

URBAN GRASSLANDS FOR DIFFERENT CITY ZONES: A SCENARIO ASSESSMENT INTEGRATING PUBLIC PREFERENCES AND MANAGEMENT ASPECTS

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Abstract. Urban grasslands are increasingly promoted as biodiversity-oriented alternatives to intensively managed lawns. However, their implementation in Latvian cities remains fragmented and is rarely embedded within comprehensive green infrastructure planning. Municipalities often lack spatially differentiated planning tools that integrate public preferences, management regimes and long-term cost considerations. The paper addresses this gap, and the aim of the study is to develop a scenario-based assessment framework to identify suitable functional urban zones for urban grassland integration, using Jelgava, Latvia, as a pilot case, with a particular focus on those functional zones where municipalities could systematically incorporate urban meadows as elements of green infrastructure within thematic spatial plans for urban territories. The research combines prior survey data on public perceptions with spatial analysis and management modelling. Functional urban zones appropriate for urban grassland implementation were selected, and integration models were developed for each zone group, distinguishing between flowering urban meadows and extensively managed existing grasslands. The proportional coverage of grasslands within each zone was modelled through test planning, and lifecycle costs were calculated over a five-year period, including both establishment and maintenance regimes. Two city-scale integration scenarios were subsequently developed, enabling comparison between establishment-intensive and management-transition approaches. The results demonstrate that spatial differentiation is critical. Larger and more continuous grassland areas can be allocated in peripheral zones, particularly near natural territories, as well as in railway corridors and technical areas, while central streetscapes and residential courtyards require controlled proportions and clearly defined design solutions to ensure public acceptance. The study concludes that urban grassland integration should be framed as a reform of maintenance regimes embedded within municipal green infrastructure planning. By linking public perception, spatial typology and differentiated management practices within a scenario-based framework, municipalities can move beyond isolated pilot projects toward systematic, cost-efficient and socially acceptable implementation of urban grasslands across functional city zones. **Keywords:** urban meadows, a scenario-based assessment, public perception, city functional zones

Introduction

This article presents a study addressing urban grasslands as an emerging initiative in Latvian cities, examining their potential integration into urban green infrastructure planning as alternatives to conventional lawns. It analyses how their implementation across different urban functional zones can be aligned with public preferences and context-specific management frameworks to support long-term institutionalisation.

1.1. Grasslands as urban green infrastructure elements

A review of the literature on urban grasslands indicates heterogeneous terminology linked to differing conceptual and management frameworks. The term “semi-natural grasslands” denotes human-established grasslands in both urban and rural settings composed of species typical of natural grasslands [17; 31]. “Urban meadows” may include such species alongside ornamental perennials, annuals or biennials and grasses, or may consist exclusively of these plant groups. In contrast, “urban grasslands” functions as an umbrella term encompassing both regionally characteristic semi-natural grasslands and mixed-species urban meadows [27; 34; 40].

In Northern and Central Europe, semi-natural grasslands have undergone significant reduction due to agricultural intensification, land abandonment and afforestation. Introducing grassland systems into urban green infrastructure can therefore contribute to expanding ecologically valuable habitats while operationalising EU policy objectives related to biodiversity enhancement and climate adaptation in cities [11; 12]. Compared to intensively managed lawns, characterised by low species richness

and limited ecological resilience, urban grasslands provide superior ecosystem service performance [10; 17; 27; 31]. Structurally diverse vegetation composed of regionally adapted species increases plant richness and supports pollinators and predatory invertebrates; for example, semi-natural grassland analogues sustain higher abundance and diversity of bumblebees than frequently mown lawns and enhance biological pest regulation through ground beetle populations [26]. Urban grasslands also contribute to climate regulation and environmental quality. Their deeper root systems and higher biomass improve evapotranspiration, soil moisture retention and thermal buffering, strengthening drought resilience and mitigating heat stress [25]. Taller and more complex vegetation enhances particulate matter capture, especially in transport corridors [32], while emerging evidence indicates improved soil microbial diversity and substrate quality in species-rich grasslands [2]. From an economic perspective, reduced mowing frequency lowers fuel consumption, irrigation demand, fertiliser use and associated emissions [45], positioning urban grasslands as cost-effective long-term alternatives to conventional lawn regimes. Socially, they enhance landscape diversity, support environmental education and contribute to human well-being through increased contact with biodiverse environments. Overall, urban grasslands represent an evidence-based solution that integrates ecological, economic and social benefits within a single green infrastructure element. Their effective scaling, however, depends on governance capacity, adaptive maintenance frameworks and alignment with societal expectations regarding urban landscape aesthetics and management.

1.2. The role of public perception and participation in urban grassland implementation

Public perception is a critical determinant of the acceptance and long-term institutionalisation of urban grasslands. Landscape perception is shaped by sensory experience, social representations and the “psychology of place” [7;44], positioning grasslands not only as ecological habitats but also as cultural symbols. In Latvia, meadows are associated with traditional land use, midsummer (Jāņi) rituals and national identity; Bunkše [4] characterises them as iconic elements of the Latvian landscape, a status reinforced by regionally distinctive sites such as the Lielupe floodplain grasslands or the Randu Meadows [24]. Yet when introduced into urban environments, grassland aesthetics often conflict with entrenched norms of tidiness and control associated with intensively managed lawns. Empirical evidence shows that vegetation preferences are shaped by cultural conditioning and perceived safety: although natural elements are valued, residents frequently favour ordered landscapes over “wild” vegetation [30;47]. Concerns about insects, reduced visibility and neglect further reduce acceptance [3;22]. Acceptance is also spatially differentiated. Support tends to be stronger in parks and peripheral or less intensively used areas, while resistance increases near residential properties, reflecting “not in my front yard” dynamics [15]. Evidence from Stockholm illustrates this tension: lawns constitute roughly one third of residential outdoor space and are highly valued for recreation and social interaction [14], yet residents also express preferences for more diverse, sensory-rich environments. This suggests that integration of urban grasslands requires strategic spatial reconfiguration rather than wholesale lawn replacement. Within such frameworks, biodiverse perennial meadows can enhance perceived site quality and aesthetic value if their management remains legible. Prolonged flowering, coherent spatial structure and visible maintenance cues are therefore critical design attributes for securing public acceptance [39].

Participatory approaches can reduce resistance by framing urban grasslands as shared socio-ecological projects. In Estonia, the programme “Igaühe looduskaitse” (Everybody’s Nature Conservation), led by Eestimaa Looduse Fond, integrates policy engagement with practical management, including the “tule niitma” movement, which revitalises traditional mowing practices and mobilises citizens in biodiversity stewardship [16]. In Riga, the municipal urban meadow programme similarly collaborates with neighbourhood communities by involving residents in collecting native meadow seeds, establishing and maintaining grasslands, and providing locally adapted seed mixtures for private gardens. It also strengthens public ecological literacy through on-site signage explaining plant species and ecological functions [42;43]. Together, these initiatives show that structured participation combined with environmental education enhances ecological awareness, place attachment and long-term social acceptance of urban grasslands.

Public perception of urban grasslands is shaped by cultural symbolism, aesthetic norms, safety concerns and spatial context. Documented benefits include improved site quality, local identity, well-being and civic engagement [1;39]. However, aesthetic resistance, safety concerns, uneven environmental knowledge and lower acceptance near residential areas remain significant constraints. Effective implementation therefore depends on context-sensitive design, visible management and participatory communication strategies that align biodiversity objectives with socio-cultural expectations.

1.3. Urban grassland management practices and considerations

Urban grasslands are multifunctional systems with diverse objectives, including biodiversity conservation, pollinator support, recreation, aesthetic representation, ecosystem service provision and educational value [10;17;39;45]. These objectives determine design and maintenance regimes. Converting intensively managed lawns into extensively managed grasslands through reduced mowing follows a different ecological and financial trajectory than establishing newly sown urban meadows with a high proportion of flowering perennial species. The former relies on gradual diversification under nutrient limitation, whereas the latter requires deliberate soil preparation and targeted seed mixtures but may achieve faster structural and visual transformation.

Management intensity strongly shapes ecological outcomes. The Swedish “LAWN” project classified grasslands by mowing regimes across spatial scales to support environmental assessment and planning, though municipal budget integration remains complex [17;18]. Evidence from Central Europe shows that fertilisation and frequent mowing increase grass dominance while reducing legumes and structural heterogeneity, confirming nutrient reduction as a precondition for meadow development [23;46]. In Rennes, France, reducing mowing from 15–20 cuts per year to one significantly increased taxonomic, functional and phylogenetic diversity, whereas intermediate regimes yielded limited gains [9]. Delayed mowing and uncut refuges in Switzerland similarly enhanced species richness [5]. Thus, mowing frequency, timing and spatial heterogeneity are decisive for pollinator and invertebrate habitat continuity. Seed sourcing is equally critical. Locally sourced seeds are widely recommended to maintain regional genetic integrity and ecosystem resilience [13;38;42], yet such services are not universally available and often increase procurement costs and administrative complexity. In Estonia, Nordic Botanical OÜ applies a full-cycle model combining local seed production with site-adapted mixtures (e.g., dry calcareous, moist, shaded habitats) and management planning, improving ecological fit and resilience [28].

However, the operationalisation of these stages is frequently constrained by systemic barriers, including the absence of unified methodological standards, insufficient lifecycle financial modelling, aesthetic resistance to taller vegetation, knowledge gaps in soil preparation and seed sourcing and limited monitoring provisions embedded in maintenance contracts. Although evidence shows that reduced mowing and ecologically informed establishment enhance biodiversity and ecosystem services [5;9;23], long-term institutionalisation depends on integrating ecological, financial and governance instruments within municipal systems.

1.4. Urban grassland implementation initiatives in Latvia and key challenges

In Latvia, semi-natural grasslands are classified as dry, mesic and wet habitats, yet they constitute the country’s most threatened habitat type, covering only 0.7% of national territory [13;34]. Their persistence depends on continuous low-intensity mowing or extensive grazing to prevent shrub encroachment and woodland succession. During the 20th century, both distribution and ecological quality declined due to agricultural intensification in productive regions and abandonment followed by afforestation in marginal areas. In cities, the remaining fragments are primarily river floodplain meadows, often located within protected areas,

and constitute only a small proportion of urban green space compared to intensively mown lawns, which, according to evidence from other European cities, may occupy up to one quarter of total urban land cover [14].

Since 2017, the Latvian Nature Fund has promoted integration of native grassland species into urban green infrastructure, framing urban grasslands as biodiversity-enhancing and participatory elements [34;42]. The largest initiative is the "Urban Meadows" network in Rīga (launched 2021), implemented with the Latvian Nature Fund, Rīga City Council and neighbourhood associations. It includes 42 sites (13.7 ha), primarily created by enriching lawns with locally sourced perennial and grass species [42;43]. Located mainly in underused green areas and large parks, these sites follow annual management plans regulating mowing regimes and invasive species control, supported by a public digital map and on-site signage explaining ecological objectives, meadow plant species and maintenance principles. Comparable approaches have been implemented in other Latvian cities at smaller scales. In Cēsis, six "landscape meadows" were designated under binding municipal regulations in 2023, specifying one annual mowing without mulching, biomass removal, intensified mowing near pedestrian infrastructure and herbicide restrictions [8]. In Sigulda, ten naturalistic meadows established since 2019 through overseeding with native perennials or mixed-origin seed mixtures function as alternatives to conventional lawns and have received positive public feedback [35]. Public participation, seed collection, sowing, site selection and monitoring, has been integral, particularly in Rīga, while informational signage in all three cities supports education and social legitimacy [36]. Binding regulations in Rīga and Cēsis further define mowing frequency, biomass management, buffer zones and visual standards, though without detailed technical guidance on soil preparation or species composition [7;33]. Despite these advances, urban grasslands in Latvia remain predominantly pilot or site-specific projects in underused green areas and large parks rather than systematically embedded components of municipal green infrastructure. Broader application across functional urban zones would require strategic integration into planning frameworks and careful management of public perceptions, particularly in intensively used spaces where grasslands may be viewed as unmanaged.

1.5. Problem definition and research gap.

Study objective

Interest in urban grasslands as alternatives to conventional lawns and elements of urban green infrastructure is increasing not only in cities that have already initiated such projects, but also in those intending to do so in response to broader European Union sustainability and green infrastructure agendas. (e.g. the EU Green Infrastructure Strategy and the Biodiversity Strategy) [11;12]. Nevertheless, current initiatives are predominantly implemented as separate projects rather than as components of a comprehensive spatial strategy or integrated green infrastructure plans. As a result, municipalities lack systematic planning tools to determine which urban zones are most suitable for extensively managed grasslands, flowering urban meadows, or conventional lawns. Furthermore, practical cost-calculation tools for different establishment and long-term maintenance regimes remain underdeveloped, thereby limiting evidence-based decision-making.

These structural gaps form the basis of the present study, whose objective is to identify the urban functional zones

most suitable for the systematic integration of urban grasslands as standardised green infrastructure solutions within thematic spatial planning frameworks of Latvian cities. The study applies a scenario-based assessment focused specifically on those urban functional zones where urban meadows could be systematically incorporated through standardised planning and management approaches, integrating public preferences together with different urban grassland management practices. The city of Jelgava, Latvia, has been selected as a pilot territory, building on previous research on public attitudes toward urban grassland implementation in this municipality [37].

This study provides a transferable, scenario-based decision-support framework that can assist municipal planners in systematically integrating urban grasslands into spatial planning and green infrastructure strategies beyond project-based approaches. Given its regionally international scope, the results offer practical guidance for municipalities in other cities, both within and outside Latvia, with comparable territorial planning systems, socio-cultural contexts and climatic conditions, thereby supporting the harmonised implementation of nature-based solutions across similar governance and environmental settings.

2. Material and Methods

2.1. Research object

Jelgava, Latvia, was selected as the case study due to the availability of prior empirical survey data on public perceptions of urban grasslands, enabling an assessment of how these findings can be integrated into specific functional zones within the city's green infrastructure framework.

Located in central Latvia, Jelgava is the country's fourth largest city (60.3 km²; 54,834 inhabitants), with 16.4% of residents aged 0–14, 63.8% of working age, and 19.7% aged 65+ [29]. Its urban structure evolved from a medieval fortified town into an industrial and educational centre, accelerated by the Riga–Jelgava railway, which stimulated economic and spatial expansion [20]. After the destruction of approximately 95% of the historic fabric in 1944, post-war reconstruction under Soviet planning principles introduced wide streets and standardized housing, fundamentally reshaping the city landscape. The contemporary cityscape combines historical fragments with revitalising Soviet-era industrial areas [19;48]. Jelgava's spatial identity (Fig. 1) is defined by the Lielupe River and its islands, while the Platone, Svēte and Driksa traverse the city and the Iecava and Vircava mark its boundary. The flat topography (2.5–4.5 m above sea level) and high groundwater levels generate extensive spring floodplains within the Lielupe basin. Green infrastructure comprises forests and forest parks, parks and squares, and courtyard and street greenery [19]. Of the total area, 272 ha are open waters, 1264 ha forests, and 162 ha parks and squares. The NATURA 2000 site "Lielupe Floodplain Meadows" covers 271.5 ha (4.5% of the city territory) [20].

Current regulatory documents of Jelgava State City do not establish requirements promoting diversified planting structures; existing provisions are limited to maintenance regulations for municipal lawns. Although Jelgava currently lacks a dedicated green infrastructure plan and detailed regulations for planting design and maintenance, the city has expressed a clear commitment to advancing green infrastructure development. This orientation is reflected in the Joint Sustainable Development Strategy of Jelgava State City and Jelgava Municipality until 2034, which identifies the quality of the living environment, green infrastructure and urban aesthetics as key strategic priorities [20; 21].



Fig. 1. The spatial and green structure of Jelgava is shaped by natural assets, cultural and historical heritage, and Soviet-era residential neighbourhoods [author photo, 2020]

2.2. Method

To achieve the stated research objective, identifying the urban functional zones most suitable for the systematic and standardised integration of different types of urban grasslands, a scenario-based assessment approach was developed, integrating public preferences with management practice considerations across those urban functional zones where urban meadows could be incorporated as replicable green infrastructure solutions. The scenario-based assessment approach comprises several stages (Fig.2).

Stage 1. Selection of city functional zones for grassland implementation

The selection of urban functional zones was based on the municipal spatial development plan, which defines the city's designated land-use categories and functional zones [21]. The identification of zones suitable for urban grassland integration followed a set of structured criteria. First, priority was given to zones characterised by relatively homogeneous spatial and functional structures (streetscapes, green areas, multi-storey residential areas etc.), allowing for the development of standardised integration models that can be systematically incorporated into the municipal green infrastructure plan. Zones with highly heterogeneous spatial configurations, such as low-density private housing areas, commercial and service districts, and industrial territories, were excluded, as they typically require site-specific design solutions.

Second, within the selected zones, only areas containing continuous open space suitable for urban grassland establishment were considered. A minimum width of 3 m was required to ensure feasible establishment and long-term maintenance. In street landscapes, eligible sites were defined as those with at least a 5 m-wide green verge, allowing for a 3 m urban grassland strip combined with 1 m-wide intensively mown buffer strips separating pedestrian and carriageway zones. Third, protected nature areas were excluded from the analysis, as these territories are already subject to specific management plans, including provisions for semi-natural grassland habitats. Finally, where possible, preference was given to municipally owned land to ensure long-term management control and maintenance planning for the proposed urban grassland areas.

Stage 2. Grassland integration models for the selected urban functional zones, proportion in % of urban grasslands within the total area

Urban grassland integration models for the selected functional zones were developed based on the results of a prior public

survey conducted in Jelgava, Latvia [37], complemented by criteria identified in the scientific literature [7;15;17;39]. In the survey, respondents were asked to select one or more of three urban grassland scenarios, conventional, intensively maintained lawn, extensively maintained existing grassland, and newly established flowering meadow, considered acceptable for specific sites with defined functions in Jelgava [37]. In addition, the proportional coverage of urban grasslands within each functional zone was modelled. This was carried out through test planning and spatial calculations for three representative sites per zone. Rather than assessing individual land parcels separately, the analysis considered each functional zone as a coherent spatial unit. For each test site, the proposed urban grassland area was delineated and its percentage of the total zone area calculated. Based on these results, integration models were proposed for each functional zone, including the calculated percentage of urban grassland coverage (Table 1).

Stage 3. Calculation of maintenance costs for different types of urban grasslands within the selected functional zones

At this stage, establishment and maintenance costs for two types of urban grassland are calculated per hectare, based on current market prices, existing practical experience in implementation and management [7;13;42], and assuming a five-year maintenance period. For comparative purposes, maintenance costs for conventional lawns are also estimated. The cost calculations include:

- Type 1 - Flowering meadow: establishment either by removing the topsoil layer and sowing a local seed mixture, or by harrowing existing lawn areas and overseeding with a local seed mixture; management consists of mowing twice per season with biomass removal.
- Type 2 - Extensively managed grassland: transition from existing lawn without reseeding, reducing mowing frequency to 3 - 4 times per season.
- Conventional lawn: installation of a 15 cm fertile topsoil layer, with mowing on average 15 times per season and no biomass removal.

The cost assessment is based on average establishment and maintenance costs, assuming that variations in seed mixtures for urban grasslands do not substantially influence the overall cost structure. Similarly, soil preparation requirements were treated as comparatively uniform, since urban grasslands generally require nutrient-poor or non-enriched

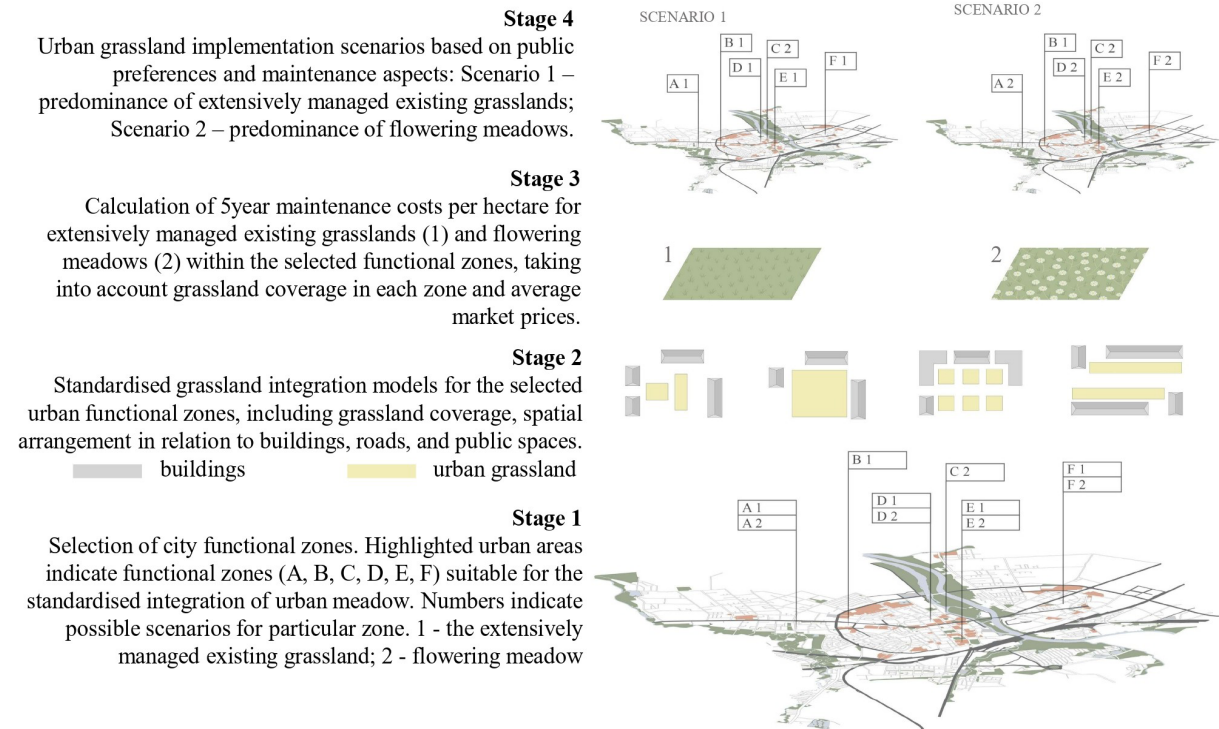


Fig. 2. Scheme of the scenario-based assessment approach and its stages, including the selection of functional urban zones for urban grasslands, integration models within the selected zones, cost calculations for different grassland types, and implementation scenarios based on public perception and maintenance considerations [created by the authors, 2025]

Table 1. Urban grassland integration models based on public survey results. Percentage coverage within each functional zone Results of the territorial selection assessment [created by the authors]

Selected functional zones within the Step 1	Urban grassland model based on survey results and literature review		Urban grassland coverage (%) within the total functional zone based on test planning layouts	Additional requirements
	Type 1 Flowering urban meadow	Type 2 Extensively maintained existing grassland		
Streetscape	X	X	up to 10%	Minimum width of 5 m, including 1 m-wide intensively mown buffer strips separating pedestrian and traffic zones.
Roundabouts	X	X	up to 80%	1–2 m-wide intensively mown buffer strip along the traffic zones.
Riverbanks	X	X	up to 80%	1–2 m-wide intensively mown buffer strip along pedestrian or traffic zones; a 2 m strip of natural riparian vegetation retained in immediate proximity to the water.
Nature and greenery areas	X	X	up to 50%	In less intensively used areas, a 1–2 m-wide intensively mown buffer strip along pedestrian routes and recreational spaces; integration into a coherent composition with existing vegetation and infrastructure; inclusion of environmental education elements (e.g., insect hotels, deadwood features).
Multi-storey residential courtyards	X	-	up to 10%	In less intensively used areas, a 1–2 m-wide intensively mown buffer strip along pedestrian routes, recreational spaces and carriageways; inclusion of environmental education elements (e.g., insect hotels).
Railway corridors, technical areas	-	X	up to 50%	Open access and safety zones to be maintained free of urban grassland vegetation.

soils rather than intensive soil improvement measures. Therefore, detailed technical specifications regarding seed compositions and soil preparation methods were considered beyond the scope of the present study. This cost assessment enables comparison of different establishment approaches and long-term maintenance regimes across urban grassland typologies.

Stage 4. Urban grassland implementation scenarios based on public perception and maintenance aspects

In the final stage, two scenarios for integrating urban grasslands into the city's green infrastructure are developed. These scenarios are based on the integration models defined for each selected functional zone and their associated management costs. The cost structure includes the selected

urban grassland type, establishment and maintenance costs per unit area, and total costs at the scale of the functional zone, calculated according to the previously determined percentage of urban grassland coverage within each zone. The scenarios are presented cartographically and accompanied by a comparative cost assessment. This enables evaluation of different integration models within individual functional zones, comparison of total scenario-level expenditures, and benchmarking against the establishment and maintenance costs of conventional lawns.

3. Results and Discussions

Application of the defined selection criteria in Jelgava resulted in the identification of following spatially and functionally homogeneous urban zone types suitable for standardised urban grassland integration: streetscapes (including roundabouts), nature and greenery areas (including riverbanks), multi-storey residential courtyards, railway corridors and technical areas (Fig. 3). Modelling of potential urban grassland coverage within these zones revealed a clear spatial gradient (Fig. 4).

The largest and most continuous grassland areas could be established in peripheral territories close to nature areas, as well as in railway corridors and technical zones, whereas central areas, streetscapes and residential courtyards, allowed only smaller, structurally controlled meadow elements. This pattern corresponds with research showing that roadside and infrastructural greenspaces can support distinct ecological assemblages when management intensity is reduced, while highly visible urban areas require stronger aesthetic legibility to secure public acceptance [9;17;39].

Following the methodological framework, two integration model types were developed for most functional zones (Fig. 5): (1) established flowering urban meadow and (2) extensively managed existing grassland. The developed models schematically illustrate the proposed urban grassland integration approaches in accordance with the conditions defined in Table 1, which describes the main requirements for urban grassland integration within the selected zones, including spatial placement, coverage percentage, the required width of buffer zones between urban grasslands and pedestrian or traffic areas, and the possibilities for incorporating additional environmental elements within

the meadow areas. In multi-storey residential courtyards, only flowering meadows were proposed. Survey results indicated a preference for visually structured and clearly recognisable meadow forms in close proximity to housing, reflecting broader evidence that public acceptance depends on perceived order and visible maintenance cues [37]; however, in socially sensitive environments, structural design and visual coherence remain critical. Consequently, flowering meadows in residential courtyards combine ecological function with aesthetic acceptability [15;39]. In contrast, railway corridors and technical areas, characterised by lower recreational use and reduced visual scrutiny, allow the application of extensively managed grassland in both scenarios. This approach is supported by evidence that reduced mowing frequency increases invertebrate densities and species richness compared to conventional regimes [5;9]. Based on the developed integration models, two city-scale urban grassland scenarios were prepared (Fig. 5 and 6). Scenario 1 is dominated by flowering meadows, except in railway and technical areas, where extensive grassland is maintained. Scenario 2 prioritises extensively managed existing grassland, retaining flowering meadows only in residential courtyards. This differentiation enables comparison between establishment-intensive and management-transition approaches, linking spatial distribution with lifecycle costs.

To enable further cost calculations of the proposed scenarios at the city scale, per-hectare cost estimates were prepared for a five-year period based on market analysis. For conventional lawns, only maintenance costs were included, amounting to 22,500 EUR/ha. For extensively managed existing grassland, with mowing reduced to 3 - 4 times per season, the total cost was estimated at 9,000 EUR/ha. For flowering urban meadows, costs included both establishment, through harrowing of the existing turf and overseeding with locally sourced meadow species, and subsequent maintenance, resulting in a total of 11,400 EUR/ha. Cost modelling over a five-year period demonstrated substantial economic differences between regimes. Compared with conventional lawns, the extensive grassland-dominant scenario is 60% more cost-efficient, while the flowering meadow-dominant scenario is 51% more cost-efficient within the five-year framework (Table 3). These findings are consistent with literature emphasising the reduced input requirements of meadow systems and their

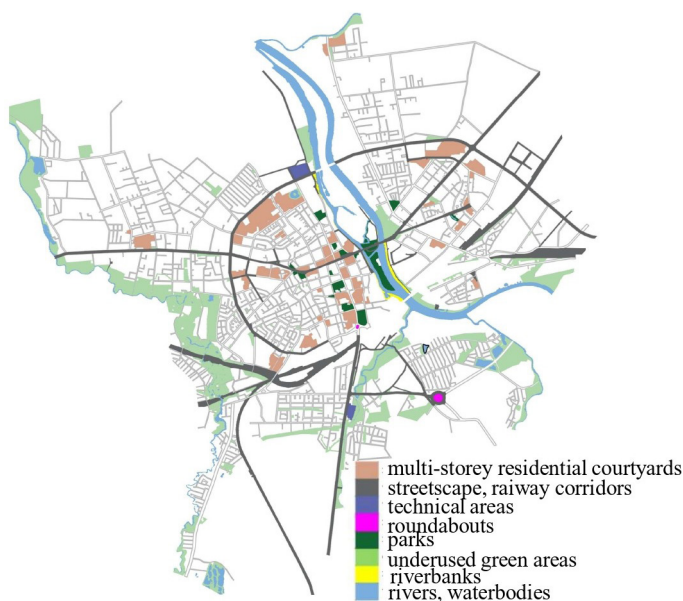


Fig. 3. Selected functional zones for urban grassland implementation in Jelgava city [authors' scheme based on [21]]

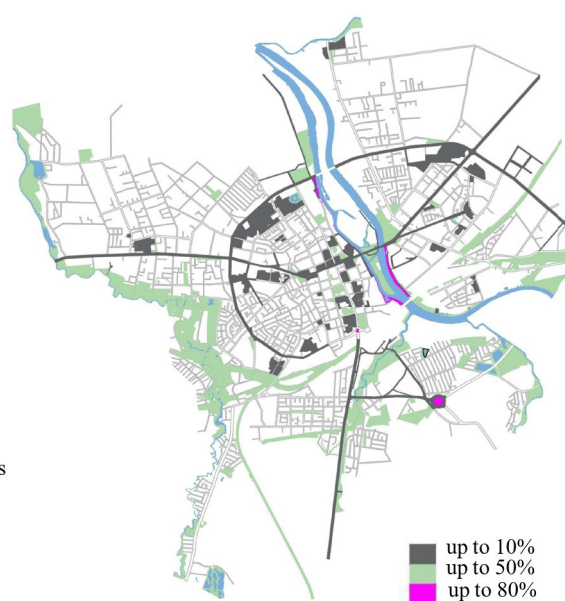
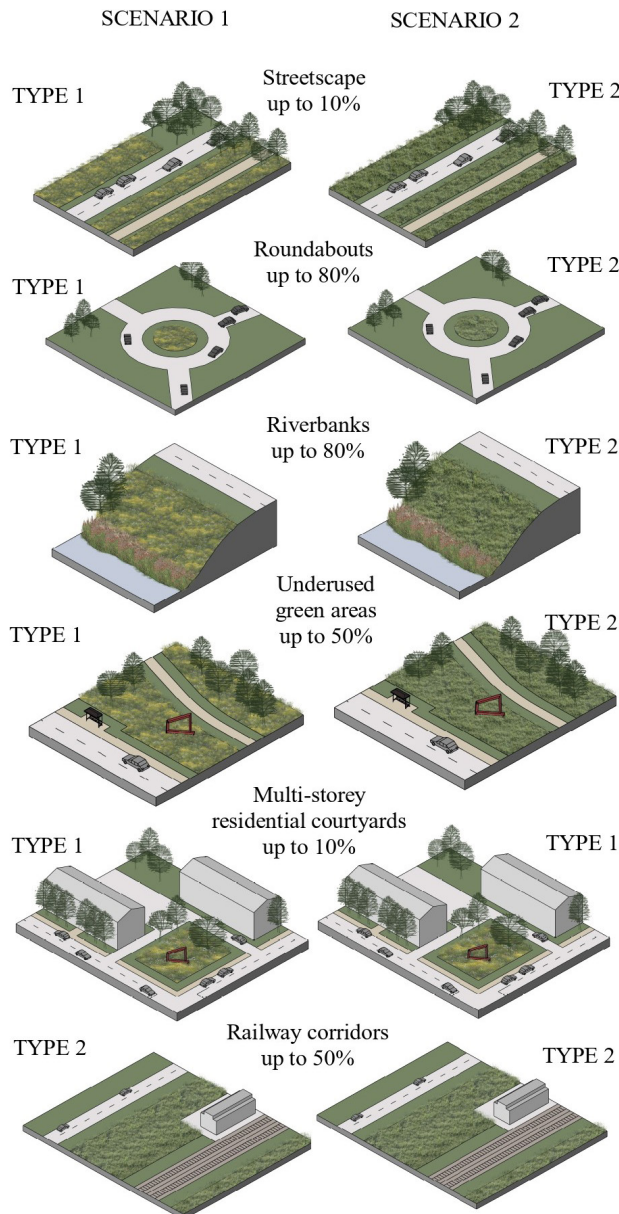


Fig. 4. Percentage of urban grassland coverage within the respective, selected functional zone [authors' scheme based on [21]]



lower long-term management costs [45].

The Jelgava modelling indicates that integrating public preference data with differentiated management regimes enables a scenario-based planning approach that systematically links spatial suitability (Fig. 3–4), typological integration models (Fig. 5), and city-scale cost implications (Fig. 6). The findings suggest that urban grassland implementation should be framed not solely as a design intervention, but as an adjustment of maintenance regimes within urban green infrastructure systems. In this context, reduced mowing intensity and zone-specific typologies function as operational variables influencing ecological performance, public acceptance and long-term cost efficiency.

To support long-term implementation, the success of urban meadows should be monitored using a limited set of practical and repeatable indicators. Core biodiversity indicators may include plant species richness, flowering cover, vegetation height, the proportion of native or target meadow species, and the abundance and diversity of key pollinator groups such as bees, butterflies, and hoverflies [9;10;15;23;40;46]. These indicators can be assessed through fixed vegetation plots, photo-point monitoring, and repeated transect walks during the flowering season. Management performance should also be documented, including mowing frequency, biomass removal, maintenance costs per hectare, and the occurrence of invasive or ruderal species. Where urban grasslands are located near transport corridors or other pollution sources, optional air quality monitoring could include measurements of PM_{2.5}, PM₁₀, and NO₂ concentrations, preferably applying a before and after comparison with control sites [25;32]. Such a monitoring approach would enable municipalities to relate maintenance costs to measurable ecological outcomes and, where relevant, additional environmental benefits. However, this

Fig. 5. The scheme of the standardised urban grassland integration models developed for the selected functional zones and their inclusion within two proposed scenarios.

Scenario 1 - the predominance of flowering meadows (Type 1); Scenario 2 - predominance of extensively managed existing grasslands (Type 2). The models are showing public preferences and management approaches, as well as the percentage coverage of urban grasslands indicated for each functional zone [authors' scheme, 2025]

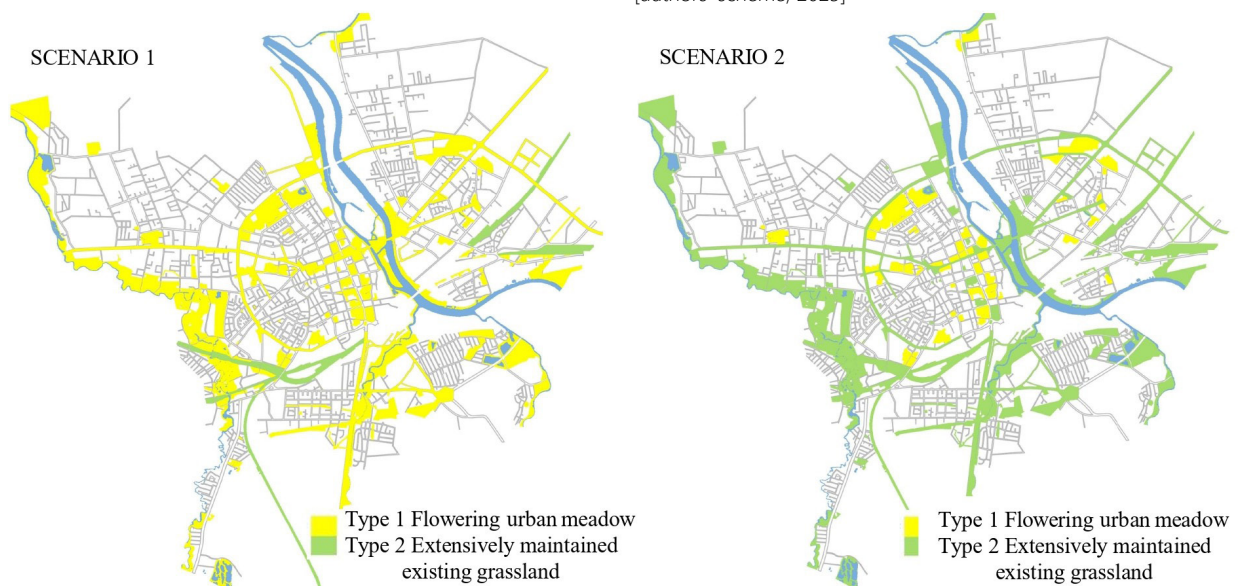


Fig. 6. Urban grassland integration scenarios for Jelgava city based on the selected functional zones and the developed integration models for those zones, taking into account public preferences and alternative management approaches [authors' scheme based on [21]]

Table 2. Costs of urban grassland integration scenarios within a five-year maintenance framework, EUR [created by the author]

Selected functional zones	Total area of selected functional zones (ha)	Urban grassland coverage within the total functional zone (% , ha)		Costs of urban grassland integrations scenarios with five-year maintenance (EUR)				Maintenance of existing conventional lawn (without implementation) (EUR)
				Scenario 1		Scenario 2		
Streetscape	161.30	10%	16.13	T1	183 882	T2	145 170	362 925
Roundabouts	2.35	80%	1.88	T1	21 432	T2	16 920	42 300
Riverbanks	8.41	80%	6.73	T1	76 722	T2	60 570	151 425
Nature and greenery areas	424.01	50%	212.00	T1	2 416 800	T2	1 908 000	4 770 000
Multi-storey residential courtyards	137.05	10%	13.71	T1	156 294	T1	156 294	308 475
Railway corridors, technical areas	112.84	50%	56.42	T2	507 780	T2	507 780	1 269 450
			Total		3 362 910		2 794 734	6 904 575

Type 1 (T1) - Flowering urban meadow; Type 2 (T2) - Extensively maintained existing grassland

type of monitoring is both financially demanding and labour intensive and may not always be feasible for municipalities to implement independently. Therefore, cooperation with scientific and research institutions specialising in this field is recommended.

Future research should further develop post-implementation evaluation approaches for urban grassland integration, including long-term resident perception monitoring under real management conditions across different functional urban zones. Such studies could assess how public acceptance changes over time in relation to vegetation structure, maintenance visibility, biodiversity outcomes and communication strategies [17;18;39]. In addition, further research could elaborate practical mechanisms for integrating urban meadow requirements into binding municipal planning and maintenance regulations, strengthening the role of urban grasslands as systematically implemented elements of urban green infrastructure.

Conclusions

The study indicates that urban grassland implementation must be simultaneously socially legitimate, ecologically justified and institutionally embedded. Public perception is spatially differentiated - support is higher in parks and peripheral areas, while resistance is more pronounced in residential contexts. Therefore, flowering meadows with visually clear management are more appropriate in socially sensitive zones, whereas extensively managed grasslands are suitable in low-use infrastructural areas. Participatory practices and educational measures strengthen acceptance and long-term legitimacy.

Management intensity is the primary operational variable determining ecological performance. Reduced mowing frequency significantly increases plant and invertebrate diversity and lowers long-term costs. Thus, transitioning from intensive lawn regimes to extensive management constitutes a functional adjustment rather than merely a design intervention. However, without integration into municipal green infrastructure plans and binding maintenance regulations, urban grasslands remain project-based and lack scalability.

The Jelgava case confirms that spatial typology enables structured integration. Homogeneous functional zones allow the application of standardised grassland models. Central and residential areas require controlled proportions and clear buffer design to maintain public acceptance. Peripheral zones provide the greatest potential for higher

coverage and ecological continuity.

Scenario modelling demonstrates that integrating public preferences with differentiated management regimes of urban grasslands allows cost evaluation at the city scale. Over five years, extensively managed grassland and flowering meadows are 60% and 51% more cost-efficient than conventional lawns. This indicates that economic feasibility supports, rather than constrains, implementation.

Urban grassland integration should be treated as a management reform embedded in green infrastructure planning. Spatial differentiation, reduced mowing intensity and regulatory incorporation are decisive conditions for achieving ecological improvement, public acceptance and long-term cost efficiency across functional urban zones.

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Kopsavilkums

Aizvien vairāk Latvijas pilsētu sāk ieviest pilsētas plavas kā bioloģisko daudzveidību veicinošu alternatīvu intensīvi apsaimniekotam tradicionālajam zālienam. Tomēr to ieviešana pilsētās ir fragmentāra, galvenokārt pilsētas plavas tiek īstenotas atsevišķu projektu un iniciatīvu ietvaros, nevis kā daļa no pilsētas zaļās infrastruktūras plāna. Pašvaldībām bieži trūkst plānošanas instrumentu plavu ieviešanai pilsētas konkrētās funkcionālajās zonās, kas ņemtu vērā gan iedzīvotāju vēlmes un uztveri, gan apsaimniekošanas un izmaksu jautājumus. Pētījums risina šo iztrūkstošo posmu, kā pētījuma mērķi izvirzot pilsētas plavām piemērotāko pilsētas funkcionālo zonu noteikšanu Jelgavas pilsētā, izmantojot scenārijos balstītu pieeju. Pētījumā apvienoti iepriekš veikto sabiedrības aptauju dati ar telpisko analīzi un apsaimniekošanas modeļēšanu. Pētījumā atlasītas pilsētas funkcionālās zonas, kurās iespējama pilsētu plavu tipveida ieviešana. Katrai zonu grupai izstrādāti plavu integrācijas modeļi, ietverot divas izveides un apsaimniekošanas pieejas – ziedoša pilsētas plava un ekstensīvi apsaimniekots esošais zālājs. Izmantojot kontrolplānojumus, modelēts plavu procentuālais īpatsvars katrā funkcionālajā zonā, kā arī aprēķinātas apsaimniekošanas izmaksas piecu gadu periodam izstrādāti divi pilsētas mēroga plavu integrācijas scenāriji, kas ļauj salīdzināt dažādas izveides un apsaimniekošana pieejas. Pētījuma rezultāti apstiprina telpiskā novietojuma nozīmi veiksmīgai plavu integrācijai pilsētā. Plašākas un nepārtrauktākas plavu teritorijas iespējams izvietot pilsētas perifērijā, dabas teritoriju tuvumā, kā arī dzelzceļa un tehniskajās zonās, savukārt pilsētas centrālajās teritorijās – ielu ainavtelpās un daudzstāvu dzīvojamo ēku pagalmos – nepieciešami skaidrāki un vizuāli atbalstāmāki risinājumi mazākās telpiskajās robežās, kas sekmētu pozitīvāku sabiedrības attieksmi. Pētījuma noslēgumā secināts, ka pilsētu plavu integrācija jāskata kā apsaimniekošanas režīmu pārveide, kas sistemātiski iekļaujama pašvaldību zaļās infrastruktūras plānošanā. Savienojot sabiedrības uztveri, funkcionālo zonējumu un diferencētas apsaimniekošanas pieejas scenārijos balstītā ietvarā, iespējams virzīties no atsevišķiem pilotprojektiem uz strukturētu, ekonomiski pamatotu un sociāli pieņemamu pilsētu plavu ieviešanu dažādās pilsētas funkcionālajās zonās.