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Research Article

Transforming an Urban Void into an Ecological Public Space: Landscape Design and Implementation of Ardahan Nation's Garden (Türkiye)

Alperen Meral[1], Doruk Görkem Özkan[2], Özgür Demirci[3], İlknur Yazıcı[4,*]

[1] Bingöl University, Faculty of Agriculture, Department of Landscape Architecture, Bingöl, Türkiye; https://orcid.org/0000-0001-6714-7187

[2] Karadeniz Technical university, Faculty of Forestry, Department of Landscape Architecture, Trabzon, Türkiye; https://orcid.org/0000-0002-0127-0948

[3] Karadeniz Technical university, Faculty of Forestry, Department of Landscape Architecture, Trabzon, Türkiye; https://orcid.org/0000-0002-1081-2892

[4] Bingöl University, Faculty of Agriculture, Department of Landscape Architecture, Bingöl, Türkiye; https://orcid.org/0009-0003-9134-2654

*** Corresponding author:** iyazici@bingol.edu.tr

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Abstract: This study presents a post-design evaluation of the Ardahan Nation's Garden (Türkiye), examining how the transformation of an underused urban void into a multifunctional ecological public space performs in terms of ecological, aesthetic, and social outcomes. The methodological framework integrates spatial analyses, ecological performance assessment, aesthetic quality evaluation, and user-oriented observations, conducted after the project's completion. Data were obtained from site surveys, vegetation inventories, GIS-based land-use measurements, drainage and permeability analyses, and on-site behavioral mapping. The evaluation follows the Nature-Based Solutions (NbS) Evaluation Framework and the Landscape Aesthetic Quality Index, enabling a systematic assessment of the design's ecological functionality and visual coherence. Findings indicate that the project increased green area coverage to 61.5%, implemented over 40,500 plantings dominated by native cold-climate species, and restored natural hydrological processes through bio-swales and permeable surfaces. Ecologically, these interventions enhanced carbon sequestration potential, biodiversity continuity, and microclimate regulation. Aesthetic analysis shows improved visual legibility through topography-sensitive spatial organization, natural materials, and seasonal vegetation dynamics. Socially, the site demonstrates increased public use, accessibility, and place attachment, functioning as a socio-ecological system that supports community well-being. Overall, the study provides empirical evidence that small-scale NbS applications in severe climatic regions can generate measurable environmental, aesthetic, and social benefits, offering a transferable model for sustainable urban design practices.

Keywords: Nature-based solutions (NbS); Ecological design; Urban resilience; Green infrastructure; Landscape aesthetics; Sustainable urban transformation.

1. Introduction

The rapidly increasing urbanisation process is causing natural landscapes to be replaced by artificial and impermeable surfaces. This transformation disrupts ecological integrity, reduces biodiversity, and increases the vulnerability of cities to climate-related risks (Antunez, 2024; Jandaghian et al., 2025). In this context, nature-based solutions provide an innovative framework for integrating ecological resilience into urban planning. These approaches aim to restore natural processes while enhancing human well-being (Cook et al., 2024; Frantzeskaki et al., 2020). Aligned with this global perspective, the Nation's Gardens Programme in Turkey represents a comprehensive initiative that redefines urban green infrastructure in terms of both climate action and social welfare. Its core goals include increasing carbon sink areas, expanding recreational access, and promoting sustainable urban transformation. In this respect, the programme is directly aligned with the United Nations Sustainable Development Goal 11: Sustainable Cities and Communities (Athokpam et al., 2024; Ugochukwu et al., 2024).

One of the most significant components of the programme is the transformation of abandoned or underutilised urban areas into multifunctional ecological public spaces. Nation's Gardens deliver broad environmental benefits by improving urban air quality, reducing carbon emissions, mitigating the urban heat island effect, and strengthening ecological connectivity (Zarei and Shahab, 2025; Zhang and Qian, 2024). These areas also function as ecosystem components that support biodiversity, provide habitats, regulate rainwater, and stabilise the soil (Antunez, 2024; Herath and Bai, 2024) Socially, they enhance cohesion and quality of life by offering opportunities for interaction with nature, physical and mental restoration, and community engagement (Ajmi et al., 2023; Wang et al., 2024).

However, large-scale green infrastructure initiatives also introduce challenges. Maintenance costs, land constraints and stakeholder negotiations often complicate the planning and management process (A. Buijs et al., 2019; Pauleit et al., 2019). Therefore, interdisciplinary approaches that balance ecological, social, and economic benefits are essential (Çakır and Gül, 2024; Corgo et al., 2024). In this context, Ardahan Nation's Garden stands out as an exemplary case of converting an urban void into an ecological, functional, and aesthetically meaningful public space.

Socio-culturally, Ardahan retains its rural town identity, shaped historically by nomadic pastoralism and small-scale livestock farming. This cultural structure keeps the tradition of open spaces alive, where residents maintain direct interaction with nature. For this reason, urban green infrastructure projects must be perceived not only as physical landscape elements but also as settings that support social belonging, local identity, and public interaction. The literature emphasises that landscape design in high-altitude, cold-climate cities must integrate both climatic conditions and user expectations into the design process (Salih and Báthoryné Nagy, 2024; Sobhaninia et al., 2025).

Ardahan's distinctive geographical and climatic characteristics offer both opportunities and constraints for the redesign of urban voids. Environmental factors such as high altitude, heavy snow cover, and a short active season require strategies that prioritise the use of native flora, consider topographical orientation, and incorporate community-based design approaches.

Urban voids and vacant lots, although often neglected, carry significant ecological and social potential in the context of sustainable urbanisation (Hashem et al., 2022; Martínez Cuaresma et al., 2025). hese spaces frequently emerge due to unplanned expansion, economic stagnation, or spatial inequalities (Chen and Hashimoto, 2025; Martínez Cuaresma et al., 2025). Their prolonged abandonment leads to environmental degradation, physical deterioration, and social problems such as insecurity and exclusion (Masood and Russo, 2023).

Recent research suggests that these areas should be seen not only as challenges but also as ecological resources that can be repurposed through nature-based solutions (Hanna et al., 2024; Pinto et al., 2023). Transforming abandoned urban areas into green infrastructure provides multiple environmental benefits, including carbon sequestration, microclimate regulation, increased biodiversity, and enhanced ecosystem services (Sanches and Mesquita Pellegrino, 2016). Socially, such transformations revitalise public life, strengthen community participation, and contribute to urban well-being (Chen and Hashimoto, 2025; Masood and Russo, 2023). Consequently, multifunctional green infrastructure is recognised as a strategic planning tool for both climate adaptation and socio-economic resilience (Korkou et al., 2025; Zarei and Shahab, 2025).

Contemporary literature in urban planning and landscape architecture highlights ecological design principles as a comprehensive framework for achieving sustainability goals (Mostafavi and Doherty, 2016; Wu et al., 2025). Ecological design seeks not only to prevent

environmental degradation but also to create systems that support nature's capacity for self-renewal (Lee and Kim, 2021). Key principles include compatibility with natural processes, energy efficiency, sustainable water cycles, increased permeability, and biodiversity conservation (Musacchio, 2009).

Using native flora is a fundamental element of ecological design. Native species are well adapted to climatic, edaphic, and microbial conditions due to long evolutionary processes (Tartaglia and Aronson, 2024). Their use reduces maintenance costs, decreases carbon footprints, and ensures habitat continuity for wildlife (Smallwood and Wood, 2023). Native plants also strengthen landscape identity and contribute to cultural continuity (Ahern, 2013). In this regard, local ecosystem-based plant design is considered a strategy that supports both ecological and aesthetic values.

The success of sustainable urban landscapes is directly related not only to ecological suitability but also to the level of public participation and social acceptance (A. E. Buijs et al., 2016). Participatory planning approaches ensure social belonging, spatial ownership, and continuity of use by incorporating the expectations of the local community into the design process (Molin et al., 2017) Furthermore, public participation strengthens stakeholder dialogue for the sustainable management of urban ecosystems and supports the equitable distribution of ecosystem services (Raymond et al., 2017).

The primary objective of this study is to evaluate the process of transforming an underutilized urban void into a multifunctional ecological public space using a nature-based solutions (NbS) approach, using the example of Ardahan Nation's Garden. The study analyzes the effects of ecological design principles, the use of local flora, and participatory planning processes on ecological integrity, visual aesthetics, and social interaction. In this context, it examines how landscape design decisions align with carbon sequestration, biodiversity enhancement, microclimate regulation, and social welfare indicators; it also reveals the site's performance in terms of climate change adaptation, ecosystem service continuity, and cultural identity reinforcement.

The research aims to develop nature-based landscape design models that are sensitive to local conditions for cities in the cold continental climate zone. Thus, the study discusses the role of the " Nation's Gardens Program" in sustainable urban transformation policies in light of empirical data, offering a framework that holistically evaluates not only ecological sustainability but also components of social resilience and spatial identity.

2. Materials and Methods

2.1. Study area

This research was conducted in Ardahan Nation's Garden, located in the provincial center of Ardahan in northeastern Turkey. Ardahan Province is situated on a plateau at an altitude of approximately 1,800-2,000 metres. Due to its high elevation, it experiences a cold continental climate (Köppen Dfb) characterised by short summers and long, harsh winters (Weather-Atlas, 2024; Wikipedia, 2024). According to the 1991–2020 climatic normals published by the Turkish State Meteorological Service, Ardahan exhibits some of the most severe continental climate characteristics in Türkiye. The annual average temperature is 4.3 °C, with markedly low values during winter; the average temperatures are –10.3 °C in January and –9.1 °C in February. During the warmest period, average temperatures reach 16.4 °C in July and 16.7 °C in August. The annual average maximum temperature is 11.3 °C, while the annual average minimum temperature is –1.8 °C. Ardahan receives an annual total precipitation of 600.4 mm, with the highest precipitation occurring in June (101.7 mm) and the lowest in January (24.0 mm). The annual average sunshine duration is approximately 5.5 hours, with longer durations observed in the summer months. These data indicate that Ardahan has a continental climate characterized by long winters, low temperatures, and relatively high levels of precipitation (Meteorological Service of Turkey, 2025). Overall, these indicators confirm that Ardahan has one of the coldest continental climates in Türkiye, with long winters, low temperatures, and relatively high precipitation levels key environmental factors influencing design and assessment decisions for the study area (Figure 1).

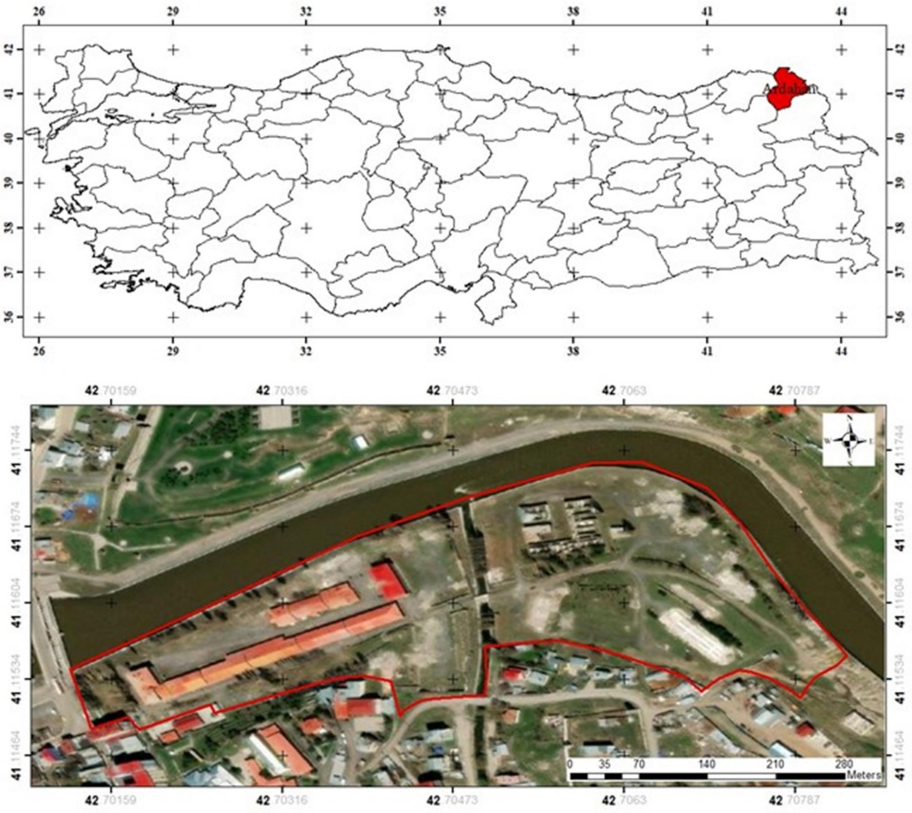

Figure 1. Study area.

Prior to the project, the area was characterized as an “urban void” due to its non-functional fill surfaces, irregular vegetation cover, and low permeability rate. Through the design process, the area has been re-functionalized around the axes of ecological restoration, recreational access, and aesthetic integrity (Figure 2). In this context, Ardahan Nation’s Garden presents an exemplary model of the application of nature-based solutions at the local level (Frantzeskaki et al., 2020).

Figure 2. Satellite images showing the pre-project (A) and post-project (B) conditions of the Ardahan Nation’s Garden.

2.2. Methods

The methodological approach used in this study is structured according to a four-stage workflow to enable the design and evaluation processes to be followed within a holistic framework. The process consists of sequential steps: conducting a current state analysis, developing a

conceptual design, proceeding to the spatial planning and detailing stages, and finally evaluating ecological, aesthetic, and social performance (Figure 3).

The scope of the Nature-Based Solutions (NbS) Evaluation Framework adopted in this study was intentionally limited to ecological, aesthetic, and social dimensions, as these components directly correspond to the project's design objectives and available post-implementation data. Expanding the framework to include additional dimensions such as economic valuation, governance structures, or long-term ecosystem service modelling was not feasible due to the early establishment stage of the site and the absence of long-term monitoring datasets required for such analyses. Thus, the selected NbS dimensions represent those for which reliable, site-specific, and methodologically consistent indicators could be applied. Similarly, carbon-related assessment tools such as InVEST and EX-ACT were mentioned as potential instruments for future monitoring because they provide scalable modelling approaches for landscape-level carbon accounting. However, smaller-scale or site-specific tools such as field-based carbon flux measurements, urban tree carbon calculators, or plot-level biomass estimation models were not applied in this study. These methods require detailed dendrometric measurements, species-specific growth curves, or long-term flux monitoring, which are not yet available for the newly established vegetation. Moreover, the project's objective was to evaluate the site's overall ecological performance, rather than producing precise plot-level carbon quantifications. For these reasons, a framework-level ecological assessment was deemed more appropriate for the current stage of the project. Acknowledging these scale-related limitations clarifies the methodological preferences and delineates opportunities for more detailed carbon accounting in future monitoring phases.

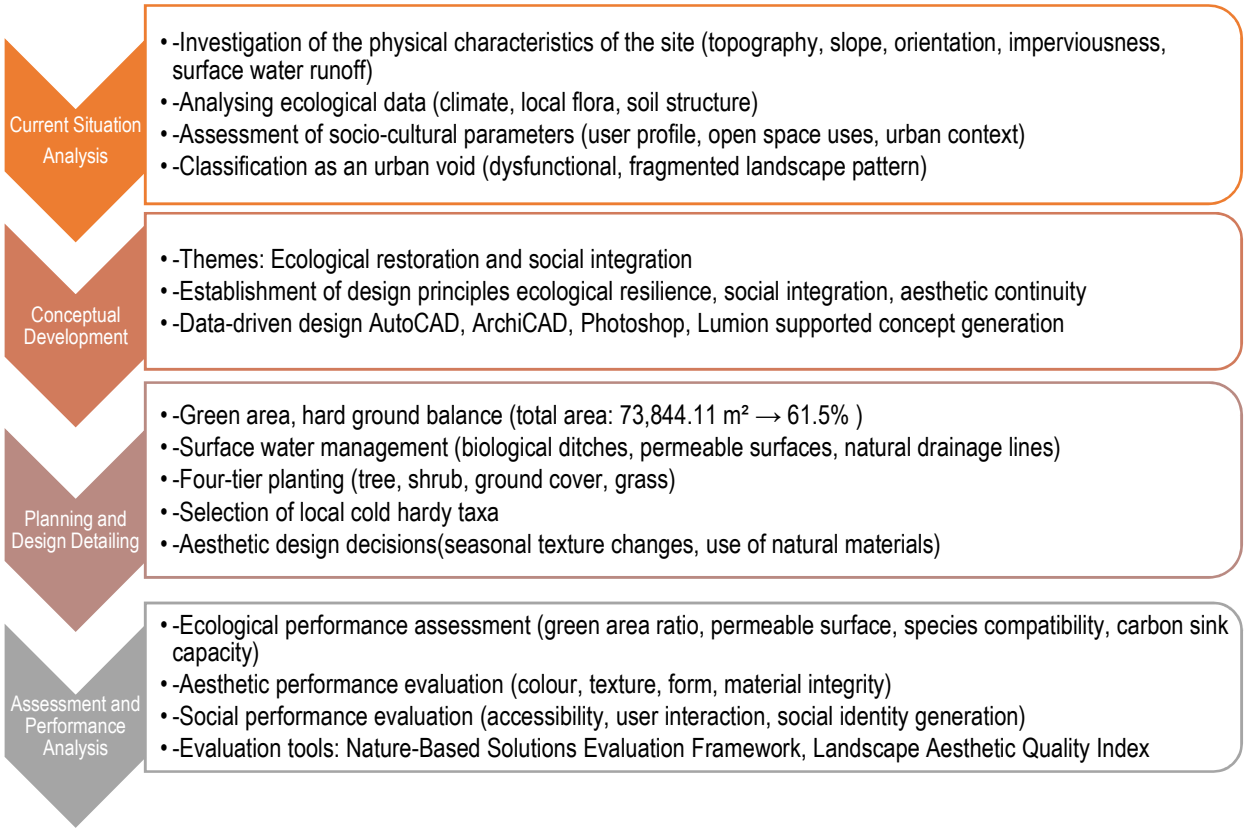

Figure 3. Method flow chart.

2.3. Limitations of the study

This study has several limitations that should be acknowledged when interpreting the findings. First, the ecological evaluation is based on data collected during the early post-implementation period, when vegetation had not yet reached full maturity; therefore, several ecological indicators particularly those related to biomass accumulation, carbon sequestration, and long-term habitat formation could not be measured with

high precision. Second, the climatic and environmental assessments relied on available long-term meteorological datasets and design-stage documentation, which constrained the analysis of microclimatic variations and fine-scale ecological processes within the site.

Third, the carbon-related evaluation was conducted at a framework level due to the absence of long-term monitoring data and the practical limitations of applying plot-level or flux-based measurement tools in newly established landscapes. This approach provides a general understanding of ecological performance but does not replace detailed carbon accounting models that could be employed in future monitoring phases. Additionally, the study focuses on a single case within a cold-climate context, which may limit the generalizability of the findings to regions with different ecological, social, or climatic characteristics.

Despite these constraints, the study offers valuable insights into the ecological, aesthetic, and social outcomes of a nature-based landscape transformation in a harsh-climate urban setting. Future research incorporating long-term monitoring, species-level growth data, and spatial modelling tools would enhance the robustness and transferability of the findings.

2.4. Phases of project preparation and design

The Ardahan Nation's Garden project has been developed in four main phases in line with the nature-based solutions approach: (i) analysis of the current situation, (ii) conceptual development, (iii) planning and design detailing, (iv) evaluation. These phases aim to systematically document both the conceptual and spatial decisions of the design process (Deming and Swaffield, 2011; Schön, 2017).

In the first phase, the physical, ecological, and socio-cultural parameters of the project area were evaluated using a holistic approach. The topography, orientation, impervious surface ratio, and existing vegetation cover of the 73,844.11 m² area were analyzed. This analysis revealed the spatial potential of the area and its morphological relationship with the urban fabric. Ecologically, considering Ardahan's cold continental climate conditions (average temperature 2.5 °C; annual precipitation 511.9 mm), the usability of cold-resistant local flora species (*Pinus sylvestris*, *Betula pendula*, *Salix alba*, etc.) in landscape design was evaluated. From a socio-cultural perspective, the site's location within the urban fabric, user profile, and local community's open space usage habits were observed. Based on these observations, planning approaches were developed to ensure the project is functional not only physically but also within its social context (Niemelä et al., 2010). As a result of all these analyses, it was determined that the area constitutes a "non-functional urban void"; opportunities focused on ecological restoration and social integration were identified for the redevelopment process (Figure 4).

Figure 4. Photograph illustrating the pre-project condition of the Ardahan Nation's Garden, showing an underused open space with limited vegetation and fragmented landscape patterns.

In the second phase, a conceptual framework centered on the themes of "ecological restoration" and "social integration" was developed based on the data obtained from the analysis findings. This framework aimed to strengthen the ecological potential of the area while also

creating a user-focused public space. Three fundamental principles were adopted in the design process: ecological resilience, social integration, and aesthetic integrity. In terms of ecological resilience, the use of cold-resistant and local flora species, the reduction of impervious surfaces, and the preservation of natural drainage lines were prioritized. In line with the principle of social integration, increasing public access and designing multifunctional open spaces that appeal to different age groups were emphasized. Aesthetic integrity has been achieved through spatial arrangements that are compatible with the topography, preserve the texture of natural materials, and support visual continuity. The conceptual design process was supported by the combined use of AutoCAD, ArchiCAD, Lumion, and Adobe Photoshop software; these digital tools enabled the design concept to mature through visual and spatial representations (Ahern, 2013; Wu et al., 2025) (Figure 5).

Each land use type and landscape element selected during the design process is directly linked to the methodological framework. For example, increasing the proportion of green space and multi-layered plant arrangements were determined by considering the ecological resilience and carbon sequestration criteria in the NbS Assessment Framework. Social spaces such as footpaths, children's play areas and activity meadows have been designed taking into account indicators of community participation and social integration. Aesthetic material and plant selections are directly linked to the colour, texture, form and spatial continuity criteria in the Landscape Aesthetic Quality Index (LAQI). The relative importance of each design criterion in the project was determined using prioritisation matrices and site analysis results, with ecological resilience and social participation forming the three fundamental axes of the design alongside aesthetic harmony. This approach ensures a transparent and systematic link between design decisions and the indicators of both the NbS and LAQI frameworks.

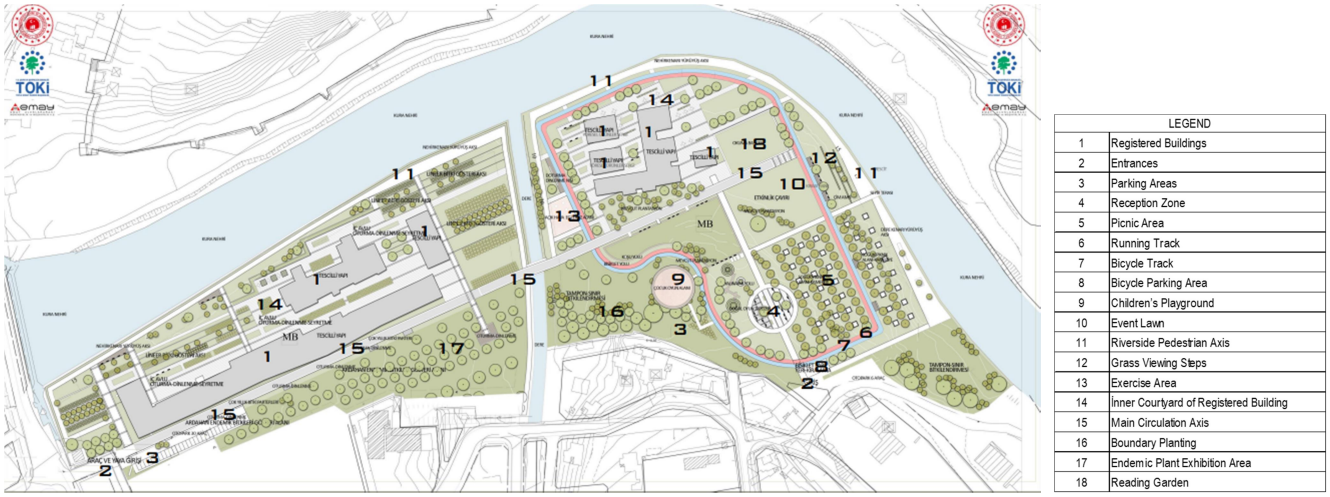

Figure 5. Conceptual program of main design decisions and land use distribution.

In the third phase, planning decisions were developed based on the spatial organization of the area and the balance between green and hard surfaces. Of the total project area of 73,844.11 m², 61.5% (45,390 m²) was planned as green space and 38.5% (28,464.11 m²) as hard surface. This ratio was determined to balance both ecological functionality and user access. Within the scope of surface water management, permeable pavement systems have been implemented; bio-swales and green drainage lines that support the natural water cycle have been designed. The planting plan has been created based on the principle of a four-layer plant structure (trees, shrubs, ground cover, grass), and the use of cold-climate-resistant species has been prioritized. These arrangements have strengthened both the ecological permeability and spatial integrity of the area. The planting design has been developed with an aesthetic approach that is sensitive to visual continuity and seasonal color changes (Tartaglia and Aronson, 2024) (Figure 6).

Figure 6. General plan illustrating the spatial organization and the balance between green and hard surfaces.

In the final phase, the project process and design decisions were qualitatively evaluated in terms of ecological, aesthetic, and social performance dimensions. Within the scope of ecological performance, the adaptation of plant species to local climate conditions, the ratio of green space, and the distribution of permeable surfaces were examined. In the aesthetic performance evaluation, color, texture, form, and material harmony, as well as spatial continuity, were observed. Social performance was analyzed in terms of public access level, user interaction, and the area's contribution to social identity. This evaluation process was conducted based on the Nature-Based Solutions Evaluation Framework (Frantzeskaki et al., 2019) and the Landscape Aesthetic Quality Index (Palmer and Hoffman, 2001) criteria. Thus, it was revealed that the design offers a holistic approach that is not only a physical transformation tool but also has the capacity to generate urban resilience, social well-being, and aesthetic integrity.

3. Results

Within the scope of this study, the transformation process of Ardahan Nation's Garden from an urban void to an ecological public space has been qualitatively evaluated within the framework of nature-based solutions. The findings reveal the spatial reflections of the ecological, aesthetic, and social principles adopted in the design process after implementation. The ecological performance of the area was evaluated in terms of plant diversity, surface permeability, and the integration of natural drainage systems, while aesthetic performance was examined in terms of color, texture, form, and material harmony. The social performance assessment covers the dimensions of public access, user interaction, and contribution to social identity. The findings reveal that the Ardahan Nation's Garden example is not only a physical transformation of a green space but also a successful model for ecological restoration, social integration, and aesthetic value production through nature-based strategies.

3.1. Ecological results

As a result of the Ardahan Nation's Garden project, the project area has undergone a significant ecological transformation. Previously barren and dysfunctional land has been transformed into a green matrix with increased ecological permeability through soil rehabilitation and grass planting. The planting plan was designed to create a multi-layered plant structure (trees–shrubs–ground cover–grass), and species selection was made considering climatic resistance, aesthetic continuity, and ecosystem services.

The deciduous tree layer includes species such as *Acer saccharinum*, *Acer negundo*, *Betula pendula*, *Tilia tomentosa*, and *Populus alba*. These species were chosen for their ability to adapt to cold continental climates as well as their functions of providing shade, evaporation, and dust retention.

In coniferous species, the use of natural and durable species such as *Pinus sylvestris* and *Juniperus sabina* has strengthened the aesthetic integrity of the winter landscape in the area by providing visual continuity throughout the year.

In the shrub and groundcover layer, species such as *Rosa canina*, *Spiraea japonica*, *Berberis thunbergii*, and *Cotoneaster horizontalis* were preferred. These species support micro-scale ecosystem functions by providing erosion control, soil stabilization, wildlife, and habitat diversity.

Approximately 70% of the plant composition consists of natural and climate-adapted species, an approach that has reduced maintenance costs, increased carbon sequestration capacity, and ensured the continuity of biodiversity. Furthermore, the area's green coverage reaching 61.5% has significantly increased ecological permeability and green connectivity compared to before the project.

This ecological transformation has enabled an urban void to evolve into a landscape system that acts as a carbon sink, microclimate regulator, and habitat provider, in line with the fundamental principles of nature-based solutions (Ahern, 2013; Wu et al., 2025; M. Yılmaz et al., 2025) (Table 1).

Table 1. Latin names, stem circumference, height, crown width, and quantity of plant species used in the planting design.

Latin Name	Stem Circumference (cm)	Height (cm)	Crown Width (cm)	Quantity
Acer saccharinum L.	20-25	350-400	150-200	447
Acer negundo L.	20-25	300-350	150-200	292
Acer platanoides L.	25-30	350-400	150-200	108
Acer pseudoplatanus L.	20-25	300-350	150-200	8
Betula pendula Roth	20-25	350-400	150-200	441
Malus × *purpurea* (A.Barbier) Rehder	18-20	300-350	150-200	69
Morus nigra L. 'Pendula'*	18-20	300-350	150-200	60
Pyrus calleryana Decne. 'Chanticleer'*	20-25	350-400	150-200	14
Robinia pseudoacacia L. 'Umbraculifera'*	18-20	300-350	150-200	200
Ulmus glabra Huds.	20-25	300-350	150-200	36
Juniperus virginiana L. 'Skyrocket'*	-	175-200	-	110
Picea abies var. *conica* Nash	16-18	300-350	200-220	39
Picea pungens Engelm.	20-25	300-350	150-200	35
Pinus mugo Turra	-	60-80	5-100	21
Pinus sylvestris L.	20-25	300-350	150-200	190

Elaeagnus angustifolia L.	20-22	300-350	-	15
Malus × *domestica* (Suckow) Borkh.	20-22	300-350	-	30
Morus alba L.	20-22	300-350	-	23
Prunus avium (L.) L.	20-22	300-350	-	9
Prunus ceracus L.	20-22	300-350	-	10
Pyrus communis L.	20-22	300-350	-	10
Berberis thunbergii DC. 'Atropurpurea'*	_	60-80	6-8 branched	485
Berberis thunberghii DC. 'Maria'*	_	60-80	6-8 branched	275
Cornus alba L. 'Sibirica'*	_	80-100	6-8 branched	1,416
Cornus stolonifera Michx.	_	80-100	6-8 branched	256
Euonymus alatus (Thunb.) Siebold 'Compactus'*	_	80-100	6-8 branched	1,002
Euonymus japonicus Thunb. 'Microphyllus'*	_	30-35	6-8 branched	1,571
Juniperus horizontalis Moench	_	50-60	6-8 branched	10,912
Rosa sp. 'Ice Meillandecor'*	_	40-50	6-8 branched	2,952
Rosa sp. 'La Sevillana'*	_	40-50	6-8 branched	1,838
Viburnum opulus var. *roseum* L.		80-100	6-8 branched	237
Alyssum sp.	_	20-25	36	9,000
Carex elata All.	_	20-30	25	2,725
Iris × *germanica* L.	_	40-60	16	5,664
			TOTAL	40,500

* Refers to cultural forms used in the landscape.

The Ardahan Nation's Garden was largely dysfunctional, barren, and fragmented during the pre-project period. Most of the area consisted of irregular fill surfaces, and the natural vegetation cover had almost completely disappeared. These conditions led to a weakening of ecological functions by causing both increased surface runoff and decreased soil permeability. After the project (2024), the ecological and visual character of the area has changed fundamentally thanks to the green infrastructure integration carried out in the area. With 61.5% of the total 73,844.11 m² area converted into green space, the permeable surface ratio has increased and natural drainage lines have been restored to working order.

The bio-swale systems, tree-lined strips, and grassed open areas created in line with the new planning decisions have enhanced the ecological performance of the area in terms of both microclimate regulation and carbon sink capacity. In particular, the area, which previously exhibited a dull, monotonous, and dusty surface character, has gained layered vegetation, soft topographic transitions, and ecological permeability in the post-project period, demonstrating a successful local application of nature-based solutions (Frantzeskaki et al., 2019).

3.2. Aesthetic results

Render analyses and application photographs (Figure 7) reveal that aesthetic decisions in the design process of Ardahan Nation's Garden were developed in an integrated manner with nature-based principles. Following the project, the area gained visual continuity through walking paths designed with sensitivity to the topography, open spaces integrated with water features, and seasonal plant transitions. The

fundamental aesthetic approach of the design is based on a simple yet meaningful spatial language that emphasizes the legibility of natural processes over artificial forms.

Figure 7. Post-construction renders and field photographs of the project (Photo credit: Ardahan Medya Gazetesi, 2024; Ahmet Nazlı, 2025).

From a planting composition perspective, the balanced distribution of coniferous and deciduous species has enhanced the visual dynamism of the area by creating contrasting colors and textures throughout the year. The use of natural stone, wooden seating elements, and earth-toned floor coverings has supported the material integrity of the space, reducing the artificial surface effect and ensuring ecological harmony with the environment. These features have significantly improved the area's visual legibility, formal harmony, and landscape identity according to the Landscape Aesthetic Quality Index (Palmer and Hoffman, 2001) criteria (Figure 8).

Figure 8. Site photographs from the landscape implementation phase (Photo credit: Ardahan Medya Gazetesi, 2024; Ahmet Nazlı, 2025).

Furthermore, when evaluated within the Nature-Based Solutions Evaluation Framework (Frantzeskaki et al., 2020), the design's aesthetic performance goes beyond visual quality alone, creating an experience that enhances human-environment interaction through nature-based processes. The natural rhythm felt throughout the area reflects both an ecological aesthetic in harmony with local climate conditions and biophilic design principles that support users' psychological relaxation and sense of belonging. In this context, Ardahan Nation's Garden serves as a strong example of the applicability of nature-based aesthetic strategies in cold-climate cities.

3.3. Social results

Post-project observations and photographic documentation of user interactions (Figure 9) show that Ardahan Nation's Garden has been transformed into a socially powerful public interaction space. The design of the area has become a unifying center of attraction within the social fabric of the city by offering multifunctional usage scenarios that appeal to all age groups. Walking trails, children's play areas, open event lawns, and viewing axes facing the riverbank stand out as important spatial components that enable users to connect directly with nature.

When evaluated within the Nature-Based Solutions Evaluation Framework (Frantzeskaki et al., 2019), this transformation reveals that the area functions not only as a physical recreation space but also as a socio-ecological system that strengthens social integration. The project has reinforced social solidarity, local belonging, and feelings of spatial ownership, particularly by bringing together rural urban identity and modern public space dynamics (Figure 9).

Figure 9. Users of the project area (Photo credit: Ardahan Medya Gazetesi, 2024; Ahmet Nazlı, 2025).

Observations reveal that with the redevelopment of the area, users interact with nature more frequently in their daily routines, and the public space has evolved from passive observation to active participation. Open event lawns, picnic areas, and riverside walking paths have contributed to the revival of collective experiences in the city's social life. These findings are consistent with the literature emphasizing that participatory planning and user-centered design directly contribute to social sustainability (A. Buijs et al., 2019; Molin et al., 2017; Raymond et al., 2017).

In conclusion, the example of Ardahan Nation's Garden demonstrates that nature-based design principles can be applied not only as a tool for ecological restoration but also as an effective strategy for promoting social welfare, public belonging, and cultural continuity.

4. Discussion

The findings of this study reveal that the transformation of an underutilized urban void into the Ardahan Nation's Garden produced measurable ecological, aesthetic, and social improvements; however, interpreting these outcomes requires a broader analytical framework that positions the project within current theoretical and empirical debates on nature-based solutions (NbS) and cold-climate landscape design. In this respect, Ardahan offers a particularly valuable case because harsh climatic conditions, short vegetation periods, and limited plant adaptability impose constraints not commonly observed in temperate urban contexts.

From an ecological perspective, the project demonstrates that NbS principles can be operationalized even in cities with extreme continental climates an aspect insufficiently addressed in the literature, which predominantly focuses on temperate European examples (Frantzeskaki et al., 2019; Kabisch et al., 2017). The substantial increase in permeable surfaces and the use of 40,500 plants dominated by native species align with existing research emphasizing that native flora enhances ecological resilience and reduces long-term maintenance costs (Tartaglia and Aronson, 2024; Smallwood and Wood, 2023). However, unlike many NbS applications in milder regions, the early-stage ecological performance in Ardahan remains constrained by slow biomass accumulation and incomplete vegetation establishment. This condition suggests that NbS strategies in cold climates may require longer monitoring periods to accurately capture ecosystem service trajectories, particularly carbon sequestration and habitat formation highlighting a gap in the current assessment frameworks, which often assume faster ecological recovery cycles.

Aesthetic outcomes of the project provide another dimension for critical interpretation. While the design aligns with the principles of ecological aesthetics, promoting simplicity, material integrity, and seasonal dynamism, these findings must be considered within the broader debate on aesthetic–ecological trade-offs in public landscapes (Gobster et al., 2007; Nassauer, 2012). In contrast to designs prioritizing ornamental visual impact, Ardahan's approach foregrounds resilience and naturalistic composition an aesthetic language shown to enhance ecological literacy and promote public acceptance of NbS (McDonald and Beatley, 2021). Notably, the contrast between evergreen and deciduous species and the integration of natural materials have contributed to a stronger place identity, which aligns with studies suggesting that aesthetic legibility significantly influences users' emotional attachment to urban green spaces (Zhong et al., 2022). Yet, some implementation constraints such as climate-induced seasonal dormancy may temporarily reduce visual richness during long winter periods, an outcome that future studies should examine in relation to user perception dynamics.

The social results of the project also resonate with the growing literature emphasizing that public participation and social acceptance are essential for the long-term success of NbS (Buijs et al., 2016; Raymond et al., 2017). Increased user activity, diversified recreational patterns, and stronger place attachment observed following the implementation support arguments that accessible, multifunctional, and ecologically meaningful green spaces act as catalysts for social inclusion and environmental stewardship (Anguelovski et al., 2018). However, compared with community-driven NbS projects in larger metropolitan areas, Ardahan's smaller population and strong rural identity appear to have facilitated rapid social integration. This finding indicates that socio-cultural context is a significant variable influencing the effectiveness of NbS interventions an aspect often overlooked in universalized urban greening models.

When compared with similar case studies in cold or high-altitude settings, Ardahan's transformation appears to align with the conclusions of Sobhaninia et al. (2025) and Herath and Bai (2024), who emphasize that landscape-scale green infrastructure in severe climates requires adaptive strategies prioritizing microclimate regulation, natural drainage systems, and carefully selected species palettes. The project's successful implementation of these elements suggests that the Nation's Gardens Programme may serve as a scalable model for cold-climate NbS applications in other mid-sized Anatolian cities. Nonetheless, the absence of long-term ecological and social monitoring data limits the ability to fully evaluate the durability of the benefits identified in this early-phase assessment.

Overall, the outcomes of this study indicate that the Ardahan Nation's Garden project not only meets NbS criteria but also contributes to a nuanced understanding of how NbS can be applied in harsh climatic conditions. These results underscore the importance of integrating ecological principles with cultural, spatial, and climatic realities. Future research should expand on this work by conducting longitudinal ecological monitoring, applying carbon accounting tools such as InVEST and Ex-ACT, and systematically evaluating user experiences over time. By incorporating such approaches, NbS-based urban transformation projects can evolve from visually improved green spaces into measurable resilience infrastructures that enhance both ecological functioning and societal well-being.

In the future, it is recommended that long-term ecosystem service monitoring, carbon budget calculations and the integration of participatory management mechanisms be implemented in similar projects. This approach will strengthen sustainable urban transformation and climate adaptation strategies.

5. Conclusions

This study has demonstrated the applicability of the nature-based solutions (NbS) approach in high-altitude, cold-climate cities with unique socio-cultural characteristics, using the example of Ardahan Nation's Garden. The research findings show that comprehensively addressing the principles of ecological restoration, aesthetic integrity, and social solidarity is crucial in transforming idle urban areas into resilient ecosystems. Within the scope of the project, increasing the proportion of permeable surfaces, promoting the use of local flora, and integrating green infrastructure systems has strengthened carbon sink capacity, improved microclimate conditions, and contributed to the continuity of biological diversity. At the same time, the multifunctional reprogramming of public space has increased the frequency of users' interaction with nature, thereby strengthening social belonging, cultural continuity, and spatial ownership.

The results obtained reveal that nature-based design principles support not only environmental sustainability but also components of social welfare and urban identity. In this regard, Ardahan Nation's Garden serves as an important model for the sustainable urban

transformation objectives of the “Nation's Gardens Program” implemented in Turkey. The project, as a concrete reflection at the local level of the national green infrastructure strategy supported by TOKİ, has successfully established a balance between climate change adaptation, carbon management, and ecological aesthetics.

In conclusion, this study demonstrates the potential of nature-based solutions to enhance ecological, aesthetic, and social resilience in small-scale cities and emphasizes the need to integrate this approach into future urban planning policies. Future research focusing on long-term ecosystem service monitoring in similar applications, carbon budget modeling (e.g., using InVEST or Ex-ACT-based analyses), and quantitative assessment of user experiences will deepen the scientific and managerial impacts of nature-based urban transformation projects.

Conflicts of Interests
Authors declare that there is no conflict of interests

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Statement contribution of the authors
This study's experimentation, analysis and writing, etc. all steps were made by the authors.

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