located in a narrow valley or a wide basin, or if it is built on the hillside. The presence of a river, lake or sea reduces the heat island effect. The characteristics of the urban climate are also different in wetland areas and in deserts. The measurable indicators of urban climate vary with seasons and time of day as well. The local factors that determine the urban climate are summarised in Figure 1.

While we cannot change local factors, such as geographical location or basic natural conditions, we can influence a number of other factors, and thus have a direct impact on the development of urban climates. Urban development and planning contribute to the development of built-up areas at local level, the development of denser urban areas, and the local development of infrastructure networks, thus indirectly influencing the development of the urban heat island. How tall are the buildings we build? Do we increase the proportion of built-up areas or do we develop underused areas, instead? How do we develop the road and transport network? Where do we locate polluting industrial activities? Where do we develop urban green spaces? These are all important questions for urban development and determine the local specificities of the urban climate. Regarding the tasks of urban planning, the definition of the local characteristics of land use, built-up areas and their density, and green surface coverage are essential.

As individuals, we can also do a lot to shape the urban climate. The material and colour of the tiling we

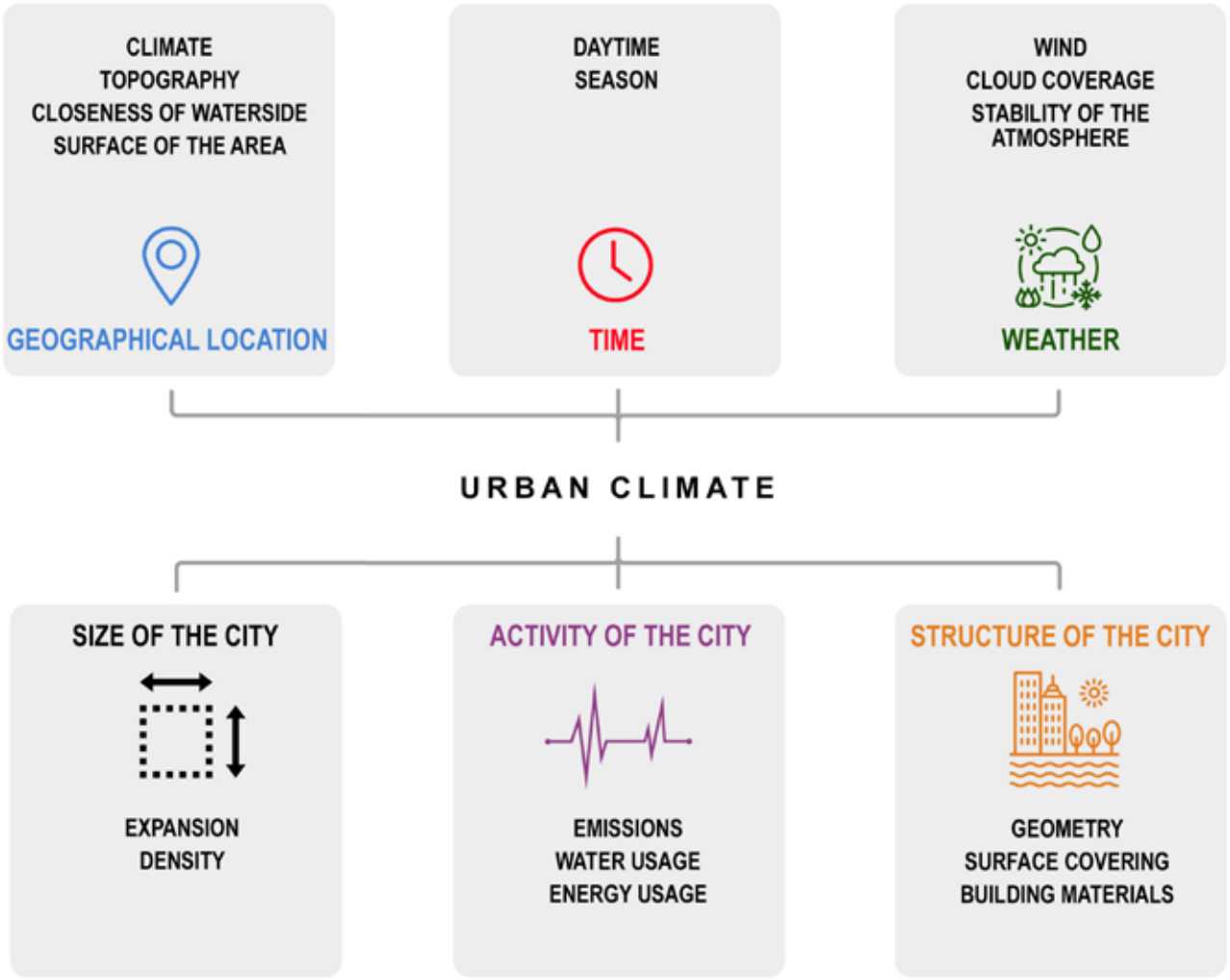

Figure 1. Impacts of urban climate

choose, the colour of the facade of our house, the material and colour of the roofing we use, the insulation and energy performance of the building, the garden we create, the way we use rainwater are all influential factors on the local and urban climate. The use of materials for buildings and paved surfaces determines not only their durability and resistance, but also their thermal performance. Today, darker and rougher building materials are popular, which absorb more heat and can contribute to heat surplus in the summer. Trendy evergreen gardens, or gardens with lawns and annual flowers, are very high-maintenance and less effective in reducing the heat island effect compared to gardens with a variety of planting and deciduous trees. We influence the urban climate not only by the way we shape our environment, but also by the way we live: how often we use our cars or whether we use air conditioning are all important factors. Decisions taken at an individual level all add up to have an impact on the urban environment, including the urban climate.

Roadside wildflower meadow

The most important features of urban climate

Surplus heat. The city is warmer!

Of all the urban climate phenomena, air temperature shows one of the most striking differences compared to its surroundings. The city is always warmer than the surrounding countryside. Air temperature can be up to 5-6°C warmer in large urban settlements and 10-12°C warmer in cities of millions. This surplus heat directly affects the amount of energy used for heating and cooling. Another important effect, much more disadvantageous and direct than the previous one, is that it increases the heat load on the environment in the summer, which affects people's comfort and health.

Wind. Special urban winds!

Compared to undeveloped areas, wind speed and direction inside cities also change significantly. The specific atmospheric movements characteristic to cities are called urban winds. The urban surface is fragmented, made up of a variety of built-up areas and green spaces. A single building (think of 10-storey blocks of flats) can be a major obstacle. As a result, wind speeds are significantly reduced in urban areas, sometimes down to -30% regarding averages. At the same time, turbulence appears and the proportion of calm periods increases. The direction of urban winds is influenced by the pattern of open spaces, creating wind tunnels inside the city. The velocity of the wind „caught up in the tunnel" increases, a phenomenon that has a significant impact on people's comfort. In the summer, the surplus heat appearing in the city centre causes air to flow upward, which is replaced by cooler air from the outside. As a result, the polluted, warm air is naturally expelled and then replaced by cleaner, cooler air, which is beneficial for reducing the summer heat.

Fog. The city is foggy!

The high concentration of pollutants in the urban atmosphere is conducive to fog formation, which is why fog is more common in cities than in the countryside. In larger cities, especially those on the waterfront, persistent fog is even more common. An interesting phenomenon in hot dry weather is urban haze, which likewise is caused by the presence of pollutants.

Drought. Urban air is dry!

The surface of the countryside and the city is very different. Urban surfaces, mainly paved and built surfaces, evaporate little. While urban vegetation evaporates, it cannot fully compensate for the dryness of inactive surfaces. Therefore, the relative humidity of the air in cities is lower than in the countryside. The difference between the relative humidity of urban areas and the surrounding countryside can be as much as 10% in summer evenings. Dry air has a negative effect not only on the condition of plants but also on human health.

Precipitation. Dry city – flooded city?

Due to altered surface characteristics, the water balance of cities is at an extreme. 55% of rainwater from buildings and impervious paved surfaces flows away and

Flowering urban meadow imitating nature (Veszprém)

ends up in subsurface drains or surface watercourses, leaving the city. 30% of rainwater evaporates and only 15% of it is stored in topsoil or the deeper layers. Thus, the city is drier than its surroundings, with only little water stored in soil. Since much of the surface is impermeable, in the event of a heavy rainfall, large amounts of rainwater falling on the surface cause spectacular and damaging flash floods, which is then dissipated within a relatively short time, given the capacity of drainage networks and the surface to absorb water. Thus, during heavy rainfalls, the normally dry cities suffer from a temporary abundance of water, or even flooding and waterlogging.

Urban climate and global climate change

Urban climate phenomena are also influenced by the trends of global climate change. In general, it amplifies the extremes of urban climates, which are becoming more frequent. The increase in the number and duration of hot, summer days cause a stronger urban heat island effect. The length and alternation of dry periods and periods with showers, the frequency of downpours, and the increase in the amount of precipitation falling in a short period of time increase the risk of flooding and the temporary overloading of urban networks. Overall, global climate change increases the negative impacts of urban climates.

Urban grassland mown to leave higher stubble

Urban climate and city dwellers

Some effects of urban climate are beneficial, others are harmful for city dwellers. In the winter, cities are definitely more pleasant when they are a few degrees warmer. The same few degrees difference in temperature can cause a lot of problems in enduring, hot summer periods. Heat waves, and tropical nights in particular, are especially stressful for patients with chronic and cardiovascular diseases, which partly contribute to the increase in mortality. Dark pavements and dark-toned walls radiate heat in the summer. Air conditioning also contributes to the hot summer air in public places. Although white walls and very light-coloured pavements do not heat up so much, they are blinding. Stronger winds can also have a double effect on people. The cold winds that sweep through urban canyons can be particularly damaging in the winter. The same wind can bring relief in the summer with cold air flowing in from the outside. Frequent fog partly exacerbated by outdated heating technology and air pollution caused by urban mobility in autumn and winter periods can be a burden. Urban life and urban climate are closely intertwined; and by changing the way we live and adapting a climate-friendly approach to our environment, we can do much to reduce the negative effects of urban climate on our health and for our own well-being.

Benedek Hill in Veszprém, a hiking spot in the middle of the city

THE ROLE OF GREEN SPACES

The benefits of green spaces

Urban green spaces provide many benefits to society. Through its conditioning effect, assimilating green vegetation is one of the most important and effective tools for shaping the ecology and improving the climate of cities. Photosynthesising green vegetation is essential for the absorption of carbon dioxide and the production of oxygen for city dwellers. (One hectare of deciduous forest can provide the oxygen needs of 30 people.) Vegetation has a moderating effect and binds atmospheric pollution; green spaces, therefore, reduce the effects of the urban heat island phenomenon. Significant amounts of dust are deposited and bound on the leaves of shrubs and trees. Through respiration, they also absorb air pollutants, thus improving urban air quality. The roots of certain plants are able to absorb toxic microelements from polluted soil, thus reducing soil pollution. Urban plants also dampen noise and vibrations with their canopy, branches and roots. By evapotranspiration, they remove heat from their surroundings, thus not only reducing the temperature of urban air, but also intensively increasing its humidity. Thanks to the foliage and branches of shrubs and trees, precipitation takes longer to infiltrate into the soil, so the water balance of the soil under vegetated surfaces is also more favourable. Urban gardens and parks provide habitats for a wide range of plant and animal species, thus increasing biodiversity.

Each area in the city has a specific role to play. Green spaces separate buildings from one another and frag-

Flowering biennials in urban grassland left high

ment the urban fabric. Their form, shape and location in the city define the character of the settlement, contribute significantly to the streetscape, and are a source of aesthetic value. Typical green spaces reinforce the community's sense of belonging and identity, improve spatial perception, and make urban areas more cosy. Parks, gardens, green walkways and waterfronts are important places for outdoor recreation and a focal point for local community life as well. Green spaces inside cities are the guarantors of health and the indicators of well-being. Quality urban green spaces promote the local economy and tourism, increase property values and investment. Preserving and enhancing urban green spaces are in our common interest for all these reasons (see Figure 2: Benefits of urban green spaces).

Figure 2. Benefits of urban green spaces

The role of green spaces in mitigating the urban climate impacts

Through metabolic and energy exchange processes, plants have a positive effect on the physical condition of urban air, and thus, directly and indirectly, have a positive effect on human physiological processes and well-being. Through its interactions with the environment, vegetation has the potential to attenuate the extremes of urban climates. This conditioning effect of green spaces depends to a large extent on the proportion of paved, built-up and green urban areas, the quantity and quality of vegetation, its spatial arrangement, and composition of species. Amongst the positive environmental effects, the most notable are the effects of green spaces in modifying the local climate and reducing air pollution, noise and vibration.

Vegetation has a direct impact on the characteristics of radiation. The canopy of trees absorbs and uses solar energy; some of it is used to produce biomass, while most of it is released into the atmosphere by evaporation to cool urban air. The canopy shades the ground, so that direct radiation does not heat up the surface or the air near the ground during the day. Since the canopy reduces the radiation from the ground surface at night as well, the temperatures of the surface and the air above the surface are more evenly balanced. The grass surface heats up easier during the day. Since nothing impedes surface radiation at night, the grass cools down faster, therefore, dew and ice formation is more frequent. Uncovered, grassy areas contribute to cooling the air to a greater extent compared to wooded areas because, although they heat up more during the day, they cool down faster at night, producing cold air in the city.

Urban gardens and parks tend to have higher temperatures in the winter and lower temperatures in the summer compared to the surrounding streets and squares without any trees. This small difference in temperature is sufficient to create local air currents that contribute to the air exchange in and regeneration of built-up areas.

The temperature-reducing effect is proportional to the size and compact shape of the green surface. By increasing the proportion of areas covered by vegetation, the cooling effect increases and remains significant up to 100 hectares. However, in the case of larger green spaces, the increase of this cooling effect is only marginal. The extent of the cooling effect depends on the weather conditions. In cloudy weather, the difference is not significant, but in sunny weather, when shade is at its most beneficial for comfort, the difference in temperature is significant, and the air can be as much as 4-5°C cooler. The cold air formed above green spaces flows toward the urban areas with warm air (e.g., the city centre). This is how it can reduce the urban heat island effects.

Vegetation influences the humidity of the surrounding air as well. Rainwater is absorbed by vegetation over extensive areas of canopy; some of it is evaporated and returned to the air, increasing the humidity of the surrounding area. Plants can have a noticeable effect on air humidity within a distance of 10-12 times their height. The relative humidity favourable for humans is 60-80%, which provides adequate human comfort.

The difference in temperature amongst urban areas of different surface covers means that warm air above paved, built-up areas ascends and is replaced by cooler air coming from the direction of green spaces. This air

movement is clearly due to the presence of vegetation. It is therefore of utmost importance that the urban fabric is structured with parks and gardens of sufficient size. This air movement is not present only inside the city, but also between the peripheries and the city. It is therefore paramount to maintain peri-urban forests, meadows, cold and fresh air-producing areas, and urban ventilation tunnels. Vegetation can also provide a simple physical barrier to flowing air and can act as a shield against unpleasantly strong winds.

Popular urban public park (Elisabeth Square, Budapest)

THE IMPORTANCE OF GRASSLAND

The natural vegetation cover of a green area is determined by environmental factors (bedrock, soil, hydrology, climatic conditions, terrain, human activities). The vegetation we see is the result of a long process of growth and development. Any empty, exposed area will first be colonised by lichens and mosses, which have the most modest environmental needs, and later, using their organic matter, the more demanding herbaceous plants will establish. On the thickening topsoil being produced, shrubs and trees can now also take root. This kind of change in vegetation is called succession. The most developed and stable plant communities in a given area are called climax communities, which make the best use of the conditions of the available space. In Hungary, arid areas with harsher habitat conditions have steppe or rocky grassland as climax.

In the mid-19th century, approximately 30% of Hungary was grassland. This is not to suggest that unfavourable soil conditions prevailed over a large part of the country, as the principle of succession would imply, but that grasslands and human use have been intertwined from the very beginning. In fact, most grassland in Hungary served for food production in response to social needs. They were used as pastures for livestock producing meat and milk, as hay fields to provide fodder for livestock, and for the cultivation of medicinal herbs. Human intervention in the succession process meant that the grasslands were not replaced by scrubs or woodlands. The accumulated nutrients were consumed by the animals, and mowing and grazing only allowed the regeneration of the grasslands.

Rocky grassland imitating nature (Budaörs)

The species-rich habitats of meadows and pastures today are also home to a number of protected plant species. Grasslands have become a key element of climate change mitigation, with their ability to sequester carbon dioxide and maintain biodiversity. Unfortunately, the grassland area in Hungary has decreased by half in the past one and a half century, due to urbanisation, greenfield developments and changes in agricultural economy.

Lawn or wildflower meadow?

Grasslands are important as much for nature conservation as for economic and recreational reasons, especially in today's climatic conditions. Semi-natural grassland habitats also play an increasingly important role in man-made artificial urban environments to stop the decline in grassland areas. The rich biological and ecological diversity of grassland areas, even if substantially different from those present in natural environments, is also an asset in the city. Gardens, parks, promenades, urban waterfronts, roadsides, ditches are all valuable grassland habitats that, in addition to their recreational role, have also become essential for nature conservation and climate adaptation.

Created and maintained by man, urban lawn and grassland areas are versatile green spaces. They are places for picnics, dog walking and outdoor sports. Homogeneous lawns consisting purely of grass species, however, are sensitive areas that require a lot of care. In Hungary, an intensely used lawn consisting of a mixture of 3 monocots can only survive with regular mowing,

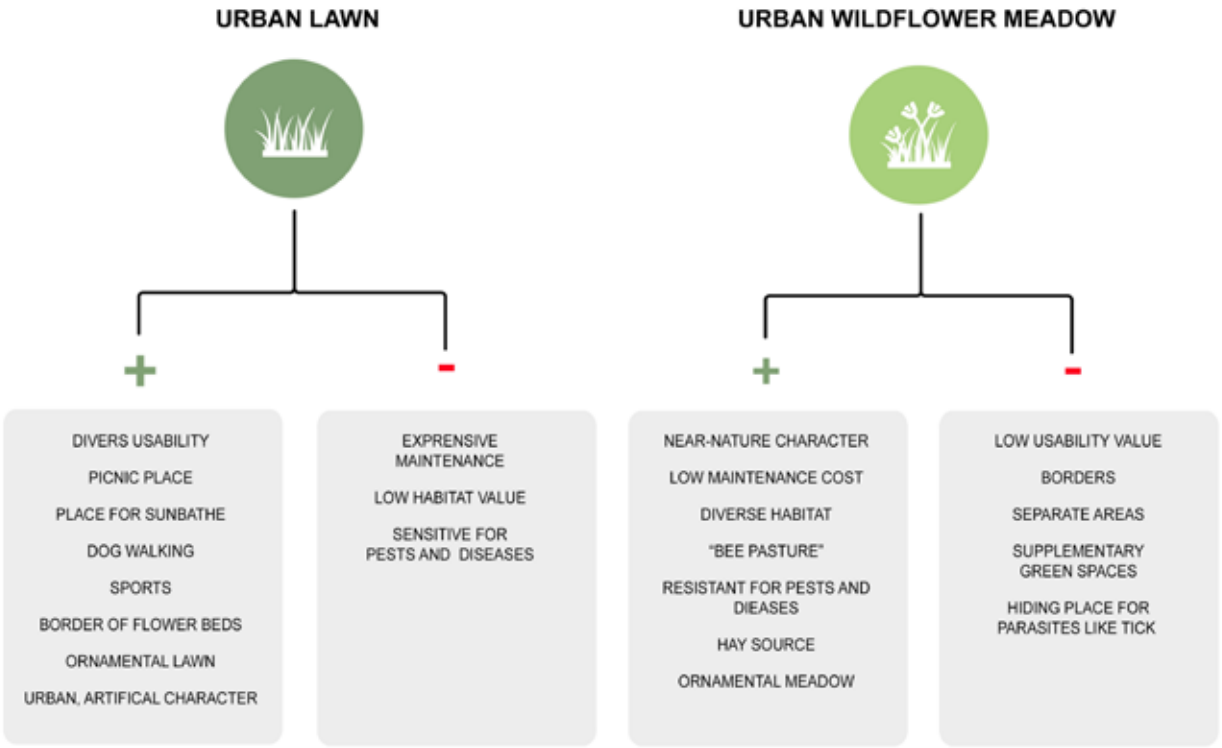

Figure 3. Lawn or wildflower meadow?

irrigation, nutrient replenishment, plant protection and soil care. As a habitat, the lawn is not particularly diverse. It is susceptible to diseases, and it requires considerable resources to keep it in good condition and to care for it regularly. Constant care and intensive maintenance processes lend an artificial, urban character to urban lawns.

A semi-natural urban grassland is more resilient to external disturbances and provides habitat and food for a greater number of animals, simply because of the combination of several plant and animal species. It can be an excellent bee pasture or even a source of hay. Urban wildflower meadows have a natural character, bringing nature close to the people in the city. They require much less maintenance than a lawn, but demand a different kind of expertise. As the stubble is taller, the usability of the urban meadow is limited. Tall grass can be suitable for traffic islands, edges, steep slopes, or underutilised green spaces. Because of its natural appearance, it often looks untidy and unmanaged to the untrained eye (see Figure 3).

All kinds of grassland can be appropriate in urban green spaces. Choosing the type of grassland to be created will depend on the site conditions and the function of the green space. Even within a single garden or park, several zones may be established with various characters and management practices.

Establishing semi-natural grasslands

In order to apply maintenance practices suitable to establish semi-natural grasslands, it is essential to use an appropriate composition of species. Experience in Bu-

Naturally established dicotyledonous flowering plants

dapest suggests that urban grasslands are fairly rich in species. One way of achieving the desired diversity is to gradually convert existing communities or to create an entirely new semi-natural grassland.

Before the establishment of semi-natural grasslands, it is necessary to select a so-called *donor area* nearby, from which seeds of native plants, which are characteristic of the landscape and the specific habitat, can be collected. When selecting the source of natural grassland vegetation, it is of utmost importance that the donor area is in the same locality, close to the settlement, as this will allow the species to adapt to the same habitat and weather conditions, and their establishment is expected to be more successful. This practice of site selection is so widespread internationally that in several Western European countries so-called „ecoregions" have been defined on the basis of climatic, topographic and soil factors, indicating the ideal donor areas within the region. The selection of donor areas requires expertise and care, taking into account the possible success of the natural grassland to be recreated in the urban environment. Natural characteristics are transformed by urban development and life, so the expected ability of the grassland species to withstand these conditions needs to be an important criterion.

Mowing and collection of cuttings

In donor sites, various so-called seed collection methods can be used. When choosing the method, it is important to take into account the size of the area to be sown, the available funds and machinery. It is essential to estimate in advance the quantity and species composition of viable seeds that can be harvested, the distance for their transportation, and whether it is necessary to store the collected material before sowing. These all influence the choice of method. In all cases, it must be ensured that the seeds are collected in a way that does not damage the regenerative capacity of the donor site. Common and cost-effective planting methods are the hay *spreading solutions*.

Working with fresh, seed-rich plant material is best done when it can be immediately spread on the area of the future grassland. This method is intensive in terms of transport, as the seed content of the cuttings is only 0.2-2%. However, the remaining plant material provides a convenient medium for seed germination as mulch. It is essential to start the harvest at an early stage of seed maturation to reduce the rate of seed loss. The process of the lawn establishment runs as follows: first the plant material is collected and transported, afterwards the

Spreading seed-rich cuttings in Veszprém

soil at the receptor area is prepared, the cuttings are spread, and, finally, the follow-up tasks are completed.

In the case of harvesting hay, the collected material can be stored before grassland establishment. In terms of seed volume, this is less economical than spreading fresh plant material, as the quantity of seeds that can be sown is 30-50% less. However, it has the advantage of allowing the seeds to be sown at a more suitable time for germination. The seed content of standard forage hay is relatively low, therefore bales of hay mown at the end of June are the most appropriate for the process.

Additional options to collect „net" seed material at a higher cost and labour are as follows:

- *Threshing fresh plant material:* a mechanised method for efficiently separating mature seeds from other parts of the plant. This is a relatively cheap

solution compared to other mechanised methods, however, combine harvesters used to perform the task may damage the natural grassland.

- *Seed harvesting*: it is done with a special harvesting machine that separates the seed from the rest of the plant without damaging it. This makes it possible to collect seeds of different species from the same area in several stages.
- *Cultivating missing species*: after manual collection, plants are grown on farmland with the aim of seed collection. Manual seed collection is time-consuming and requires special knowledge, but it is efficient. In Germany, 2,000 ha of grassland is created annually with this method.
- *Vacuum harvesting*: powerful air stream generated by a motorised turbine is used to collect the seeds from the plants. There are manual and tractor-mounted turbine versions. This solution is most recommended for species with small seeds.
- *Raking*: a method to be used on low grasslands. It often serves to collect both seeds and parts of plants that can be propagated vegetatively. It is usually employed in cases where it would be difficult to harvest seeds by other means.

In the case of partial success, or if there are only a few species missing for the stability of the established grassland, these can be added by *overseeding*. This involves spreading a selected seed mixture across the existing grassland. Before seeding, the soil must be properly prepared. In preparation, the area must be raked and the felt layer removed. The seeds should land on a bare soil surface to ensure germination. Perennial species that are missing from the grassland can be replaced not only by overseeding, but also by planting them in a grid or randomly, which process is called initiation. In the best case, the plants used for planting also come from semi-natural habitats. In urban environments, however, the plants used are often obtained from horticultural production. Planting can be done by planting individuals or below-ground parts, or even by „turf transplantation" from the donor site. A few Hungarian and many international examples show that pieces of turf from natural grasslands can be transferred to green roofs or urban public spaces, and survive in their new urban habitats.

Wildflower meadows for intensive maintenance

Commercially available „wildflower meadow mixtures" are usually seed mixtures for intensive maintenance produced by conventional horticultural methods. They are composed of dicotyledonous and monocotyledonous flowering plants. Long flowering period and high ornamental value are essential. They often contain seeds

Intensive sown flowering lawn, Porici (with standard seed mix product)

Intensive flowering lawn

imported from abroad, so even if they have the proper plant composition (species composition), from an ecological point of view they are not acceptable. The genetic stock of foreign seeds is different from that of domestic species, which in the long run may lead to a „dilution" of the genetic stock of domestic species. These grasslands are often established as flowerbeds, as most of them require intensive care. From an ecological point of view, this solution is favourable to traditional low-mown artificial lawns containing only monocots. Although it is not a semi-natural grassland, it is a good bee pasture due to the abundance of dicotyledonous flowers. It gives a natural character to the garden. Recommended for areas of intensive maintenance.

Semi-natural wildflower meadows

Genuine semi-natural wildflower meadows are always created using a mixture of seeds from the flora of the surrounding landscape, obtained by seed collection or seed production. Their species composition is fairly diverse, with species occurring naturally in the same habitat blended together. They provide habitat and food source for insect, bird and small rodent species native to natural grassland communities. Maintained extensively, they require only the most necessary interventions: removal of invasive plants and prevention of scrub growth. Due to being semi-natural and tailored to the site conditions, they do not require irrigation or nutrient replenishment. They have a lower ornamental value and a shorter flowering period, with several cycles. They have a natural character and are recommended for extensive management. Such seed mixtures are not yet commer-

cially available in large quantities in Hungary. However, locally produced small quantities are already available in several cities. Similar seed mixtures are mainly used by the National Park Authorities for the restoration of semi-natural grasslands.

Management of semi-natural grasslands

Semi-natural grasslands require skillful maintenance, not only to preserve and enhance their amenity value, but also to increase their diversity. The practice of conservation mowing employed in agriculture can also be applied in the city. One cornerstone of the method is that by reducing the frequency of mowing, space is provided for dicotyledonous flowering perennials that are hidden among monocotyledonous grasses, thus allowing them to produce seed and reproduce in the grassland community. Another important aspect of this technique is to adjust the timing of the mowing to control the spread of the preferred plants and discourage the undesirable ones. The third important element of the method is the use of different and spatially varied stubble heights. Even in a single park, there may be areas of grass with different heights, the location of which may vary from season to season or from year to year within the park. The varying, but generally taller than average, height of the stubble not only aids seed maturation but also provides shelter for animals. Areas managed with conservation mowing provide many benefits to the city. Thanks to enhanced diversity, the number of pathogens and pests is reduced, requiring less use of chemicals and pesticides.

Natural dry grassland along Road 8

Meadow in Bakony Hills

Extensive wildflower meadow with sage

The actual technology to be used in semi-natural grassland areas with less frequent mowing, may be influenced not only by urban needs but also conservation management practices. For example, the habits of any animals living in the grassland, the flowering and seed maturation times depending on the species composition, and, if the plant material is to be used (e.g. for forage), the desired quality of the hay may also be crucial. In addition to being a management method, mowing can also be used to „adjust" the species composition of the habitat. The more species-rich patches of existing grasslands can serve as donor patches, as well as the spread of species that are present in small numbers in the grassland can be encouraged by so-called selective mowing. Selective mowing is also a way to control unwanted invasive species.

There are a number of factors that influence the timing of mowing. For example, mowing too late will result in late regrowth of dead grass, which can lead to a dry soil surface, and premature mowing can result in the poor development of valuable plants. Therefore, the time and frequency of mowing should always be matched to the needs of the vegetation and the area's use. Since grasslands have always been an economic asset, the plant material of tall grasslands can be used, in urban areas after composting, for nutrient replenishment, but also as animal fodder if cut appropriately. The mowing calendar may vary from year to year, always adapting to the actual weather conditions and patterns of growth and seed maturation. When choosing the time of mowing, a specialist should be consulted. Due to weather conditions, the actual dates of mowing may differ significantly from the previously scheduled ones.

Since leaving the grassland tall supports semi-natural habitat dynamics, the number of plant species in the grassland will increase, leading to an increase in the number of insects using the grassland as a shelter and food source, and consequently, to a growing number of birds consuming them. In harsh urban environments, only robust, adaptable and often invasive animal species survive, but by creating diverse semi-natural habitats and maintaining them in a way that respects nature, we can also provide opportunities for native species to establish. This process takes a long time, therefore it is necessary to monitor the species richness of both flora and fauna by means of ongoing habitat surveys, so that the management of the areas can be adapted to their needs. Habitat preservation is a key consideration in conservation grassland management, so it is important to maintain a suitable area for birds that may nest in the grass, known as a leftover strip, to provide safe hiding place during the management period.

Insects

The most significant fauna of urban grasslands is that of insects. The role of pollinators, i.e. pollinating insects, is of particular importance for wildlife. Pollination is partly carried out by inanimate elements, such as wind or water, but the activity of pollinating insects is the primary factor in the survival of flowering plants.

In a study in England, the effect of moderate mowing during the flowering season of wildflowers was investigated. As part of the study, a new management regime was introduced in 2012, with half of the park's grassland mowed only once, in the autumn. In spring 2013, 4 blocks were defined in the park, which were further divided into 30 x 5 m strips. The strips were managed according to various mowing regimes:

- mown every 2 weeks, from spring to late summer,
- regularly mown until 2 June,
- regularly mown until 5 July
- mown once, in the autumn

The number of wildflowers and insects visiting the flowers increased significantly due to moderate mowing. In the abandoned strips mown once a year, their numbers multiplied approximately by 3 to 5 compared to the other management methods. The method also increased the number of insect species present. Among the most important pollinators are bees, which, besides their many benefits, are also indicator species: their presence is a sign of good environmental conditions.

In the UK survey, the number of the following pollinators (mainly butterfly and bee species), also native to Hungary, increased:

- bumblebees – Bombus spp.
- ringlet - Aphantopus hyperantus
- meadow brown butterfly - Maniola jurtina
- gatekeeper - Pyronia tithonus
- large white butterfly - Pieris brassicae
- small white butterfly - Pieris rapae
- common blue butterfly - Polyommatus icarus
- small skipper - Thymelicus sylvestris
- silver Y moth - Autographa gamma
- Zygaena moths - Zygaena spp.

Insects in wildflower meadow

Wildflower meadow after flowering

Ticks in urban grasslands

Many urban residents, especially dog owners, are concerned about ticks in tall grass. A study of the Białowieża Forest in north-eastern Poland and the central urban parks of the capital, Warsaw, compared the prevalence of tick populations. The research was conducted between 2012 and 2015. The results showed an average density of 9-11 specimen/100 m^2 in urban areas and 15-18 specimen/100 m^2 in forest areas. In both study areas, tick numbers peaked in spring and early summer.

However, a surprising result has been reported about the populations and the bacteria they carry that are potentially transmissible to humans. The bacterial strain *Borreliella*, which also causes Lyme disease, was found in nearly equal proportions in tick populations in natural woodland areas and in urban areas. Despite the higher number of specimens observed in the forest population, they carried only 1.5% more bacteria. This suggests that urban green areas managed extensively have a slightly higher risk of infection in case of tick bites compared to intensively mown areas. The number of ticks that colonise low mown urban lawns is almost the same as that of those expected in urban meadows with wildflowers left tall.

Where to use them?

Careful selection of the location of wildflower meadows within urban green spaces is a key issue. Areas of urban green spaces often provide opportunities for sports, sunbathing and relaxation, which require lawns that are kept short. However, those parts of the green spaces that are out of use, or that are particularly challenging to maintain (e.g. a steep slope), offer an excellent location for a species-rich wildflower meadow. Their placement may not only be based on functional aspects, but may also enhance the park's diversity, for example through a network of paths cut into the tall grass, a labyrinth system.

Monitoring

Monitoring refers to the regular observation of the condition and changes in the grassland. The periodic monitoring of the development of the grassland will ensure that it always receives the appropriate treatment. The end result of the task is not only an understanding of how the urban habitat is changing, but also the selection of the best management method to promote the success of the grassland. Knowing the basic site conditions, the monitoring will include soil cover, weed abundance, the proportion of monocotyledons and dicotyledons, pollinators present, public satisfaction, environmental education, etc. Monitoring is a specialist task, but some of its processes (e.g. butterfly counts) are excellent for involving the public.

Source: http://eletigenlok.hu/a-kutyakra-is-veszelyes-a-kullancs/

Grassy walkway in a historic park in England

Other management methods – sheep in the city?

Urban grasslands can also be maintained with livestock grazing. Maintaining and enhancing biodiversity is of paramount importance in this management method, and therefore an area can be grazed with the suitable number of animals based on a properly calculated so-called „grass yield". Keeping grazing at an optimal level is important, as overgrazing may cause the grass to die back, and undergrazing may lead to scrub encroachment to the detriment of the grassland. In Western Europe, urban grazing has become a common practice in many places, especially in the historic gardens of England, where grazing is seen as a tradition and a cultural and historical asset. In the case of grazed urban grasslands, it is important that grazing itself does not interfere with the use and original function of the urban green space and does not raise public health concerns.

Community involvement, environmental education

Alternative urban grassland management methods are most effective when they go hand in hand with local community involvement. Any such change will require the public to be properly informed. A major task is to communicate the new methods and their benefits through community dialogue. At first, residents perceive grasslands managed in a nature-friendly way as weedy green areas, but as they learn about the programme, they increasingly view them as a slice of nature in the city. The conscious shift in management is most often indicated to visitors by the retention of a conventionally maintained „safety strip" along park paths. This is to signal that the intervention is a conscious activity, and the site is under management. The established semi-natural areas serve as particularly important sites of environmental education for children living in urban neighbourhoods. Equipped with information boards and educational programmes, they can be excellent venues for outdoor environmental education lessons.

Hay from urban grassland as fodder

Thematic outdoor programmes to promote urban wildflower meadows

Urban beekeeping

Urban beekeeping is when honey is produced by colonies of bees „foraged" in an urban environment. Surprisingly, international experience shows that in cities bees are healthier and more productive. This is due to new trends in urban green space management and the practice of monoculture farming. In the 21st century, cities are increasingly bringing larger areas under semi-natural management, taking care of urban biodiversity. As a result, bees in the city are exposed to fewer pesticides and more flowers to be pollinated than in the vicinity of large-scale industrial farmland in peri-urban areas, and can develop a stronger immune system while enjoying a more varied diet. They also have more opportunities for safe hibernation in winter, with nearly one and a half times more bees surviving the winter in cities than in the countryside.

The provision of urban habitats and urban beekeeping is of paramount importance because of what is known as the „depopulation syndrome" of bees, the sudden disap-

Information board about urban beekeeping next to Genk Town Hall

pearance of large numbers of worker bees from a colony. The causes are not precisely known, but it is most likely related to the presence of pesticides or mite species. This mass mortality is affecting bee populations all over the world in various ways. It was first observed in the United States in 2006, where it affected around 80% of bee colonies. Later, in 2007, the phenomenon was also recorded in Europe. The large-scale death of bees also has a huge impact on food supply, so it is not only an ecological but also an economic interest to provide suitable habitat for as many bee colonies as possible.

Urban beekeeping is also emerging in cities such as Los Angeles, New York, London and Paris. In cities where this is not yet common practice, residents are often prejudiced against urban bees. However, this form of beekeeping does not pose a threat to city dwellers. According to experts, bees are least likely to sting during the swarming stage, when they are easier to handle than during other stages of honey production. In most big cities, the activity is promoted through programmes, publications and education by beekeeping organisations such as the New York City Beekeepers Association, the Bee Friendly Notthingham, the Genk Municipal Beekeeping Programme and an international organisation „Bees Without Borders". Since beekeeping is relatively cost-effective and requires limited labour, this activity is also being promoted in many developing countries as a means of alleviating poverty, including the Dominican Republic and Southern Cameroons. In Hungary, there is a growing interest among beekeepers to develop urban bee pastures, but no local municipality has yet committed to urban beekeeping at the programme level.

Urban bee hives at the Genk Town Hall

GOOD PRACTICES

Basel, Switzerland
(www.urbanhabitats.org, www.basel.com)

The Swiss City of Basel has a long history. As early as around 120 BC, a Celtic settlement stood on the banks of the Rhine. Its current population is 19,000, while considering the agglomeration as well, it is close to one million. Its lowest point is 244.75 m above sea level. The whole conurbation covers 37 km^2, 14.3% of which is made up of green spaces: public parks, cemeteries and forests. In Basel, green roofs have been a mandatory feature of all new flat-roofed buildings since 2001. In the case of roofs over 500 m^2, it is required to use planting media composed of natural soils from the surrounding region. The first green roofs were built in 1914, primarily in order to provide thermal insulation. Today they provide habitat for 175 plant species throughout the city, including 9 orchid species. The roof gardens are covered with extensively maintained native grassland communities. The city has also set a mowing season: no mowing is allowed on public spaces before mid-June in order to preserve flowering grasslands.

Thalie Park, Châlons-sur-Saône, France
(www.landezine.com)

Châlons-sur-Saône is located on the river Saône in Eastern France. It has a surface area of 15.2 km^2 and a population of 45,000. Once a busy port town, it is now a centre of industrial production (metallurgy, engineering, plastics and nuclear industry). Its altitude is 172 m above sea level. Thalie Park, adjacent to the town, is a public park bordered by railway lines and abandoned land, which was once a landfill site. Restored and declared a park, the area acts as a link between the hospital and medical complex and the gateway public spaces of the neighbouring municipality of Châlons-sur-Saône. During its planning, care was taken to ensure that, in

addition to the role of green space provided for the medical center, it also promotes the enhancement of local biodiversity, as well as ensures ecological continuity between the Thalie Valley and the newly created green spaces.

Elephant Park, London, United Kingdom
(www.landezine.com)

London covers an area of 1600 km^2. Its total population consists of 8,962,000 inhabitants. The city centre is flanked by the Thames, with Elephant Park just 1.5 km away. The park called 'The Meadow' was created in 2018, which, together with the neighbouring Elephant Park, is a green space integrated into the large-scale reconstruction of the neighbourhood. The park features wildflower borders that provide a wide range of habitats for pollinating insects. The plant selection consists of species rich in pollen, which bloom for a long time. The project's unconcealed aim is to mitigate the rapid decline of pollinator species, which has been going on since the 1950s and has even accelerated due to urbanisation.

Kastrup Park, Copenhagen, Denmark
(www.landezine.com)

Copenhagen is the capital of Denmark, with a population of 2,000,000. Its lowest altitude is only 1 m above sea level and it covers an area of 1768 km^2. The public park in the Kastrup district was opened in 2015 on a former landfill site. Given the size of the site and the many existing features, the designers wanted to achieve the greatest impact for the least investment. In order to minimise maintenance costs, the hillsides and slopes were sown with a high-growing, native meadow seed mix.

Shanghai is located in East China, at the mouth of the Yangtze River on the Pacific Ocean. It covers an area of 6340 km2, and has a population of 24,281,000. It is a global economic, innovation and commercial centre. Waterfront Park aims to reflect on its industrial, warehousing and logistical past by reconnecting with nature. Currently home to the Modern Art Museum Shanghai, the building was once used for coal storage, while the current open spaces along the waterfront were used for industry and logistics. The project has created rich, diverse habitats. Appropriate plant selection adapted

MOMA Waterfront Park, Shanghai, China
(www.landezine.com)

to the habitats and water retention played a key role in this. The mainstay of the diversity is the mixed selection of grass species left tall. The park was opened in 2017.

Park Groot Schijn, Antwerp, Belgium
(www.landezine.com)

Antwerp is a large city of 523,000 inhabitants covering 205 km^2 in Northern Belgium. It is situated on the Scheldt River and it is a port city. The lowest altitude is 16 m above sea level. Antwerp's Park Groot Schijn is a large, multifunctional urban park with sports areas, playgrounds and a cemetery. It is flanked by a suburban meandering stream. Along the stream, there is a natural stand of trees, the preservation of which was an explicit objective. The grasslands have been established using native, diverse species. The areas are rarely mown and no maintenance work is carried out in the few-metres-wide strip along the stream. Irrigation is carried out with a small amount of water extracted from the stream that flows through the area.

Urban Apiculture Programme, Genk, Belgium
(https://oppla.eu/)

Genk is a city in Northeast Belgium, situated between Antwerp and Liege, on the banks of the Albert Canal. It is one of the most important industrial cities in Flanders. It has a population of 66,110 and covers an area of 88 km^2. Following the closure and liquidation of the Ford car plant, a multi-year action plan was developed for the reclamation of the industrial site. The focus of the plan was on exploiting Genk's natural and human resources in a way that would create sustainable

value. Nature-based solutions were an integral part of the plan, which also helped to create blue and green infrastructure links and to involve the local community.

In the framework of the Bee Plan project, the municipality has set 3 objectives:

- Improving ecological conditions for urban pollinating insects, with a focus on food and habitat
- Involving the public: creating flower meadows in private gardens, installing bee hotels
- Supporting beekeepers and strengthening their cooperation

Beside the Bee Plan, changes have been made in creating and maintaining unique urban green spaces. In the Genk City Park, green space is maintained through grazing and selective mowing. Taller grass is left on the edges and around larger trees, leaving adequate shelter for animals. Sedges have been left on the banks of the natural watercourse running through the park, with banks cleared only in the intensely used parts of the park. This created a suitable wetland in the city. The park is alive with frogs croaking and birds chirping.

In the urbanised village centre of a small village of 475 inhabitants in Eastern Bohemia, hand mowing and selective mowing have been reintroduced to maintain public green spaces, based on the traditions of the village. A wildflower meadow strip, typical of the local semi-natural habitats, has been established along the edge of the park in the village centre. When realising new development, a wildflower meadow seed mix, produced from native seeds typical of the region, is used to create roadside green spaces. The tradition of community mowing has been revived, not only to maintain green spaces, but also to strengthen the community and

Pořiči u Litomysle, Czechia

to maintain health. Their work has been recognised by the *Entente Florale Europe* landscape architecture competition with a Gold Medal.

Bad Saulgau, Germany
(http://www.entente-florale.eu)

Bad Saulgau is a municipality in the state of Baden-Württemberg in Southern Germany. It has a population of 17,500 and covers an area of 97 km^2. Both the

population and the city administration have a strong green attitude. Several exemplary initiatives have been launched to create a sustainable urban environment. Across the city, underused grasslands in most parks have been replaced by perennial, extensively maintained wildflower meadows. Depending on the soil conditions of the areas, different wildflower seed mixtures were used, containing seeds of at least 30 species. The majority of the traffic islands were also sown, increasing their ecological value. To support this, the city has phased out the use of fertilisers and has also minimised the use of natural manure. To encourage home-growing, a total of 20 planters have been installed throughout the city to grow kitchen herbs, small vegetables and fruit plants. However, the 'Edible City' initiative is not only popular with residents, but is also attractive to insects, including bees. The city council has launched an adoption programme for a total of 50 flower beds in residential areas. The flower beds will be looked after by the adopter, who will be responsible for watering, pruning, planting new plants and collecting waste. The flower beds all contain ecologically important perennials, flowering shrubs and tree seedlings. In return for the adoption, small rewards are given, such as free tickets to events organised by the municipality. In 2018, the Municipality of Bad Saulgau has published a free gardening guide for garden owners on how to create a natural, semi-natural garden. The publication is in demand nationwide. The city has received the Award European Capital of Nature and Biodiversity and the Gold Medal of the *Entente Florale Europe* for its efforts.

Wildflower meadow developed through management

VESZPRÉM WILDFLOWER MEADOWS

From 2015 on, a new way of thinking and a different approach has characterised the maintenance of the green spaces in Veszprém. With a population of nearly 60,000, the seat of the Transdanubian county has a high green space coverage, which is a major challenge for local actors in green space management. The classical green space maintenance, with low mowing every 21 days, the increasing load by urban climate and the challenges of climate change have prompted a reform of the grassland management. Sustainable grassland management was launched by introducing alternative technologies in response to the challenges of the 21st century, as part of a joint programme of Szent István University and Veszprémi Közüzemi Szolgáltató (Veszprém Public Utility, hereinafter VKSZ) cPlc. The research and education cooperation aims to rethink urban grassland management practices, develop ecological and diverse practices and recycle resources. If we have to deal less with grasslands, the savings will allow us to increase the budget for the examination and care of mature trees, for example, which will bring much greater benefits in the long run. Pre-surveyed, carefully selected green spaces with different characteristics were chosen for the experiment. Firstly, the original practice of grassland maintenance was reviewed, later the study areas were selected, habitats were surveyed and, in some cases, maintenance techniques were changed on an experimental basis.

Preparatory phase – data collection, creating a vision

In the first phase of the programme, a study entitled *'Changing the character of public gardens – by changing the green space maintenance technology'* was compiled, in which lecturers and students of the BSc Programme in Landscape and Garden Engineering and the MA Programme in Landscape Architecture and Garden Art summarised the effects of the new grassland management and developed proposals for changing the image of urban green spaces in Veszprém. The vision was inspired by the varied appearance of grasslands resulting from the change in maintenance technology. In the study, a number of good practical examples and domestic natural models were collected, and in the design workshops, students created maintenance plans incorporating park use and image factors, and formulated educational proposals to promote the project. Let the dreams come!

1. Séd Valley, Betekints Valley – a public park

We have been working on reimagining the part of the lush, streamside public park which is located further from the city. In the 13,000 m^2 park area a lush, undulating, streamside strip of flowering and sedgy grassland was designed that follows the lines of the stream and the curved walkways playfully, sometimes intertwining with them. The undulating, tall grassland strips and patches and the tall border create varied garden spaces. The sunny and shady flower meadow and the streamside tall-herb vegetation strips surround intense-

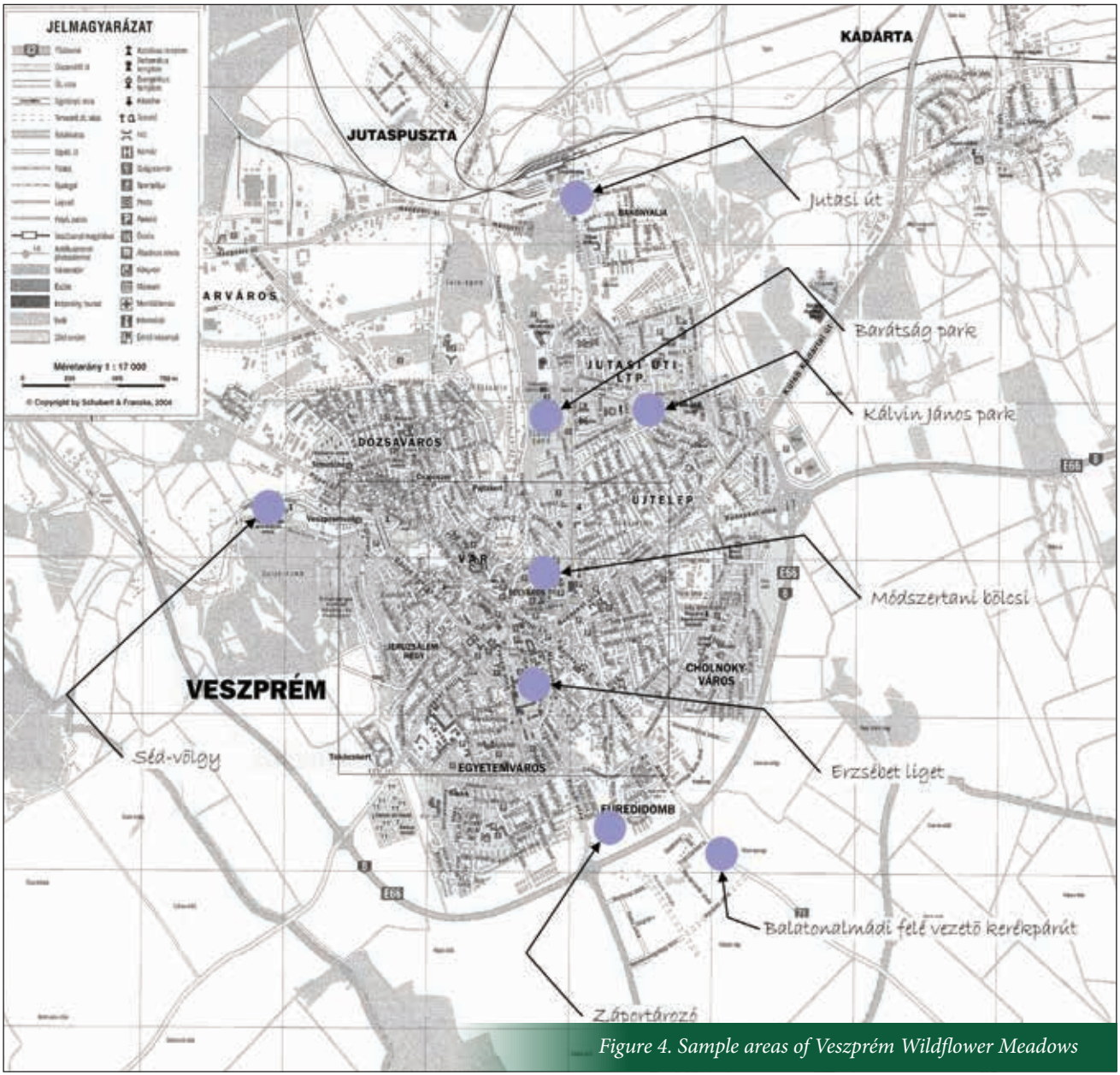

Figure 4. Sample areas of Veszprém Wildflower Meadows

ly maintained lawn, creating recreational and picnic 'islands'. Hay bales are an important part of the park, usable as seating and outdoor 'building blocks'.

2. Barátság Park – green space in a housing estate

A complete development proposal has been formulated for the large area with low intensity of use and few functions. The backbone of the layout, reminiscent of a tortoise shell, is made up of the walkway network to be developed. The function of the fragmented park cells linked by the walkways depends on the intensity of maintenance. The zones, characterised by grasslands of different heights, create varied edge effects and park spaces. Installation of custom-designed benches and information panels and creation of four distinct maintenance zones were proposed around the envisioned straw bale maze, concrete fire place and lookout point.

3. Erzsébet Promenade, Calvary Hill – urban public park and heritage site

The narrow, sometimes steep-edged green axis adjacent to the city centre is of diverse nature. A concept plan has been developed for the area which illustrates different urban grassland maintenance strategies, thus helping with the functioning of areas of varied character. In addition to informing adults, we also had the younger generation in mind: we proposed to turn the park into a constantly visited recreational destination, by installing colourful interactive panels with versified stories as well as natural wooden playground elements imitating a grassland community in underused parts of the park. The Calvary Hill, which rises from the axis of the park, was transformed into a ruin site and lookout point by means of grassland and shrub management.

Grasslands in various urban green spaces

The field work

The practical implementation of the programme was mainly based on international, scientific results as well as on the experience gained in Budapest. The programme started with aiming to increase biodiversity and reduce maintenance costs in green spaces in the inner administrative area within 3-5 years, using the tools and technologies of semi-natural grassland management. The selection criteria for the sites were determined by pre-existing grassland management practices and grasslands of different urban character but typical of the area. All of the study areas ere classified as *uncharacteristic secondary grasslands* according to the habitat classification (Á-NÉR, General National Habitat Classification System). The following 7 study areas were selected in different parts of the city:

1. *Green strip along the Almádi Road cycle path*
   An underutilised grassland area located between a traffic area and a woodland strip, far from residential areas. Dry but species-rich grassland habitat. Mowing is difficult and time-consuming around the tree line. Using a string trimmer can cause damage to the trunks of trees.
2. *Reservoir area (Füredi Road)*
   An area close to a residential area with detached houses, used for walking dogs at most. Semi-dry grassland can be found on the slopes and mesic grassland at the bottom of the reservoir. Maintenance on the slopes is time-consuming.
3. *Erzsébet Grove (shady public park, slopes)*
   A grove close to the city centre, on the border of an institutional zone and a zone of detached family houses. The grassland is poor in species. The green spaces with a small outdoor gym is currently used for pedestrian crossing. Maintenance on the slopes is time consuming..
4. *Slope next to the methodological nursery (north-facing slope)*
   An unused grassland area located in the city centre, in an institutional area, separated from the children's play area. Semi-dry grassland with tall top-grasses. The steepness of the slope makes it very difficult to maintain.
5. *Kálvin János Park (reconstructed green space in a housing estate)*
   Situated in a housing estate, the park was renewed in 2014, and is characterised by active public use. It was nevertheless chosen because it is a good showcase for its large attendance. The area is covered with semi-arid and relatively species-rich grassland. It is an intensely maintained area.
6. *Barátság Park (green space to be reconstructed in a housing estate)*
   A public park between a housing estate and a forest park, with playground and outdoor gym, also used for dog walking. Species-poor, open grassland. Under the trees, there is a non-functional grassland area, whose maintenance is time-consuming.
7. *Séd Valley (Betekints Valley)*
   A 2.3-km-long streamside area, between an area of detached family houses and a forest park. The grassland is mesic and species-rich. It is an intensely used and maintained public park, opened in 2011. This area was selected for its extent, large attendance and very distinct characteristics.

In each study area, one sample plot per area was designated to assess biodiversity, 2x2 m in size. These sample plots are called *quadrats*. The initial condition was the first mowing after the designation. This was carried out by VKSZ cPlc. only twice a year, in April and November, instead of the usual 6 times a year. Species composition and habitat change were assessed two to four times a year, and character change and usability of the green spaces were assessed twice a year.

The main trends in succession were observed in the research, based on the herb layer. During the field survey, we identified the plant species present in the quadrats (presence data). In order to evaluate the results, we assigned Raunkiaer's life forms, ecological indicator values (water demand) and Borhidi's social behaviour types (generalist, specialist, etc.) to the species.

Already in 2017, a total of 74 species were found in the quadrats, most of which, more than half, are dicotyledonous flowering perennials found in average domestic gardens. Most important genera (and species):

- yarrow – Achillea spp.
- daisy – Bellis perennis
- wormwood – Artemisia spp.
- shepherd's purse – Capsella bursa-pastoris
- mouse-ear – Cerastium spp.
- chicory – Cichorium intybus
- field bindweed – Convolvulus arvensis
- strawberry – Fragaria spp.
- St John's wort – Hypericum perforatum
- dead-nettle – Lamium spp.
- whitetop – Cardaria draba
- geranium – Geranium spp.
- plantain – Plantago spp.
- potentilla – Potentilla spp.
- buttercup – Ranunculus spp.
- sage – Salvia spp.
- white campion – Silene alba
- dandelion – Taraxacum officinale
- clover – Trifolium spp.
- speedwell – Veronica spp.
- vetch – Vicia spp.

Between 2016 and 2019, a total of 91 species were found in the sampling quadrats, with a total of 67 species in the initial year (2016, reference state) and 54 species in 2019, of which 9 were new. Our hypothesis is that the extensive grassland management will lead to a species rearrangement, whereby mowing twice a year (= repelling competitive grasses) will lead to a more coordinated and slightly more species-rich grassland – this trend seems to be confirmed.

The rate of species replacement declined at almost all sample plots by year 4; the number of new species typically ranged between 4 and 10; the number of species lost from samples varied between 6 and 11. The change in species composition shows significant dynamics in successive years with decreasing intensity over the years.

In 2018, the expected trend of a steady increase in the proportion of perennial species and a decrease in the proportion of annual and biennial species over the years was already observed.

In each sample quadrat, the plant species indicate different habitats according to their water demand. The majority of the plants are characteristic of semi-arid, semi-mesic habitats (about 60% in total). This proportion does not change significantly over the years, i.e. the habitats are not drying.

In 2017, three of the seven study areas, and in 2020, one more were designated test sites: in these locations we abandoned the traditional, intensive urban green space maintenance and let nature run free. Moderately,

of course! We also changed the stubble height and the machines used for mowing.

Test Area 1: grassy strip along the road and the cycle path to Balatonalmádi (sunny, in the outer administrative area)

In 2016, we started a new type of treatment on 21,600 m^2. The area was divided into two parts. Along the cycle path on both sides, a safety lane was marked out in the width of a 'ride-on mower track', where mowing continued regularly, 6 times a year. Besides, as an additional attraction, a field running track was marked out in the grassland, which was also mowed 6 times a year. In the other areas, the grass was left tall and mowed only twice. An important criterion for the zoning was to have the tree line in the tall grassland in order to simplify the technology and avoid the use of a string trimmer, which is much more expensive and can cause damage to the trunks of the trees. The sample quadrat was fenced in and marked with an information board. We also placed information boards along the cycle path and at the crossroads with traffic lights, so that cyclists could get brief information on the project while waiting at the red light.

Selective mowing along the Balatonalmádi cycle path

Biodiversity was much higher in the 'wildflower', tall grassland: Salvia nemorosa (woodland sage) and the tall top-grasses gave the grassland a special character. The only problem was the mass emergence of Erigeron annuus (annual fleabane), which had to be controlled in the following years by appropriate management. In the following year, we also mowed in mid-summer in order to prevent the spread of the fleabane and to encourage the second flowering of the sage. The site is popular with cyclists and runners, and the change in character has not provoked any negative public response. The area was taken out of the municipality's management in 2018, so the experiment was ended at this site.

Test Area 2: János Kálvin Park (reconstructed green space in a housing estate)

The recent (2014) reconstruction of the park in the housing estate provided an opportunity to experiment with the transformation of the newly planted lawn. Due to the large area, the traditional mowing regime and the new technology in the 1100 m2 area could be observed side by side. Three currently underutilised grassland areas, away from intensive use, have been identified, the boundaries of which are defined by walkways. In April, the entire park was mowed once. From then on, we mowed only along the walkways in the designated areas, in the so-called 'safety lane', at the usual frequency, in the width of one ride-on mower track, and twice more in the inner parts, in mid-summer and in autumn. The continuous maintenance in the one-track-wide strip indicated that this was an intentional measure, while the use of the benches and walkways was not disturbed by the overgrowth of the vegetation. The areas with the new management technique have a nice character with

Designation of sample quadrat, Kálvin János Park, Veszprém

the top-grasses, which adds variety to this part of the park, and at the same time the tall grass does not impede the use of the park. Mass emergence of the annual fleabane was typical also here, which was removed by manual weeding. Subsequently, there were only few specimens in some places. The number of man-hours devoted to maintenance has decreased, with a 7% reduction compared to 2016.

In 2019, we have included nearly 5000 m^2 of wooded roadside verges of the neighbouring Haszkovó Housing Estate, with the aim of achieving higher savings and a more diverse character. By changing the frequency of mowing, the character of the grassland was changed: creating a curved wildflower strip on the wide green space, fitted to the local landmarks and trees, resulted in a more exciting, more dynamic residential green space, with the flowering urban meadow giving a completely new look. The species survey of the area revealed an unexpected diversity, with 49 native plant species. The flowering grassland was home to a wide range of pollinators, including bumblebees, bees and butterflies. In addition to examining diversity, it was also possible to observe community attitudes in the highly populated housing estate.

The green space in the Haszkovó Housing Estate was also used as a donor area, by transporting the mown grass to other green spaces we could help them to be transformed. In 2019 and 2020, we used the mown grass from the donor area to cover the test area in Kálvin Park, helping flowering plants to establish more effectively. The park with the new look is the venue of the annual Wildflower Picnic, which has been held since 2019, and we plan to set up a permanent environmental education point at this location. The aim of the information point will be to communicate the results of the project through a permanent and interactive environmental education board and to provide local schools and kindergartens the opportunity to teach children about urban biodiversity, green space maintenance and the relationships between them in an outside environmental education class.

Test Area 3: Barátság Park (shady green space to be reconstructed in a housing estate)

A planted forest park is located on the hillside of the Séd Valley, on one of the borders of the extensive green space adjacent to the Jutas Housing Estate. Less used parts of the park, owned and managed by the municipality, have a significant tree population. Within the contiguous grassland area, a section of 3,100 m^2 has been designated, the boundary of which is defined by walkways. During April, the entire park was mown once. No further mowing was carried out in and around the grove of trees within the designated area, and only the area around the benches and fitness equipment, i.e. the functional parts of the park, remained regularly maintained.

As the grass developed on a shallow soil and there are many shady trees, despite the different technology, there is no significant change in the character of the grassland. Its condition is moderately natural, with a character reminiscent of semi-natural rocky grasslands in some places. The quadrat has been repeatedly vandalised at this site. The man-hours devoted to maintenance have decreased, with a 5% reduction in expenditure compared to 2016..

Test Area 4: Cholnoky Street – green strip along a residential road

The green strip along the housing estate was designated as a test area in 2020. The sunny grassland strip along the road was mown in spring, mid-summer and autumn. Already in the first year, a number of flowering plants similar to those in other test areas appeared in the study area, dominated by sage. We will extend the study next year.

Wildflower strip in Cholnoky Street, Veszprém

Results

In general, the project is making good progress regarding all three of its objectives. In the areas studied, the new technology has clearly increased biodiversity and the number of dicotyledonous flowering plants. In some places, the proportion of undesirable invasive weeds has also increased, which is a natural phenomenon in the first few years of technological change. (As the technology continues, the number of these plants tends to decline.) The combination of tall and intensely managed grasslands creates a contrast in public spaces, which has changed their character: the herb layer of the areas has a much more varied appearance.

Reducing the frequency of mowing has already resulted in spectacular visual experience with the appearance of wildflower meadows in the first year, which will also serve as seed banks in the future. The tall and diverse flora increases the number of shelters, foraging insects and then birds. The new technology resulted in increasing biodiversity and reduced maintenance costs within 3-5 years, as expected. Man-hours dedicated to maintenance were already less in 2017, by 7% compared to 2016 in some study areas. In fact, there are study areas where the expenditure is only 38% of the original.

With the change in technology, the unit cost of grassland maintenance has been reduced in these areas. The savings were the biggest as for the management

of the green strip along the cycle path next to Almádi Road, where the new treatment saved 62% in the test year 2017 in the study area. Significant changes were mainly observed where the use of the string trimmer was significantly reduced (e.g. in the immediate vicinity of trees, it was recommended to keep the grass tall). For overseeding and initiation, searching for propagation material from the region and donor sites is still ongoing.

Awareness-raising, environmental education

From the very beginning of the project, we were sure that communication was a key issue, as we wanted to introduce and promote a method that would reduce the usual intensity of park maintenance.

Our basic communication strategy has been to let residents know in advance of any activity we are going to do, so that we do not have to deal with complaints about lack of mowing and 'unkempt' parks afterwards. On the website of VKSZ cPlc. and on the Facebook page 'Városom, Veszprém' (My Town, Veszprém), posts in plain language have been published since the beginning of the project, whenever something important happens or something new is introduced. Each spring or in the case of theft, the information boards of the quadrats and the test areas are replaced, showing that the study continues in the areas.

We also launched awareness-raising at the event 'Sustainability at any time' organised by VKSZ cPlc. in 2016, together with the Park Maintenance team of VKSZ cPlc. Firstly, the project was modelled for the public under the name 'wildflower meadow' with the involvement of children, who could assemble an 'insect hotel' based on their own design from various materials and crops available, among other playful tasks. The stand had nearly 100 active visitors. The communication of the event helped a lot to promote the project, and every year afterwards we have welcomed kindergarten and school groups and families to the spring event with new games and information brochures.

In autumn 2016, we continued to promote the project in primary schools through a series of unconventional, interactive environmental science lessons, where we had the opportunity to go into sustainability with children in more detail and longer, especially in relation to green space maintenance. Our aim was to make them understand the importance of diversity in urban environment, and then we asked the classes to colour butterflies, which we later used stuck on thin sticks as illustrations at our events.

In September 2019, the 'Wildflower Picnic' was held for the first time, with the focus on promoting the project, especially to the residents of the housing estate. It was organised in one of the test areas, the Kálvin János Park, where visitors could take a guided walk with an ecologist to gain insight into the monitoring process. Furthermore, students were involved in promoting the philosophy, aims and results of the project through posters, leaflets and workshops.

We gave a presentation to professionals on sustainable green space management at the national environmental conference 'Adapting to climate change – local tasks and challenges', touching on the opportunities for grassland management and our existing experience of course. We were also invited to the 6th Green Student Parliament – 'Sustainable Cities and Communities' event, where we gave a presentation on the project to secondary school students.

Results of the communication programme

In addition to the interested and enthusiastic visitors at the events, we are proud of the awards that Veszprém has received in professional circles.

Ozone Green Award 2018: A competition to support creative and environmentally conscious organisations that are working to reduce their ecological footprint and help protect the planet.

At the *Entente Florale Europe* international award ceremony, Veszprém was awarded the Gold Medal in the category of cities in 2018 and also received the 'President's Award'.

Climate Star Award 2019: A competition to reward best examples of municipal green space management.

Climate Star Award

Veszprém City Council decided to support the long-term application of the programme, therefore the Green Strategy prepared in 2019 includes a proposal to extend the sustainable grassland management method to areas where active grassland use is not typical, e.g. around traffic areas and watercourses. The strategy considers it important to keep the public informed and to ensure community participation in the work process to gain understanding and acceptance.

Participants of the Veszprém Wildflower Meadows project

Experts involved in the project: Ildikó Réka Báthoryné dr. Nagy (landscape architect, project leader, associate professor), Attila Gergely (biologist, senior lecturer), Kata Pernesz (landscape architect, head of the park maintenance team, VKSZ cPlc.), Henrik Auer, Tamás Köller, Krisztina Németh, Krisztina Panyiné Presits, László Sudár (VKSZ cPlc.).

Landscape architecture students involved in the project: Nóra Ambrus, Emese Andráskó, Csilla Erzsébet Balásházy, Réka Bancsi, Dorka Bátori, Borbála Böszörményi, Benedek Bubics, Attila Csupcsák, Ágnes Erdelics, Alexa Haraga, Levente Hollós, Máté Horváth, Réka Kakas, Dorottya Kalocsai, Éva Erzsébet Kecskés, Johanna Krisztina Kiss, Klára Kocsis, Lili Koppány, Vivien Kovács, Emese Flóra Kubik, Kata Sára Kun, Luca Lakatos, Zsolt Leel-Őssy, Kornél Attila Lendvai, Alexandra Mátlé, Orsolya Miklós, Noémi Pap, Hanga Pénzes, Emese Judit Sápi, Brigitta Sas, Róbert Schuck, Ede Schwiegelhofer, Zsuzsanna Somodi, Péter Szabadi, Mária Szabó, Réka Szabó, Iringó Szendrődy, Sándor Vilmos Tacsi, Dzsenifer Ulbert, Dorottya Vass, Beatrix Szavéta Vidák.

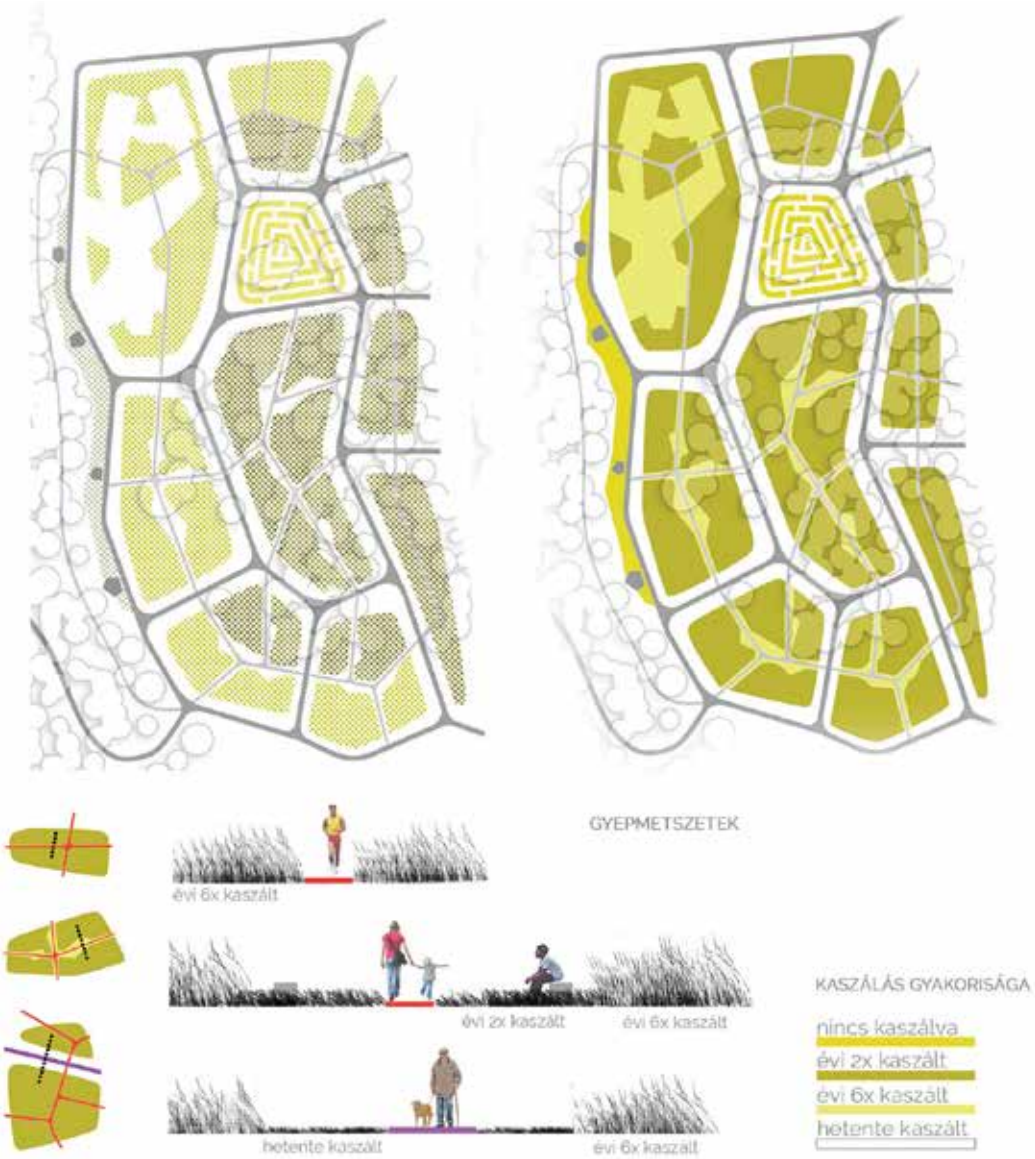

Figure 5. Changing the character of urban lawns through management – visions from students in landscape architecture and garden art for sites in Veszprém

What can you do in favour of wildflower meadows?

- **Rationalise your grass surface!** You should have grassland in the garden only where it is absolutely necessary! In other areas, you should use lower, ground-cover perennials that will substitute grass.

- **Mow your grass less often!** English lawn requires maintenance and expertise. Besides being expensive, it has not only low diversity, but it is not home to flowering plants either. Mow only where the grassland is intensely used, and let it grow tall in the rest of the garden!

- **Do not use weed killers on the grass!** These products kill dicotyledonous flowering plants. Remove allergenic or invasive alien weeds by hand, and leave the rest in the grass.

- **Rake the grass!** Raking your grass every spring to free up the soil surface will help flower seeds to take root.

- **Install an insect hotel!** It is good to have a place in the garden where insects can hide for the winter or lay their eggs. A pile of wood or brick can be suitable for this. Make an insect hotel of natural materials and place it near the grassland.

What can you do for pollinating insects and bees?

- **Plant wildflower grass!** Let the grass grow tall so that the plants in it can flourish! The more colourful, the better!

- **Let your grass grow taller!** An average garden grass will usually have 7-10 different flowering plants. However, they do not produce flowers due to frequent mowing or low stubble height. By mowing less often, you not only save time and energy, but also help the bees to feed. Think about in which areas of your garden (usually at borders, along fences, in the back garden) you do not use the grass! In these strips, let the grass grow! You can provide a safe home for pollinating insects in the tall grass.
- **Do not plant double-flowered plants!** Certain horticultural varieties of some plants have huge, so-called 'double' flowers. Their beauty comes from the fact that their stamens have turned into petals, but this means they cannot be a food source for bees. Instead, choose plants with simple flowers and a natural effect, which will not only be the jewels of your garden, but also help beneficial insects!

- **Let the ivy bloom!** At the end of summer, its pollen-rich flowers are a great help to bees. Depending on the weather, it may even bloom until late autumn, just at the time when the flowers are becoming scarce. Once the bees have gone into hiding for the winter, you can start pruning!

- **Leave the autumn foliage in the garden!** It is decent to leave small piles of fallen leaves, because they are a great place for insects to hibernate for the winter!

- **Drive less!** Exhaust fumes from urban traffic mask the smell of flowers from bees, making it more difficult for them to find the flowers. Cycling or walking can be a good transport alternative to nearby or even distant destinations.

- **Buy local honey!** Support urban beekeeping! Supporting local beekeepers is a sustainable and environmentally friendly solution.

From urban lawn to wildflower grassland in 10 steps!

You can convert your existing grassland easily and cost-effectively into a semi-natural wildflower grassland in just a few years. See figure.

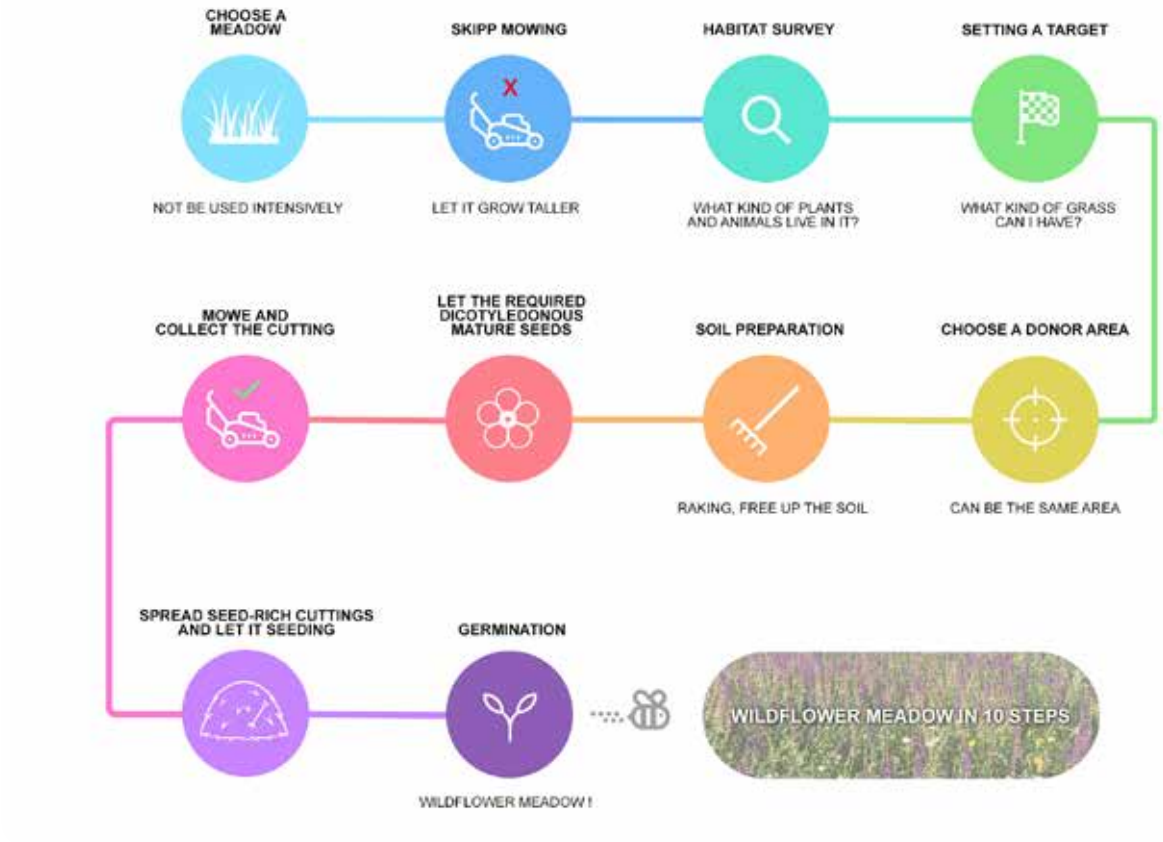

Figure 6. From urban lawn to wildflower grassland in 10 steps

OTHER GOOD PRACTICES IN HUNGARY

Hódmezővásárhely

In Hódmezővásárhely, an experiment was carried out to manage grassland by grazing on a nearly 6000 m² unused, municipally owned plot in the inner administrative area. The experimental area used to be an industrial site. Although three quarters of the site is green space, the remains of the facility made it difficult to manage it mechanically, but they did not hinder the animals. A key consideration for the site selection was the possibility to guard the animals, so the primary preparatory task was to check the fence and install a lockable gate. Then, a watering place was created for the animals and the vegetation was checked for species that were toxic to the animals. Registered, ear-tagged animals were released in the area, 32 ewes and one ram, and the animals were guarded at night. The grazing period lasted for 3 weeks, during which time the entire area was cleared, leaving only the invasive tree of heaven (Ailanthus altissima) saplings.

Sheep grazing in the city in Hódmezővásárhely

The project has basically proved to be highly successful and effective from a professional point of view. From a social point of view, the reception was twofold, which experience has shown that broad communication of the purpose, professional background and ecological and economic benefits of this type of projects is one of the keys to their success.

Újpest (www.vadviragosujpest.hu)

In the District No. IV of Budapest, the 'Újpest Wildflower Meadows' project aims to create new plant communities in green spaces as well as a more liveable urban habitat. The green spaces have been used to create plant communities that are native to the area, and provide food and habitat for pollinating insects. An integral part of the programme is to raise public awareness and communicate the objectives and the values that can be created properly. This will be done through information panels, awareness-raising programmes and online communication. Wildflower meadows have been established at two priority sites in the programme, in Homoktövis Park and in Sporttelep Street, so far.

SUMMARY

The use of urban, semi-natural grasslands, new in our country but common in Western Europe, has undeniable benefits for biodiversity, urban climate and green space management. Its increasing popularity is also due to the environmental challenges of the 21st century, which can be experienced more and more often, thus it should not be absent from the future toolbox of urban development necessary for creating a liveable urban environment. National and international experience, supported by the case studies presented, shows that its practical application is successful and leads to tangible results. However, in order to ensure its widespread use, it is important to promote and emphasise the method among professionals and lay people, as well as decision-makers and the general public. In this way, a comprehensive awareness-raising process can be achieved, which will not only increase the acceptance of semi-natural grasslands, but will also open up further research and development opportunities on the native flora.

Semi-natural dolomite rocky meadow, donor area in the centre of Veszprém

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CLIMATE-ADAPTIVE GRASSLAND MANAGEMENT
IN URBAN ENVIRONMENTS

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