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Original Paper

A SITES-Informed Retrofit Framework for Wetland-Adjacent Urban Parks: Evidence from Mogan Park, Ankara, Türkiye

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Abstract

This study develops a Sustainable Sites Initiative (SITES)-informed retrofit framework for Mogan Park, a wetland-adjacent urban park located on the Lake Mogan shoreline in Ankara, Türkiye. The park lies within a protected landscape system shaped by the Gölbaşı Special Environmental Protection Area, hydrological thresholds, biodiversity sensitivity, and intensive recreational use. The study combines GIS-based spatial analysis, field observation, documentary review, and an adapted SITES v2 assessment to evaluate site context, water management, soil and vegetation, materials, human well-being, construction impacts, and operations and maintenance. Results indicate that the assessed 406,367.12 m² footprint is dominated by green surfaces and hardscape, while wetland surfaces remain limited and highly sensitive. The most critical operational deficiency is park-wide drainage underperformance affecting circulation routes, the promenade, running track, amphitheater, pools, and sports fields. The proposed retrofit package prioritizes wetland-edge protection, seasonal access control, rain gardens, bioswales, permeable materials, native and riparian vegetation restoration, canopy-based microclimate regulation, and adaptive monitoring. The framework demonstrates how international site-sustainability criteria can be translated into context-specific retrofit standards for ecologically sensitive urban parks.

Keywords: ecological engineering; green infrastructure; stormwater management; native vegetation; adaptive management; protected landscape governance

1. Introduction

Global landscapes are undergoing rapid social-ecological change driven by climate disruption (IPCC, 2023), a 69% decline in monitored wildlife populations since 1970 (WWF, 2022), and rising resource consumption (Friedlingstein et al., 2020). These pressures undermine ecosystem integrity, human welfare, and environmental quality through land degradation, water stress, and resource depletion (Díaz et al., 2019; Ceballos et al., 2017; Watts et al., 2019; Patz et al., 2005; WHO, 2021; FAO, 2015; Mekonnen & Hoekstra, 2016). Accordingly, landscape planning increasingly requires evidence-based approaches that integrate ecological function with urban development and coordinate natural resource management across scales (Steiner, 2014; Ahern, 2013; Steffen et al., 2015; United Nations, 2015).

Urban parks are key social-ecological systems (Nassauer & Opdam, 2008) and strategic sites for implementing landscape sustainability. However, most parks were not designed to contemporary sustainability standards (Harnik, 2010), creating a need for retrofit approaches that balance ecological performance, budget constraints, and social equity (Low et al., 2005; Rigolon, 2016). Since the 1992 Rio Earth Summit (United Nations, 1992) and the European Landscape Convention (Council of Europe, 2000), ratified by Turkey in 2003, ecology-based spatial planning has become central to landscape practice (Steiner, 2014; Ahern, 2013). The ELC frames landscape protection, management, and planning across scales (Jones & Stenseke, 2011), yet Turkish legislation (Law No. 2872, 1983; Law No. 5393, 2005) provides general environmental mandates without specific sustainable design standards for park retrofits.

Although sustainable landscape design is a well-established conceptually (Steiner, 2014; Thompson & Sorvig, 2008; Lyle, 1999), relatively few studies operationalize these principles for retrofitting existing urban parks in emerging economies characterized by limited municipal budgets and incomplete sustainability policy infrastructure (Harnik, 2010). Existing research focuses primarily on new construction (Kibert, 2016) or high-resource contexts (SITES, 2014), leaving important gaps in context-specific assessment tools adapted to local climate, ecological conditions, and socio-economic constraints (Erdoğan & Aklıma, 2015), retrofit methods that optimize existing site assets while addressing performance deficiencies (McHarg, 1969; Hough, 2004), and policy operationalization that translates

general environmental mandates into quantifiable standards for municipal planning and procurement (Keleş, 2000; Ersoy, 2012; Tekeli, 2009).

This study addresses these gaps by developing an evidence-based retrofit methodology for urban parks in contexts where sustainability infrastructure is still evolving. Using Mogan Park, Ankara, as a case study (Yin, 2014), the study aims to: (1) assess the sustainability performance of an existing urban park using adapted SITES criteria across seven dimensions—energy efficiency, water conservation, native vegetation utilization, sustainable materials, site management practices, ecological function, and social equity (SITES, 2014; Mazria, 2003; Vickers, 2001; Tallamy, 2007; Thompson & Sorvig, 2008; Benedict & McMahon, 2006; Low et al., 2005); (2) develop retrofit strategies integrating energy efficiency, ecological function, economic viability, social equity, and aesthetic quality through site-adaptive solutions that optimize vegetation, topography, hydrological patterns, solar access, and climate (McHarg, 1969; Hough, 2004); and (3) propose a replicable methodology for urban green-space retrofits aligned with international frameworks and adapted to the Turkish context to inform municipal planning and procurement (SITES, 2014; ELC, 2000; Erdoğan & Aklıma, 2015; Tekeli, 2009).

Site analysis documented climate, topography, vegetation, water resources, circulation networks, recreational uses, infrastructure, and landscape features (Oke, 1987; Burrough & McDonnell, 1998; Kenney et al., 2011; Ferguson, 2005; Forsyth & Krizek, 2011; Booth & Hiss, 2011). Sustainability evaluation against SITES criteria identified performance gaps that informed retrofit strategies prioritizing native vegetation, sustainable materials, and accessible circulation (Tallamy, 2007; Thompson & Sorvig, 2008). In doing so, the study extends sustainable landscape planning to retrofit contexts shaped by existing conditions, heritage values, and limited resources; adapts international standards to municipal application in emerging economies; and establishes quantifiable criteria for Turkish urban green-space planning and procurement (Erdoğan & Uslu, 2011; Steiner, 2014; Ahern, 2013; SITES, 2014; ELC, 2000; Law No. 5393, 2005; Tekeli, 2009; Keleş, 2000; Ersoy, 2012).

1.1. Conceptual and Evaluative Framework

1.1.1. Sustainability Frameworks for Landscape Planning

Sustainability emerged from recognition that industrial development had exceeded ecological limits (Meadows et al., 1972). The Brundtland Commission defined sustainable development as “meeting the needs of the present without compromising future generations’ ability to meet

their own needs" (WCED, 1987, p. 43), establishing intergenerational equity as a core principle. This principle was subsequently operationalized through the Triple Bottom Line (Elkington, 1997), the Planetary Boundaries framework (Rockström et al., 2009; Steffen et al., 2015), and regenerative design theory (Lyle, 1999; Reed, 2007), which together underpin contemporary landscape practice and assessment systems such as SITES (GBCI, 2014).

Since the Industrial Revolution, fossil fuel use increased 50-fold between 1800 and 2000 (Smil, 2017). During the post-1950 "Great Acceleration," global urbanization reached 57% (UN DESA, 2018), multiple planetary boundaries were exceeded (Rockström et al., 2009), biodiversity declined by 69% since 1970 (WWF, 2022), urban expansion increasingly threatened conservation areas (Seto et al., 2012), and cities generated 75% of global emissions (UN-Habitat, 2011). Governance responses included the Stockholm Conference (UN, 1972), Agenda 21 (UN, 1992), the UNFCCC (1992), the CBD (1992), and the European Landscape Convention, ratified by Turkey in 2003 (Council of Europe, 2000), alongside sustainability assessment systems (SITES, 2014; LAF, 2012).

This study adopts a three-pillar framework—Economy, Ecology, and Equity (3E)—for landscape architecture (Atıl et al., 2005), aligned with the European Landscape Convention and SDG 11 (Council of Europe, 2000; UN, 2015). Economic performance is evaluated through life-cycle costs (≤$15,000/ha/year, LAF, 2012), irrigation water use (≤50% potable water, SITES v2, 2014), and lighting and maintenance energy use (≤30 kWh/m²/year, LEED v4, 2019). Ecological performance is assessed through canopy cover (≥40%, Bowler et al., 2010), native vegetation (≥60%, Tallamy, 2007), stormwater retention (90th-percentile storm capture, EPA, 2015), and soil organic carbon (≥3%, Lal, 2004). Social equity is measured through 100% ADA-compliant pathways (DOJ, 2010), equitable facility distribution (Gini coefficient ≤0.30, Rigolon, 2016), and participation from underserved groups (≥30%, Fainstein, 2010).

1.1.2. Ecological Landscape Planning Principles

Ecological landscape planning integrates climate, topography, soil, hydrology, and vegetation into design and management decisions to align land use with ecological carrying capacity and support existing ecological processes (McHarg, 1969; Steiner, 2014; Ahern, 2013; Atıl et al., 2005). Contemporary practice emphasizes multifunctional landscape systems—habitat corridors, urban air corridors, and green infrastructure—that simultaneously support recreation, biodiversity, stormwater management, and microclimate regulation (Ahern, 2013).

Strategic vegetation placement can reduce building energy use by 20–40% (McPherson & Simpson, 2003; Akbari, 2002), while urban tree cover can lower ambient temperature by 2–5°C and electricity demand by 5–10% (Gill et al., 2007). Integrating native vegetation, hydrological patterns, and green infrastructure can reduce life-cycle costs by 20–30% while enhancing carbon sequestration (250–500 kg CO_2/tree/year), biodiversity, and public health (Tallamy, 2007; Spirn, 1984; Ahiablame et al., 2012; Nowak & Crane, 2002; Müller et al., 2013; Hartig et al., 2014). These strategies require calibration to regional climate and ecological conditions (Benedict & McMahon, 2006). Precedents such as Downsview Park, where tree infrastructure covers 25% of a 291-acre site, and Yongning River Park demonstrate that layered ecological design can integrate habitat restoration, stormwater control, landscape connectivity, and social use (Tree City Plan).

1.1.3. Energy-Efficient Landscape Design

Energy-efficient landscape design uses solar radiation, wind, precipitation, vegetation, topography, and surface properties to reduce fossil fuel dependence for heating, cooling, and lighting while improving environmental quality and thermal comfort (Erdoğan & Uslu, 2011; McHarg, 1969; Hough, 2004; Krigger, 1995). Urban green areas are on average 3.5°C cooler than non-vegetated urban areas, and tree-lined streets are approximately 6°C cooler than treeless streets (Zolnoun, 2013). Tree shading can reduce cooling energy by 17–57%, lower surface temperatures by 10–35%, reduce soil temperature under canopy by up to 19.5°C, and decrease combined heating and cooling energy use by up to 25% when trees are strategically placed near buildings (Panagopoulous, 2008). Water bodies further moderate temperature through evaporative cooling and humidity regulation.

Passive strategies also generate measurable gains. Building orientation and vegetation placement can reduce heating loads by 30–70% (Mazria, 1979). Windbreaks can reduce heating energy by 10–25% while improving air filtration (Heisler & DeWalle, 1988; Barış, 1995). Natural ventilation can reduce mechanical cooling demand by 30–50% and indoor summer temperatures by 6–12°C (Givoni, 1998; Zolnoun, 2013). Rainwater harvesting can reduce pumping energy by 40–60% (Farreny et al., 2011). High-albedo and permeable surfaces mitigate urban heat island effects, while vegetation shading over impervious surfaces improves thermal comfort and reduces vehicular cooling demand (Şenol, 2019; Duman, 1999; Hoeven, 1982). Vegetation placement remains decisive: appropriate planting can reduce winter heating by 15% and summer cooling by more than 50%, with deciduous trees

preferred on south and west facades and evergreens on north facades (Robinette, 1983; Hoeven, 1982; Krigger, 1995; Alpay et al., 2013). Native species further enhance resilience while reducing water, fertilizer, and pesticide inputs (Erdoğan & Uslu, 2011). Complementary strategies, including photovoltaics, green roofs, green walls, and urban agriculture, extend this logic; green roofs can reduce heating and cooling demand by up to 50% and yield fuel savings of 2 L/m² annually, while vegetated walls can reduce surface temperatures by up to 30°C (Koç & Gültekin, 2010; Korkut et al., 2017; Üsküplü & Polat, 2019).

1.1.4. Water-Efficient Landscape Design

Water-efficient landscape design reduces potable water demand while improving hydrological performance and ecosystem health through greywater recycling, rainwater harvesting, xeriscaping, rain gardens, and green infrastructure (Şenol, 2019; Tanık, 2017; Calkins, 2005; EPA, 2015). Xeriscaping combines drought-tolerant planting, mulching, reduced turf, and efficient irrigation to lower water, labor, and energy use while maintaining habitat value (Şenol, 2019). Rain gardens capture, infiltrate, and filter runoff; the 200 m² Mount Tabor Middle School rain garden illustrates the multifunctional capacity of such systems (Aydoğdu, 2018). Built precedents such as Bryant Park, Knoch Knolls Nature Center, and Hillside Eco Park show that rainwater management can be integrated with broader ecological and energy-performance objectives (Anonymous, 2025u; Anonymous, 2025ü; Anonymous, 2025v).

1.1.5. Sustainable Landscape Approaches in Urban Park Improvements

Urban parks are multifunctional social-ecological systems that provide recreation, public health benefits, and critical ecosystem services, including microclimate regulation, improved air–water–soil quality, noise reduction, stormwater management, biodiversity conservation, carbon sequestration (250–500 kg CO_2/tree/year), and urban cooling (2–5°C) (Karadeniz, 2019; Chiesura, 2004; Eşbah, 2006; Nowak & Crane, 2002; Gill et al., 2007). Park standards also emphasize minimum size, walkable access, transit connectivity, and inclusive programming (Karadeniz, 2019). Under accelerating urbanization, however, heat island effects, habitat fragmentation, pollution, infrastructure deficits, land degradation, and ecosystem service loss have intensified, particularly where urban green spaces remain disconnected from natural cycles and sustainability goals (Korkut et al., 2017; Onur, 2012; Atıl et al., 2005). Since the late 1990s, sustainable park planning has shifted toward resource

self-sufficiency, ecological alignment, and performance-based design quality (Cranz & Boland, 2004). Retrofitting existing parks with water- and energy-efficient strategies is therefore central to contemporary practice (Panagopoulos, 2008). Such retrofits can reduce maintenance costs by up to 80%, improve environmental quality through native planting, reduce greenhouse gas emissions, mitigate soil erosion, buffer noise, and strengthen long-term ecological and economic value through local materials, native vegetation, rain gardens, waste separation, and composting (Uğur, 2009; Kavuran, 2021; Tregay, 1986; Calkins, 2005). On this basis, the criteria synthesized from McHarg (1969), Tunçer (1994), Cranz and Boland (2004), Calkins (2005), Atıl et al. (2005), Aklanoğlu (2009), Onur (2012), and Alpay et al. (2013) are operationalized in Table 1.

Table 1. Sustainable landscape planning and design approach: urban park improvement criteria (Original, 2020).

No.	Urban Park Improvement Criteria	Key sustainability focus
1	Conserve the existing landscape character by limiting interventions in natural development and maintaining a natural appearance.	Landscape character / visual integrity
2	Support existing biodiversity and provide habitat for threatened/endangered species.	Biodiversity / habitat
3	Protect urban ecosystems and existing habitats.	Urban ecology / habitat protection
4	Ensure design compatibility with natural resources (e.g., climate, topography, soils) and with historical and cultural values.	Context-sensitive design / heritage
5	Provide activities that are consistent with the site's natural structure and social needs, strengthening human–nature interaction.	Human–nature interaction / programming
6	Adopt approaches that reduce energy and water consumption (energy- and water-efficient design; green roofs and green walls; sustainable agriculture/permaculture; xeriscaping; rain gardens; bioswales).	Energy–water efficiency / green infrastructure

7	Achieve solar control on existing ground/paving surfaces through vegetative and structural materials.	Solar control / heat mitigation
8	Provide wind control by leveraging natural vegetation.	Wind control / microclimate
9	Use natural, local, and recycled materials with low maintenance requirements/costs.	Materials / low maintenance
10	Use local and well-adapted plant species.	Native/adapted planting
11	Use renewable energy sources.	Renewable energy
12	Integrate recycling practices into site management and maintenance (recovery of energy, waste, and water).	Circularity / resource recovery
13	Measure and analyze seasonal performance indicators within site management to ensure controlled continuity over time.	Monitoring / adaptive management
14	Embed sustainable and ecological management policies in the site mission and management framework.	Governance / ecological policy
15	Ensure accessibility (universal access).	Accessibility / equity
16	Build environmental awareness in society by foregrounding landscape aesthetics with ecological value, advancing the concept of ecological aesthetics, and establishing standards.	Environmental awareness / standards

1.1.6. Certification Systems for Sustainable Site Creation

LEED (Leadership in Energy and Environmental Design), established by the U.S. Green Building Council (USGBC) in 1998, is a green building certification system based on a 100-point scorecard covering Sustainable Sites (26), Water Efficiency (10), Energy & Atmosphere (35), Materials & Resources (14), Indoor Environmental Quality (15), Innovation in Design (6), and Regional Priority (4). Certification levels are Certified (40–49), Silver (50–59), Gold (60–79), and Platinum (80+). LEED-certified buildings typically use about 35% less energy and 30–50% less water than conventional buildings, while reducing pollutant emissions, improving indoor environmental quality, and lowering operating costs.

SITES (Sustainable Sites Initiative), launched in 2005 by the American Society of Landscape Architects (ASLA), extends sustainability assessment from buildings to landscapes. It

evaluates site protection, planning, water-efficient design, soil and vegetation management, materials reuse, user health and accessibility, construction practices, low-impact maintenance, education, monitoring, and innovation. In practice, SITES-certified projects reduce water and energy use, improve stormwater management and air quality, create wildlife habitat, and enhance recreational value. Projects such as Portland's Cully Park and Woodland Discovery Garden illustrate how SITES supports comprehensive land restoration and landscape-scale sustainability beyond individual buildings.

2. Materials and Methods

2.1. Study Area

The case study site is Mogan Park, a landscape of national and international significance located along the Lake Mogan shoreline in Gölbaşı, Ankara, Türkiye. The site lies within the Gölbaşı Special Environmental Protection Area (GSEPA), designated for its ecological value and natural resource conservation priorities.

2.2. Data Sources and Materials

The study used 13 primary data inputs grouped into four categories: government documents, park management materials, field data, and secondary sources, together with five software platforms for spatial analysis, documentation, and visualization (Table 2). Together, these materials supported site inventory, landscape character assessment, performance evaluation, and retrofit development.

Table 2. Primary data sources, software platforms, and analytical tools for the Mogan Park sustainable landscape assessment.

Table 1: Primary Data Sources

No.	Category	Document/Material	Year	Source Institution
1	Environmental Management	GSEPA 1/50,000 Scale Environmental Plan Research and Explanatory Report	2020	Ministry of Environment and Urbanization
2a	Environmental Management	GSEPA Management Plan	2015-2019	Special Environmental Protection Agency
2b	Biodiversity Monitoring	Habitat and Species Conservation Monitoring Project Report	2015	Special Environmental Protection Agency
3a	Site Documentation	Mogan Park Site Plan	-	ANFA Mogan Park Management
3b	Vegetation Inventory	Imported Plant List	-	ANFA Mogan Park Management
4	Municipal Planning	Gölbaşı Municipality Strategic Plan	2020-2024	Gölbaşı Municipality
5	Problem Assessment	Mogan Park Problem Report	2019	Ankara Metropolitan Municipality
6	Urban Planning	2023 Ankara Master Development Plan	2023	Ankara Metropolitan Municipality
7	Conservation Status	Status Report	2019	Doğa Derneği (Nature Association)
8a	Field Data	On-Site Observations	2019-2020	Primary Field Investigation
8b	Stakeholder Input	Oral Interviews	2019-2020	Primary Field Investigation
8c	Visual Documentation	Site Photography	2019-2020	Primary Field Investigation
9	Literature Review	National and International Academic Sources	-	Scholarly Databases
10	Web-Based Data	Online Geographic and Environmental Data	-	Web-Based Acquisition

Table 2: Analytical Tools and Software Platforms

Tool/Software	Version	Primary Application	Specific Use in Study
ArcGIS	-	Geographic Information System	Spatial mapping, natural landscape character assessment, environmental data visualization
AutoCAD	2020	Computer-Aided Design	Site plan documentation, technical drawing preparation
Google Earth	-	Satellite Imagery Platform	Regional context analysis, topographic assessment
Photoshop CC	2017	Image Processing Software	Site photography processing, visualization enhancement
SketchUp Pro	2020	3D Modeling Software	Three-dimensional site visualization, design scenario modeling

Data Source Summary: 6 Government Documents | 2 Park Management Materials | 3 Primary Field Data Sources | 2 Secondary Sources | 5 Analytical Tools = 18 Total Data Inputs

2.3. Research Design and Methodological Framework

The study followed a seven-phase sequential methodology (Figs. 1 and 2). Phase 1 identified the research problem and objectives through a literature review focused on sustainability deficiencies in urban parks in Türkiye and on energy- and water-efficient landscape retrofit approaches. Phase 2 established the theoretical and evaluative framework by synthesizing sustainable landscape criteria from ecological planning and landscape retrofit literature, including McHarg (1969), Cranz and Boland (2004), Calkins (2005), and SITES certification standards. This phase operationalized criteria related to energy and water efficiency, accessibility, ecological performance, and nature conservation for urban park assessment.

Phase 3 involved case study selection and regional context assessment. Mogan Park was selected based on its ecological significance within the GSEPA, its scale (more than 40 ha), its accessibility within metropolitan Ankara, and its retrofit potential. Regional investigation addressed the environmental characteristics of Gölbaşı and the natural landscape character of the broader setting. Phase 4 comprised field investigation and data acquisition. Fieldwork included on-site observation of topography, functional uses, urban furniture, material applications, planting design, lighting systems, irrigation infrastructure, and drainage networks; stakeholder interviews with park management and municipal authorities; and systematic photographic and visual documentation.

Phase 5 involved spatial analysis and GIS-based processing. ArcGIS was used for mapping and natural landscape character assessment; AutoCAD 2020 for site-plan documentation;

Google Earth for regional context analysis; Photoshop CC 2017 for visual processing; and SketchUp Pro 2020 for three-dimensional modelling. Natural landscape character was evaluated through a multi-criteria assessment integrating topography, hydrology, vegetation, and land-use patterns.

Phase 6 consisted of sustainability evaluation using SITES criteria. Park performance was assessed across seven dimensions: (1) site context and pre-design assessment; (2) site design for water; (3) site design for soil and vegetation; (4) site design for materials selection; (5) site design for human health and well-being; (6) construction; and (7) operations and maintenance. The assessment combined quantitative indicators, including energy and water use, material properties, and accessibility compliance, with qualitative indicators related to ecological performance, user experience, and management practices.

Phase 7 translated the findings into retrofit strategies and policy recommendations. Performance gaps were identified by comparing site conditions with international sustainable landscape benchmarks. Retrofit proposals were then developed to address deficiencies in energy efficiency, water management, material selection, accessibility, and biodiversity conservation while prioritizing ecological performance, cost-effectiveness, and implementation feasibility.

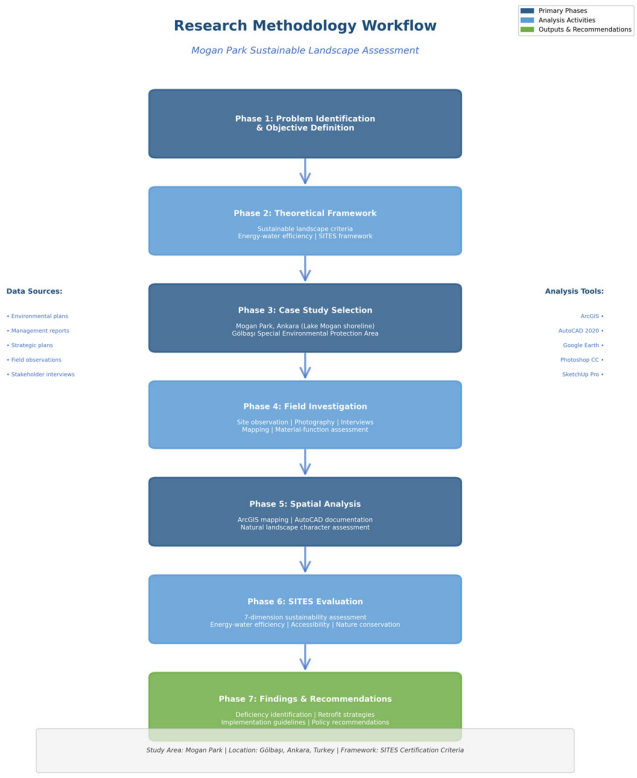


Fig. 1 Research methodology workflow

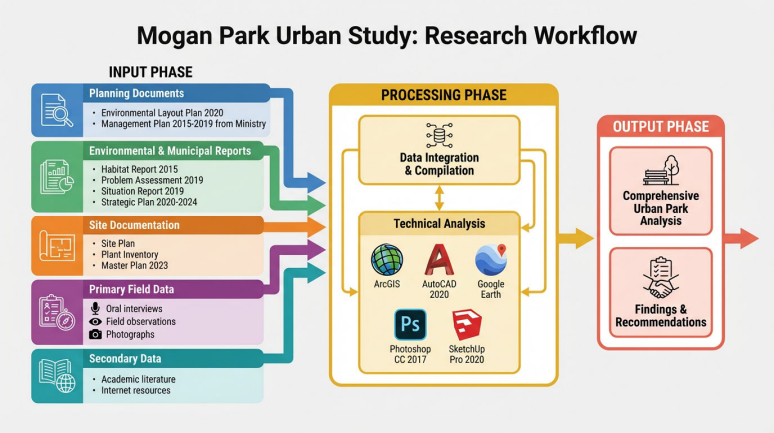


Fig. 2 Mogan Park research methodology workflow

2.3.1. Analytical Approach

The study employed a mixed-methods analytical approach integrating qualitative and quantitative evidence. Qualitative assessment relied on structured comparison between observed site conditions and SITES-based evaluation criteria. Quantitative assessment addressed energy and water consumption patterns, material characteristics, accessibility conditions, and vegetation-related performance indicators. Findings were triangulated across documentary review, field observation, stakeholder interviews, and spatial analysis to strengthen methodological rigor and interpretive validity.

3. Results

3.1. Study Area Characterization and Ecological Context

Mogan Park occupies 406,367.12 m² (40.6 ha) on the southwestern shore of Lake Mogan in Gölbaşı (Ankara, Türkiye), approximately 19 km south of Ankara city centre at 970 m elevation. Designed between 2000 and 2004 and opened in 2005, the park functions as a multi-use lakeshore recreational landscape organized by ring-road circulation and interval-based activity nodes (Fig. 3).

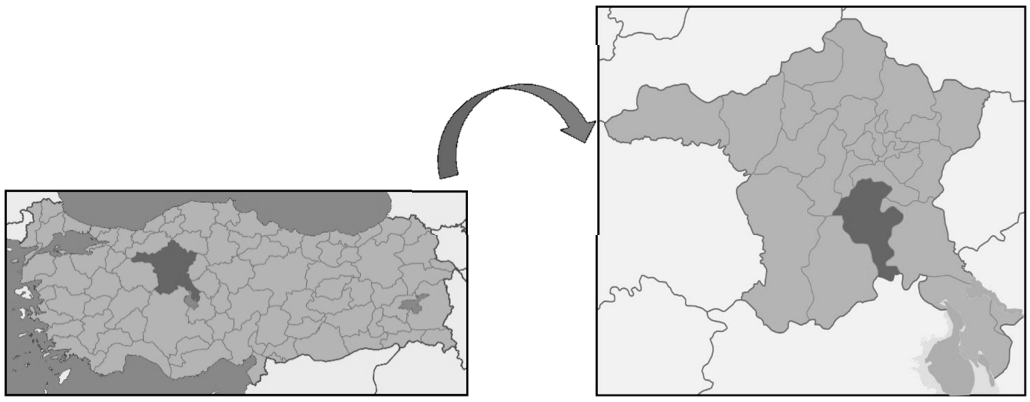


Fig. 3 Location map of Mogan Park (Anonymous, 2019a)

The park is embedded within a nested protection framework that includes the Gölbaşı Special Environmental Protection Area (GSEPA), which covers 273.94 km² (approximately 18% of the district) and was established by Council of Ministers Decision No. 20702 dated 21.11.1990; the Lake Mogan Important Natural Area, identified as a nominated Ramsar site; and Natural Site designations around Lakes Mogan and Eymir (SEPA, 2020) (Fig. 4). According to SEPA data, Lake Mogan has a surface area of 5.0 km², elevation of 972.6 m, and depth of 2.8 m, whereas Lake Eymir has a surface area of 1.2 km², elevation of 967.6 m, and depth of 5.0 m (SEPA, 2015–2019; SEPA, 2020).

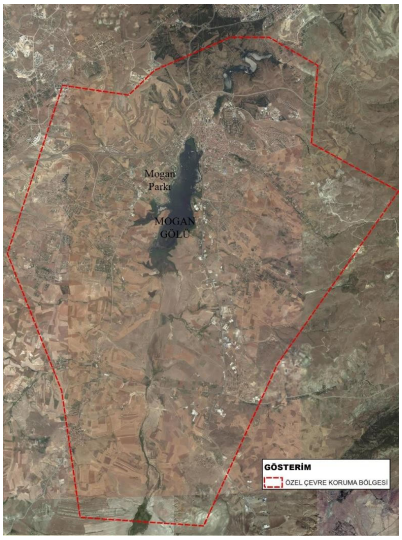


Fig. 4 Gölbaşı SEPA boundaries (SEPA, 2020)

This wetland–lake mosaic underpins the area's high ecological value and planning sensitivity. The GSEPA supports 488 plant species, including the emblematic endemic *Centaurea tchihatcheffii* Fisch. & C.A. Mey.; 249 bird species, including 40 breeding species, 30 year-

round resident species, and 22 raptor taxa; and 25 mammal species (SEPA, 2015–2019; GBSP, 2020–2024). Wetland and marsh areas provide key ecosystem functions directly relevant to planning and design constraints, including groundwater storage, dry-season water supply, storm buffering, flood and overflow control, sediment control, pollutant retention, and microclimate regulation (GBSP, 2020–2024).

At the district scale, Gölbaşı contains 5,185,231 m² of total net existing open–green space and 1,401,711 m² of designated open green space. Mogan Park accounts for 618,320 m² of the district's designated open green-space inventory and represents approximately 11.9% of its total net existing open–green space (computed from Doğan & Küçük, 2019). Active open–green space provision is reported as 10,43 m²/person, exceeding the national standard of 7 m²/person (Doğan & Küçük, 2019). Despite this quantitative adequacy at district scale, development pressure is concentrated north of Lake Mogan, particularly near wetland-sensitive areas, whereas the southern and southwestern sectors remain comparatively less developed but still ecologically sensitive (Figs. 5).



Fig. 5 Location and boundaries of Mogan Park (Anonymous, 2019b)

Within the park, infrastructure is structured by a ring-road circulation system connecting two main gates in the southwest and northeast, supported by distributed parking areas and activity hubs. The shoreline program includes viewing terraces, promenade and walking paths, a

marina and maritime museum, a boat shelter and boathouse, fishing piers, a sea-bike rental area, a lighthouse, beach volleyball courts, islands and piers, and lakeshore cafés. Built structures are predominantly one- or two-storey, with an intended material and façade unity across the park. At the same time, regional sources indicate that rapid urbanization in Gölbaşı, domestic and industrial waste loads, and agricultural inputs have increased nitrogen and phosphorus pressures and contributed to eutrophication risk in Lake Mogan (SEPA, 2020). Regional management plans, therefore, frame the Mogan–Eymir system as a priority landscape for conservation-based, energy- and water-efficient planning responses (SEPA, 2015–2019).

Table 3. Quantitative specifications of Mogan Park and its protected landscape context (Original, 2025)

Indicator	Value (unit embedded)	Operational definition / notes	Source
Park implemented shoreline-project footprint	406,367.12 m² (40.6 ha)	Implemented lakeshore project area; 1 ha = 10,000 m².	Anonymous, 2019b
Mogan Park (district open–green inventory)	618,320 m²	Administrative open–green space inventory figure; not identical to implemented footprint (different accounting definitions).	Doğan & Küçük, 2019
Total net existing open–green space (district)	5,185,231 m²	District-scale open–green space stock (active + passive).	Doğan & Küçük, 2019
Designated open green space (district)	1,401,711 m²	District plan designation for open green space.	Doğan & Küçük, 2019
Mogan Park share of district net open–green space	11.9 %	Computed as 618,320 / 5,185,231 × 100 (rounded).	Computed from Doğan & Küçük, 2019
Active open-green space provision (district)	10.43 m²/person	Reported provision; national standard: 7 m²/person (1999 regulation).	Doğan & Küçük, 2019

Gölbaşı SEPA total area	273.94 km²	≈18% of district area.	SEPA, 2020; SEPA, 2015-2019
SEPA legal basis	Decision No. 20702 (21.11.1990)	Special Environmental Protection Area designation.	GBSP, 2020–2024
Lake Mogan (SEPA reference)	5.0 km²; 972.6 m a.s.l.; 2.8 m depth	Surface area / elevation / depth values from SEPA boundary table.	SEPA, 2015-2019; SEPA, 2020
Lake Eymir (SEPA reference)	1.2 km²; 967.6 m a.s.l.; 5.0 m depth	Surface area / elevation / depth values from SEPA boundary table.	SEPA, 2015-2019
Mogan → Eymir hydrologic coupling (excess water share)	~98 %	Excess water from Lake Mogan constitutes ~98% of Lake Eymir volume.	SEPA, 2020
Catchment reporting (context / basin / drainage)	973 / 929 / ~1,070 km²	Catchment context; DSİ basin; broader drainage domain (reported).	SEPA, 2020
Lake Mogan morphometrics (reported)	~6 km²; 6,000 m; 900–1,100 m; ~14 km	Surface area / length / width / shoreline length (reported).	SEPA, 2020
Lake levels (design thresholds)	972.00 / 973.25 / 974.25 m	Normal / maximum / flood level; no facilities below flood level.	SEPA, 2020
Facility extension threshold	~973.50 m	Facilities generally extend down to this level (reported).	SEPA, 2020
Ecological critical threshold	972.50 m	Critical lake level threshold (reported).	SEPA, 2020
Recent lake-level decrease (reported)	~35 %	Reported recent decline in lake water level.	SEPA, 2020

Plant richness (region)	488 species	Regional biodiversity reporting; includes endemic taxa.	SEPA, 2015–2019
Bird richness (region)	249 species	Includes 40 breeding; 30 year-round; 22 raptor taxa (reported).	SEPA, 2015–2019; GBSP, 2020–2024
Mammal richness (region)	25 species	Regional biodiversity reporting.	SEPA, 2015–2019
Diurnal butterfly richness (region)	126 species	Regional fauna reporting.	SEPA, 2020
Peak autumn bird counts (reported)	>70,000 individuals	Bird counts documented periods exceeding 70,000 in autumn.	SEPA, 2020
Weekday vehicle load (park use intensity)	~3,000 vehicles/day	Reported daily entries/exits on weekdays.	Original, 2025
Weekend vehicle load (park use intensity)	~6,000–7,000 vehicles/day	Reported daily entries/exits on weekends.	Original, 2025
Parking provision	12 lots; 1,566 vehicles	Total number of parking areas and total vehicle capacity (reported).	Original, 2025
Amphitheater capacity	~3,000 persons	Reported user capacity for amphitheater.	Original, 2025

3.2. Protection Status and Ecological Significance of the Lake-Wetland System

The Mogan–Eymir system is a high-biodiversity inland wetland complex that performs important hydrological, ecological, and microclimatic functions. Wetland and marsh zones at the lake inflow interface provide groundwater storage, dry-season water support, storm buffering, flood and overflow control, sediment retention, pollutant retention, and local microclimate regulation (GBSP, 2020–2024; Tülek & Barış, 2014). The system supports 249 bird species used for feeding, sheltering, and breeding, including 40 breeding species and 30 species observable year-round, and has been nominated as a Ramsar Site in Türkiye (GBSP,

2020–2024). The regional flora includes 488 plant species, including *Centaurea tchihatcheffii* Fisch. & C.A. Mey. and other endemic taxa of conservation significance (SEPA, 2015–2019; SEPA, 2020). In response to increasing pollution loads associated with urban growth, domestic and industrial waste, and agricultural inputs, a 274 km² area covering the Gölbaşı district centre, the surroundings of Lakes Mogan and Eymir, and 10 settlements was designated as a Special Environmental Protection Area under Council of Ministers Decision No. 20702 dated 21.11.1990 (GBSP, 2020–2024).

3.2.1. Biophysical Baseline: Hydrology, Soil, and Vegetation Structure

Hydrologically, Lakes Mogan and Eymir form part of the Ankara Stream Sub-Basin. Excess water from Lake Mogan is transferred to Lake Eymir through a wetland–marsh corridor beginning approximately 2 km from the southern margin of Mogan, with an elevation difference of approximately 5 m; this outflow constitutes about 98% of Lake Eymir's water volume (SEPA, 2020) (Fig. 6).

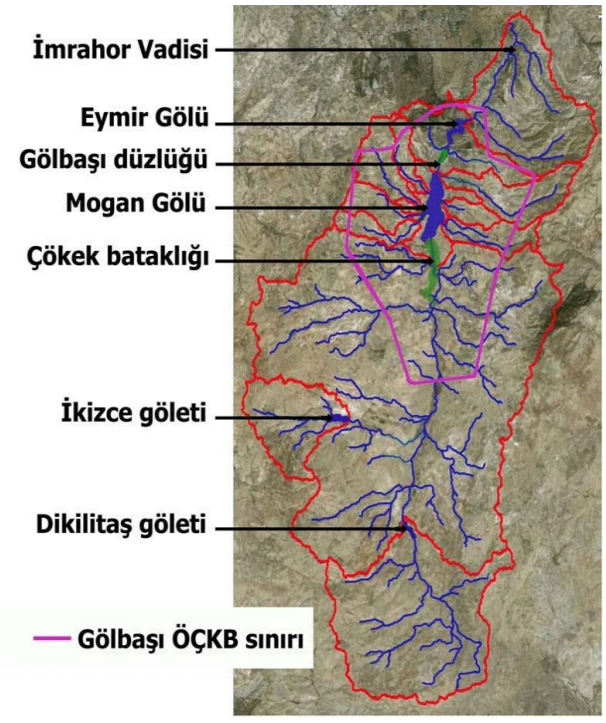


Fig. 6 Surface-water system of the Mogan and Eymir basin (SEPA, 2015-2019)

Groundwater and surface waters from a 973 km² catchment pass through the lakes and connect to downstream flood-control and urban stormwater systems (SEPA, 2020). DSİ

records indicate a basin area of 929 km² and a broader drainage domain of nearly 1,070 km² extending south of Ankara toward Lake Tuz (SEPA, 2020). Reported morphometric values for Lake Mogan include an approximate surface area of 6 km², length of 6,000 m, width of approximately 900–1,100 m, and shoreline length of approximately 14 km. Reported design thresholds are 972.00 m for normal water level, 973.25 m for maximum level, and 974.25 m for flood level, below which facilities are not permitted. The 972.50 m level is identified as an ecologically critical threshold, and a recent decrease of approximately 35% in lake water level has been reported (SEPA, 2020).

Soil groups in the area include brown, non-calcareous brown, reddish-brown, hydromorphic, alluvial, and colluvial soils. Within Mogan Park, brown soils dominate at approximately 78%, whereas reed–marsh soil groups occur more locally in the southern sections of the site (SEPA, 2020) (Fig. 6). The vegetation structure is characterized by steppe, anthropogenic steppe, hydromorphic vegetation, and irrigated agricultural vegetation, with limited forest components, notably almond, black pine, and cedar. The study area lies within the Irano–Turanian phytogeographic region. Around Mogan Park, anthropogenic steppe is dominant, while hydromorphic vegetation is concentrated in the southern reed–marsh zones (SEPA, 2020) (Fig. 6).

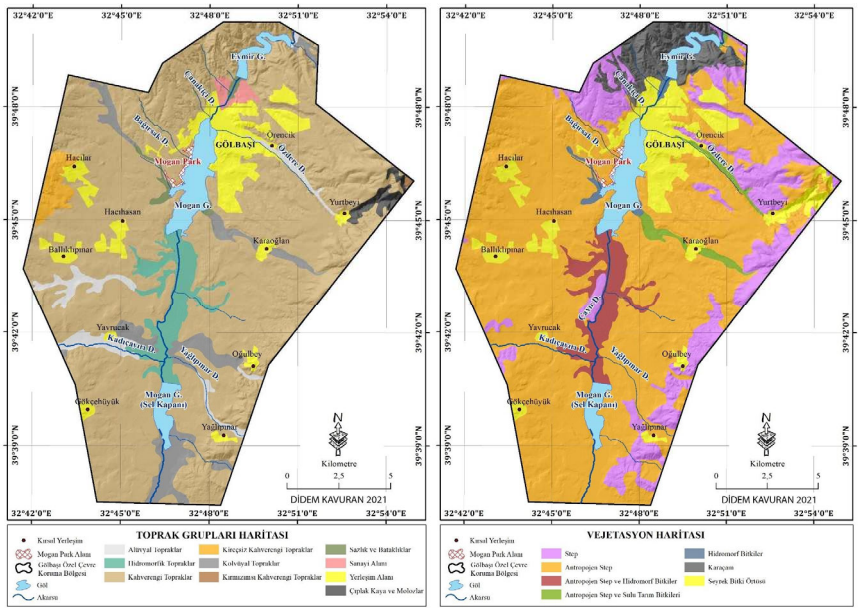


Fig. 7 Soil group map and vegetation map for the Mogan Park context (SEPA, 2020; Original, 2025)

Reported endemic taxa in the SEPA include Erysimum torulosum, Dianthus ancyrensis, Astragalus acicularis, Astragalus micropterus, Ebenus hirsuta, Helianthemum nummularium ssp. lycaonicum, Verbascum vulcanicum var. vulcanicum, Allium cappadocicum, and Centaurea tchihatcheffii Fisch. & C.A. Mey., with selected taxa categorized in the national red-list framework as Critically Endangered (CR), Vulnerable (VU), or Near Threatened (NT) (SEPA, 2020) (Appendix Table A1). Faunal records indicate 15 fish species in the Mogan–Eymir region; Cyprinus carpio and Barbus tauricus are reported as Vulnerable, whereas Alburnus orontis is reported as Endangered, and invasive species such as Pseudorasbora parva and Carassius gibelio are also present (SEPA, 2015). Among amphibians and reptiles, Testudo graeca is reported in the Vulnerable category according to IUCN-based classifications (SEPA, 2020) (Fig. 6).

	Takson Adı	E	TE	Kırmızı Liste		Popülasyon Büyüklüğü	ÖDA Kriteri
				K	B		
	Centaurea tchihatcheffii	I	I	_	CR	Var	A1, A2
	Puccinellia anisoclada ssp. mekderisiana	I	0	_	EN	Var	B1, B2
	Acrocephalus melanopogon	0	0	LC	LC	Var (Üreme)	CI
	Ardea purpurea - Avrupa ve Akdeniz	0	0	LC	LC	3-5 Çift (Üreme)	CI
	Ardeola ralloides - Avrupa ve Akdeniz	0	0	LC	LC	30-40 Çift (Üreme)	CI
	Aythya nyroca - D. Avrupa ve Akdeniz	0	0	NT	VU	74-200 Birey (Göç)	B1, C1
	Aythya nyroca - D. Avrupa ve Akdeniz	0	0	NT	VU	10-20 Çift (Üreme)	B1, C1
	Botaurus stellaris - Avrupa ve Akdeniz	0	0	LC	LC	1 Çift (Üreme)	CI
	Calandrella rufescens niethammeri	I	0	LC	VU	Var (Üreme)	B1
	Circus aeruginosus	0	0	LC	LC	10 Çift (Üreme)	CI
	Falco naumanni	0	0	VU	LC	300 Birey (Göç)	A1, C1
	Fulica atra - Akdeniz ve Karadeniz	0	0	LC	LC	25000-70100 Birey (1994 Göç)	B3, C3
	Ixobrychus minutus	0	0	LC	LC	10-30 Çift (Üreme)	CI
	Netta rufina - D. Akdeniz ve Karadeniz	0	0	LC	LC	673 Birey (1993 Göç)	B3, C3
	Nycticorax nycticorax - D. Avrupa ve D. Akdeniz	0	0	LC	LC	10-20 Çift (Üreme)	CI
	Oxyura leucocephala - Doğu Akdeniz ve İran	0	0	EN	VU	3-4 Çift (Üreme)	A1, B1, C1
	Lutra lutra	0	0	NT	_	Var	CI
	Emys orbicularis	0	0	NT	NT	Var	CI
	Testudo graeca	0	0	VU	NT	Var	A1, C1

Fig. 8 SEPA flora and fauna assessment (Nature Association, 2019)

3.2.2. Current Condition of Mogan Park: Spatial Programme, Surface Structure, and Wetland-Pressure Interface

Within the 406,367 m² study area, reported surface components comprise 11,607 m² of built surfaces, 236,420 m² of green surfaces, 139,594 m² of hardscape landscape surfaces, 13,265 m² of water surfaces, and 5,483 m² of wetland surfaces. These figures correspond to 58.17% green surface, 2.85% built surface, 34.35% hardscape, 3.26% open water, and 1.34% wetland, with the site reported overall as 62.77% natural surface (Original, 2021; Yeang, 2008) (Fig. 6). However, the dominance of turf-based green surfaces represents a performance constraint within the study's broader energy- and water-efficiency framework (Original, 2021).

The park accommodates an intensive recreational programme, including shoreline promenades, viewing routes, floating piers, a marina and boathouse, sports areas, picnic areas, cafés and restaurants, islands, and an amphitheatre. This use intensity is reinforced by 12 parking areas with a total capacity of 1,566 vehicles and an amphitheatre capacity of approximately 3,000 persons (Original, 2021). Ecologically, the park occupies a high-exposure interface with wetland-sensitive areas: it is located within the Gölbaşı SEPA, adjacent to biodiversity refuge areas, and its southern section overlaps the Dikkuyruk Pond zone, identified as an important bird habitat (Original, 2021) (Fig. 6).

Shoreline construction and landscape arrangement works have included lakeshore infilling and concrete applications along promenades and viewing terraces. Although these interventions were intended to facilitate birdwatching and human–nature interaction, the absence of a clearly defined wetland protection zoning scheme has exposed sheltering, feeding, and breeding habitats to pressure from intensive park use (Uğur, 2009) (Fig. 6). Reported impacts include declines in bird abundance and species diversity, as well as ecological degradation associated with reed cutting and reduced dissolved oxygen levels (Uğur, 2009). Under the Ramsar Convention, the Wetlands Protection Regulation, Article 4 of the Bern Convention, and Article 10 of the Wetlands Protection Regulation, the conservation of these habitats is prioritized (Uğur, 2009). Historical reporting indicates that reed-bed cutting prohibitions were violated under intensive use pressure, after which cutting was banned and wire fencing was installed along parts of the shoreline to restrict access (Uğur, 2009). Spatially, the northern, northwestern, and northeastern sectors of the park are described as more detached from natural landscape character, whereas the southern sections retain relatively higher naturalness despite ongoing pressure from surrounding development and agricultural land uses (Uğur, 2009).

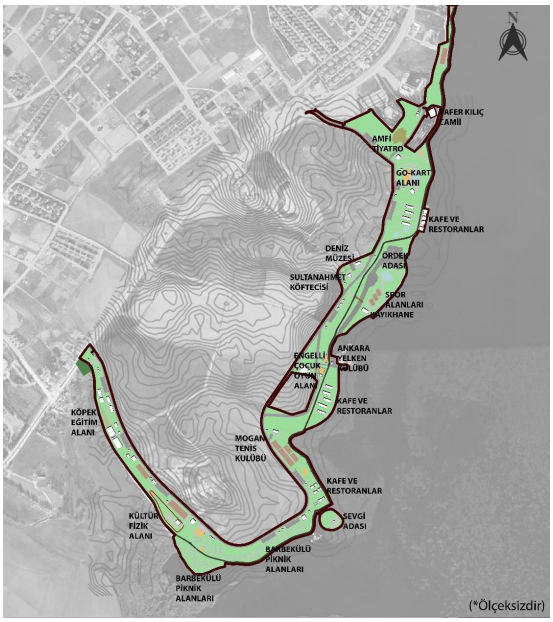


Fig. 9 Site plan of Mogan Park: surface structure and spatial layout (Original, 2021)

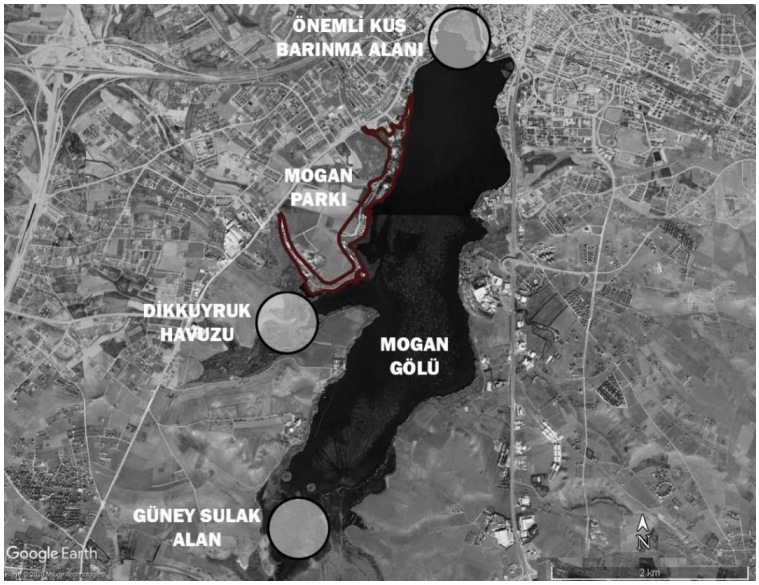


Fig. 10 Wetlands and sensitive areas around Mogan Park (Original, 2021)



Fig. 11 Construction views and shoreline infilling evidence (Uğur, 2009)

4. Discussion

4.1. Interpreting Mogan Park as a Wetland-Adjacent Urban Park Retrofit Problem

The findings position Mogan Park as a high-sensitivity urban park in which ecological integrity, wetland conservation, hydrology, and drainage performance function as binding design constraints rather than secondary considerations. Because the park is embedded within nested protection regimes, including the Gölbaşı SEPA, Natural Site designations, and the Lake Mogan Important Natural Area/Ramsar nomination, the retrofit challenge extends beyond conventional park upgrading to conservation-oriented landscape management. In this context, recreational programming must be reconciled continuously with habitat protection, wetland-edge sensitivity, and hydrological regime stability.

4.2. SITES v2 Interpretation: Strong Baseline Diagnosis, Weak Operational Zoning

From a SITES v2 perspective (GBCI, 2014), the study demonstrates strong alignment with site context and pre-design assessment requirements through explicit documentation of legal protection status and detailed biophysical baseline conditions, including hydrology, soils, vegetation, land-use adjacency, and microclimate. However, the results also reveal a central governance gap: despite the protected-area status of the site, the absence of a dedicated wetland protection zoning scheme has exposed feeding, sheltering, and breeding areas to intensive recreational pressure (Uğur, 2009). The key challenge, therefore, is not recognition of ecological sensitivity, but its translation into enforceable spatial controls, including wetland buffers, habitat-protection zones, seasonal restrictions, and carrying-capacity-informed programming.

A related interpretive issue concerns the use of multiple area definitions, notably the difference between the implemented park footprint and the administrative inventory area. For SITES-consistent reporting, these accounting units should be explicitly distinguished and tied consistently to calculations of surface composition, drainage intervention, and monitoring performance. The evidence–gap structure summarized in Table 4 is therefore important not only for diagnosis, but also for auditability and subsequent municipal implementation.

Table 4. SITES v2-based evidence-gap synthesis and indicative retrofit implications for Mogan Park.

SITES v2 dimension +	**Case evidence (Mogan Park)**	**Fit / gap interpretation**	**Priority retrofit levers**

codes (GBCI, 2014)			
SITES v2: Site context & pre-design assessment Codes: Pre-Design P2.2; Pre-Design P2.3	Nested protected designations (Gölbaşı SEPA 273.94 km²; Decision No. 20702, 21.11.1990; Ramsar nomination; Natural Sites). High biodiversity context (488 plant spp.; 249 bird spp. incl. 40 breeding, 30 year-round, 22 raptors; 25 mammal spp.). High-resolution biophysical baseline documented (hydrology/soils/vegetation).	Strength: strong evidence of sensitivity and regulatory context. Gap: results report absence of a dedicated wetland protection zoning scheme, exposing feeding/sheltering/breeding areas to intensive use pressure.	Operationalize conservation–use balance via wetland protection/control zone, buffer delineation, seasonal closures during breeding, and explicit definition of the performance reporting boundary (implemented footprint vs administrative accounting).
SITES v2: Site design—Water Codes: Water P3.1; Water P3.2	Coupled hydrology (Mogan→Eymir excess-water share ~98%); catchment reporting 973 / 929 / ~1,070 km². Lake levels: 972.00 m (normal), 973.25 m (max), 974.25 m (flood); ecological critical threshold 972.50 m; reported ~35% lake-level decrease. Park-wide drainage failures reported across routes/promenade/running track/amphitheater/pools/sports fields; pools not operated due to leakage/economic constraints.	Strength: clear identification of hydrological thresholds and drainage bottleneck. Gap: current drainage performance and wetland-edge hardening (infilling/concrete) are misaligned with infiltration- and retention-oriented stormwater management and wetland sensitivity.	Prioritize rain gardens, green infrastructure, permeable surfaces, stormwater harvesting, and greywater recovery/treatment integrated with existing irrigation/reservoir systems; introduce monitoring of runoff performance and eutrophication-related parameters (N–P).
SITES v2: Site design—Soil + Vegetation Codes: Soil+Veg P4.1; Soil+Veg C4.6	Soils: brown soils dominate (~78%); reed–marsh soils locally in southern sections. Vegetation: steppe/anthropogenic steppe and hydromorphic vegetation in reed–	Strength: strong baseline characterization of soils/vegetation and explicit conservation-relevant taxa. Gap: turf-	Shift planting palette toward native/local and riparian plant communities aligned with hydromorphic

	marsh zones; Irano–Turanian context. Surface structure: 58.17% green surface, 34.35% hardscape, 1.34% wetland; turf-dominant green surfaces flagged as a performance issue. Conservation-relevant taxa include Centaurea tchihatcheffii Fisch. & C.A. Mey. (CR) and Euphydryas orientalis (rare).	dominant green structure implies high water/energy input and weaker habitat performance relative to native/riparian communities; reed-bed disturbance risks persist.	zones and steppe character; reduce turf footprint; protect reed beds (no cutting for views); rehabilitate soils where compacted/eroded; establish habitat-supportive zoning.
SITES v2: Site design—Materials selection Codes: Materials C5.2; Materials C5.6	Hardscape share is high (34.35%) and wetland-edge interventions included lakeshore infilling and concrete placement along promenades/viewing terraces; shoreline barriers (e.g., wire fencing) noted in recommendations.	Strength: material-related pressures are clearly observable through hardscape dominance and wetland-edge hardening. Gap: current material palette increases imperviousness and limits infiltration; aesthetic/ecological conflicts at shoreline are unresolved.	Replace impervious surfaces with permeable, ecological and recycled/natural materials; reduce wetland-edge hardening; apply shading strategies on remaining hardscape; specify low-impact materials through procurement standards.
SITES v2: Site design—Human health + well-being Codes: HHWB C6.3; HHWB C6.9	High recreational intensity: weekday ~3,000 vehicles/day; weekend ~6,000–7,000 vehicles/day; 12 parking areas (1,566-vehicle capacity); amphitheater ~3,000-person capacity. Diverse program along shoreline (promenade, cafés, sports). Microclimate exposure noted (wind regime; shading deficits) and universal accessibility measures are proposed.	Strength: strong accessibility and programming capacity. Gap: use intensity concentrates pressure near wetland-sensitive areas; microclimatic comfort deficits and disturbance during breeding periods require tighter management.	Implement universal access upgrades (ramps, tactile paving) while reducing habitat disturbance via temporal/spatial zoning; expand shade and wind-responsive planting; strengthen interpretive systems to support nature literacy.

SITES v2: Construction Codes: Construction P7.2; Construction P7.3	Construction and shoreline arrangement included infilling and concrete placement adjacent to wetlands; historic reed-bed cutting violations and subsequent reactive control measures are reported.	Strength: impact pathways are documented. Gap: past practices indicate high disturbance risk at wetland edge; future works must prevent sediment/pollutant mobilization and avoid breeding-season disturbance.	Adopt phased retrofit implementation with erosion/sediment control, topsoil protection, and strict wetland-edge protection measures; schedule works outside breeding periods; apply low-impact construction techniques.
SITES v2: Operations + Maintenance Codes: O+M P8.1; O+M P8.2	Existing irrigation infrastructure is reported; however, drainage failures persist and pools remain idle. Recommendations emphasize continuous performance tracking, standards development ("Mogan Park Improvement Standards"), waste separation, mulching, composting, and reduced chemical inputs.	Strength: clear governance direction and defined improvement pillars (energy–water efficiency, accessibility, nature conservation). Gap: evidence of reactive controls at wetland edge suggests insufficient proactive O+M protocols and monitoring indicators.	Institutionalize adaptive management with measurable indicators (drainage performance, water use intensity, wetland-edge disturbance, biodiversity response); implement waste separation and composting; reduce pesticide/fertilizer use; periodic reassessment aligned with SEPA obligations.

4.3. Hydrology and Drainage as the Dominant Retrofit Driver

Among the assessed dimensions, water emerges as the dominant retrofit driver at both basin and park scales. Hydrological coupling within the Mogan–Eymir system is particularly significant: excess water from Lake Mogan reaches Lake Eymir through a wetland–marsh corridor with an elevation difference of approximately 5 m, and this transfer constitutes about 98% of Lake Eymir's water volume (SEPA, 2020). Catchment reporting at 973 km², 929 km², and approximately 1,070 km² further indicates that park-scale runoff and pollutant pathways are embedded within a larger basin system rather than being confined to the park boundary

(SEPA, 2020). At the same time, the lake-level regime establishes clear planning thresholds: 972.00 m normal water level, 973.25 m maximum level, 974.25 m flood level, and 972.50 m as an ecologically critical threshold, together with a reported recent water-level decline of approximately 35% (SEPA, 2020). These values frame hydrology as a non-negotiable design parameter.

At the operational scale, drainage deficiencies reinforce this conclusion. Reported failures across roads, pedestrian routes, promenades, the running track, amphitheatre areas, pools, and sports fields indicate systemic underperformance, while leakage and economic constraints have rendered pools inoperative (Original, 2021). Under a SITES-aligned interpretation, this combination of basin vulnerability and local drainage dysfunction supports prioritizing rain gardens, permeable surfaces, stormwater harvesting, and green infrastructure retrofits integrated with existing irrigation and water-storage systems.

4.4. Ecological Integrity, Vegetation Structure, and Material Pressure

The soil and vegetation baseline indicates high ecological sensitivity, particularly at the wetland interface. Brown soils dominate approximately 78% of the site, while reed–marsh soils occur locally in the southern sections (SEPA, 2020). Vegetation is structured by steppe, anthropogenic steppe, hydromorphic communities, and irrigated agricultural vegetation within an Irano–Turanian phytogeographic context (SEPA, 2020). Conservation-relevant taxa, including *Centaurea tchihatcheffii* Fisch. & C.A. Mey. categorized as Critically Endangered (CR), further confirms the site's ecological significance (SEPA, 2020). These conditions strongly support SITES priorities related to the protection of sensitive soils, habitat-supportive vegetation, and ecologically valuable plant communities.

However, the current spatial structure reveals a mismatch between ecological sensitivity and landscape performance. Although 58.17% of the assessed footprint is categorized as green surface, this green structure is dominated by turf, which the study identifies as problematic from an energy and water efficiency perspective (Original, 2021; Yeang, 2008). Simultaneously, hardscape occupies 34.35% of the site, while wetland surface accounts for only 1.34%. This composition suggests a clear retrofit direction: reduce high-input turf and expand native, local, and riparian plant communities that correspond to hydromorphic zones and steppe character, thereby improving habitat value and lowering irrigation demand.

Material performance raises similar concerns. Hard-edged shoreline treatments, including concrete applications along promenades and viewing terraces, as well as lakeshore infilling,

conflict with infiltration-oriented stormwater management and wetland-edge sensitivity (Uğur, 2009). From a retrofit perspective, this supports a shift toward permeable, lower-impact, and ecologically compatible materials, particularly in shoreline and high-use transition zones.

4.5. Reconciling Recreational Intensity with Wetland-Edge Conservation

The park's recreational capacity is one of its major public assets, but also one of its major ecological pressures. The programmed includes promenade routes, viewing platforms, floating piers, a marina and boathouse, sports areas, picnic spaces, cafés and restaurants, islands, and an amphitheater, while reported use intensity reaches approximately 3,000 vehicles/day on weekdays and 6,000–7,000 vehicles/day on weekends, supported by 12 parking areas with capacity for 1,566 vehicles and an amphitheater capacity of approximately 3,000 persons (Original, 2021). These figures indicate that human health and well-being goals must be delivered under conditions of unusually high pressure on wetland-adjacent habitats.

The evidence suggests that current management responses remain more reactive than preventive. Reed-bed cutting, shoreline disturbance, and subsequent declines in bird abundance and species diversity, together with reduced dissolved oxygen, indicate that habitat-sensitive areas have historically been exposed to intensive use (Uğur, 2009). Later measures, including cutting bans and shoreline fencing, represent corrective controls rather than an integrated conservation–use strategy (Uğur, 2009). A stronger SITES-aligned approach would therefore combine universal accessibility and recreational provision with temporal and spatial zoning, seasonal closures during breeding periods, controlled access to wetland-edge areas, and interpretive systems that support nature literacy while reducing disturbance.

4.6. From Reactive Protection to Adaptive Management

The results indicate that the most important governance transition for Mogan Park is a shift from reactive protection to adaptive management. Wetland-edge infilling, hard shoreline construction, drainage failures, and habitat disturbance have generated both ecological and operational liabilities (Uğur, 2009; Original, 2021). In this context, SITES v2 is useful not only as an assessment framework but also as a management logic: future interventions should be phased, constrained by breeding-season timing, supported by erosion and sediment control, and designed to minimize disturbance to reed beds and hydromorphic vegetation.

Operations and maintenance are especially decisive. The study's emphasis on continuous performance tracking, waste separation, composting, reduced chemical inputs, and the development of "Mogan Park Improvement Standards" can be formalized into an adaptive management framework with measurable indicators, including drainage performance, water-use intensity, wetland-edge disturbance, and biodiversity response. Such a framework would strengthen compliance with SEPA obligations while improving the long-term implement ability of retrofit proposals.

4.7. Planning and Policy Implications

From a Landscape and Urban Planning perspective, the case shows how SITES v2 and European Landscape Convention principles can be translated into retrofit decision-making in a protected wetland context where municipal sustainability standards for existing parks remain limited or weakly operationalized (Council of Europe, 2000; GBCI, 2014). The nested protection regime, explicit hydrological thresholds, and high recreational pressure make Mogan Park an effective test case for converting ecological constraints into design, zoning, and management standards. The broader implication is that retrofit methodology is transferable, but retrofit packages cannot be standardized mechanically; they must be calibrated to local hydrology, soil–vegetation structure, conservation status, and use intensity.

4.8. Limitations and Future Research

Some performance benefits discussed in the retrofit literature, including energy savings from vegetation placement, runoff attenuation, and water savings, should be interpreted here as literature-grounded performance ranges used for prioritization rather than as directly measured site outcomes, unless validated through site-specific monitoring. Future research should therefore adopt a before-and-after monitoring design to quantify: (i) runoff volume and peak-flow changes after green infrastructure and rain-garden interventions; (ii) water-quality parameters linked to eutrophication risk, particularly nitrogen and phosphorus dynamics; (iii) microclimate and thermal-comfort performance under revised canopy and surface-material configurations; and (iv) biodiversity responses to seasonal zoning and wetland-edge disturbance controls, especially for conservation-relevant taxa such as *Centaurea tchihatcheffii* Fisch. & C.A. Mey. and *Euphydryas orientalis*. A parallel cost-performance analysis addressing capital cost, operating cost, maintenance burden, and procurement feasibility would further strengthen the budget-constrained retrofit proposition and support municipal uptake.

5. Conclusions

Ecological identity and conservation constraints. Mogan Park should be repositioned as a high-sensitivity urban ecosystem in which ecology-led, wetland conservation-oriented, and drainage-informed interventions are implemented within a sustainability governance framework. The wetland system of Lake Mogan, together with reed beds, freshwater marshes, meadows, steppe areas, afforestation zones, and forest openings, sustains multiple habitat types and a strong microclimatic gradient that supports high biodiversity. Within this system, the southern reed-bed habitats have remained comparatively less disturbed than the rest of the park. For this reason, all future interventions should be evaluated first in terms of their effects on the biotic components of the ecosystem, rather than primarily through recreational expansion or visual upgrading. A SITES-informed improvement logic is therefore appropriate for Mogan Park, provided that site hydrology, habitat continuity, low-impact material use, human well-being, and long-term operations and maintenance are treated as interdependent performance categories rather than as isolated design targets.

Hydrological regime, water quality, and shoreline protection. Protection of natural resources in Mogan Park depends on strict safeguarding of the lake's hydrological regime and water quality. Because Lake Mogan is a naturally formed lake within a wetland-dependent ecological system, even limited interventions in water presence, runoff pathways, or shoreline morphology may trigger adverse effects on water quality and biodiversity, especially during dry periods. Accordingly, hydrology and wetland conservation should function as hard constraints for planning and design decisions. From a shoreline-protection and erosion-control standpoint, existing hard barriers such as wire fencing reduce visual quality and often conflict with the recreational interface. Shoreline treatment should therefore be redesigned to deliver both ecological function and spatial quality. At the same time, open-air cafes and restaurants located along shoreline-protection lines are highly exposed to microclimatic conditions and prevailing northeasterly winds; where these uses are already established, selected segments may be retrofitted as glass-fronted winter gardens in order to reduce climatic exposure without undermining the protection line or further expanding into sensitive wetland edges.

Drainage underperformance and integrated rainwater management. The most immediate operational bottleneck in Mogan Park is park-wide drainage underperformance. Vehicular roads, pedestrian routes, the promenade, the running track, the amphitheater, pools, and

sports fields all experience drainage failures because of insufficient channel grates and weak runoff capture. This condition should not be treated as a localized infrastructure defect but as a site-scale performance problem requiring integrated green infrastructure. Rain gardens, bioswales, permeable and ecologically compatible surface systems, and strategically located retention areas should therefore become core elements of the improvement program. This network should be linked to the park's existing automatic irrigation system and 400-ton water reservoir so that runoff collected from green areas, sports-field edges, rain gardens, roofs, and hardscape interfaces can be biologically treated, stored, and reused for irrigation and other non-potable demands. In this sense, rainwater management in Mogan Park is not an auxiliary technical service but the operational backbone of a SITES-oriented retrofit strategy (Table 5).

Table 5. Sustainable improvement action proposals (Original, 2025).

Sustainability theme	**SITES-aligned focus**	**Synthesized action proposals**
Sustainability	Energy-water-efficient design	Utilization of microclimatic, topographic, water-presence, and natural-vegetation data; ecological construction materials; shading of existing hardscape surfaces through vegetative and structural means; windbreak belts formed with native vegetation; permeable surface materials; photovoltaic systems; natural, ecological, and recyclable urban furniture; green roof and green wall applications where appropriate; permaculture, hobby gardens, and urban gardens; greywater recovery and stormwater management; automatic irrigation; green infrastructure systems, xeriscape, natural landscape areas, rain gardens, and strategic planting; use of native and local plant species; waste separation units, mulching, compost production, and broader energy-water conservation.
Accessibility	Universal access and inclusive mobility	An accessible transportation system and bicycle lanes; universal access to the site and on-site mobility solutions for all users; suitability of functions for broad user groups; accessible ramps; and tactile paving and guiding surfaces for visually impaired users.
Nature conservation	Site rehabilitation	Conservation and improvement of natural landscape character; habitat creation; shoreline protection and erosion control; flood control and microclimate formation; prevention of water and environmental pollution;

	and habitat continuity	protection and enhancement of natural vegetation and biodiversity; protection of lake- and basin-scale groundwater and water-table levels; use of natural, ecological, and recycled materials and native/local plant species; waste separation, compost production, mulching, and energy-water conservation.

Built structures, service units, and shoreline cafes. Mogan Park's built structures occupy 11,600 m^2 and are located at or above the 974.25 m level, with no development below this elevation. Most of these buildings are two stories or less and are predominantly constructed with steel frames and fiberboard or betopan cladding; moreover, current uses differ substantially from the park's original program, and several units are now underused or inactive. The 292 m^2 Administrative Building, together with the Anfa Security Directorate and related service/technical units, exemplifies the park's service-building typology: concrete-dominant surroundings, limited climatic responsiveness, inadequate permeable surfaces, and recurrent water accumulation. These structures should be retrofitted through low-impact material upgrading, permeable surroundings, roof-based rainwater capture, selective photovoltaic integration on suitable south-facing roofs, and wind-responsive planting belts, especially on north-to-east exposures. The same logic applies to the park's cafe and restaurant units. Four over-water cafe/restaurant structures occupy 780 m^2 and intensify human-nature interaction by enabling direct visual contact with the lake, yet they also generate noise and pollution pressure on fauna and on riparian and aquatic habitats. In total, there are 11 cafe and restaurant structures in the park; excluding the over-water units, the remaining facilities occupy 2,830 m^2, are generally betopan-dominant, and often suffer from weak facade planting and wind exposure. Their retrofit should therefore prioritize selective photovoltaic integration, roof-runoff harvesting, greywater reuse where feasible, windbreak planting, and ecological material substitution without increasing pressure on shoreline habitats.

Parking, circulation, and accessible surface retrofit. Parking infrastructure and circulation surfaces are major contributors to hardscape dominance and runoff stress in Mogan Park. The Park contains a total parking capacity of 1,566 vehicles, and roads and parking surfaces cover 52,696 m^2. The pedestrian circulation network alone accounts for 143,268 m2 of hardscape, of which 103,726 m^2 consists of sidewalks and connecting paths; the promenade extends for 3,787 m and covers 22,400 m^2, while the running track occupies 1,118 m^2. Across these surfaces, concrete- and asphalt-dominant construction, insufficient shading, deteriorated markings, and inadequate drainage infrastructure intensify surface heat gain, water

accumulation, and ecological fragmentation. For this reason, parking areas, pedestrian routes, promenade edges, service-building surroundings, picnic zones, pool edges, and selected sports-field interfaces should be retrofitted with permeable and ecologically compatible surfaces integrated with linear drainage and the wider green infrastructure network. At the same time, accessibility should be corrected at both park and building scales. Given the total parking capacity, approximately 78 accessible spaces are required, yet current provision is markedly inadequate. Ramps, handrails, tactile warning surfaces, and continuous guiding lines should be implemented in accordance with TSE standards across parking areas, sidewalks, connecting paths, the promenade, building entrances, and spectator areas so that surface retrofit also improves universal access and route continuity.

High-impact retrofit zones: amphitheater, sports fields, and pools. Several large program areas require targeted retrofit because they combine high land take with low environmental performance. The amphitheater covers 2,625 m^2, accommodates 3,000 users, and has remained unused for an extended period. As a large inactive concrete mass located in a runoff-receiving part of the site, it intensifies impermeable-surface pressure and drainage problems, particularly in backstage areas. It should therefore be reconfigured as a green amphitheater and flexible open green space that retains the topographic form while reducing concrete intensity and improving infiltration. Sports facilities occupy 9,750 m^2 and include four basketball courts, two football fields, five tennis courts, and three beach volleyball courts. In the protected wetland context of Mogan Park, these uses generate noise and disturbance pressure, particularly where Basketball Courts-1 are located close to reed beds. The southern sports zone also suffers from strong solar exposure, precipitation-related damage, and insufficient channel drainage. Here, the priority should be improved court-edge drainage, lower-impact edge and tribune materials, and selective partial covering of the southern courts to support winter use, rainwater harvesting, and, where appropriate, south-oriented photovoltaic integration. The park's four pools, with a total area of 3,255 m^2, are largely non-operational because of leakage and infrastructure deficiencies. Rather than leaving these as empty concrete basins, they should be converted into biological or ecological pond systems integrated with runoff retention, aquatic vegetation, and natural purification processes.

Picnic areas with barbecue. Because Mogan Park lies within a protected wetland context, picnic and barbecue areas should be managed as ecologically sensitive use zones rather than as conventional recreation lawns. In Picnic/Barbecue Area 1, topography has been used but

slope design remains insufficient for effective visual access, and reed beds have been cut to improve views. In Picnic/Barbecue Area 2, terracing is more successful, yet the location of picnic units on sloping terrain creates drainage problems. In both areas, uncontrolled barbecue use on grass surfaces and littering toward the lake place pressure on water quality, hydrological balance, and flora-fauna integrity. Improvement should therefore focus on clearer terracing, view management that does not require reed-bed removal, permeable paving around activity units, and runoff control through rain gutters or dolomite-based drainage directed toward planted areas. On the southern facade, selected picnic units may incorporate photovoltaic canopies combined with rainwater-harvesting cells so that energy generation, shading, and water reuse operate as a single site-responsive system.

Children's playgrounds and inclusive play environments. The children's playgrounds in Mogan Park require both ecological and climatic redesign. Existing play areas are largely surfaced with poured rubber (EPDM), and most equipment is polyurethane-based plastic; in a park heavily used by children of different age groups, these materials are environmentally weak and may raise long-term health concerns. Site conditions also vary significantly: southern playgrounds are exposed to excessive solar radiation and rainfall, whereas northern playgrounds are more vulnerable to water accumulation. A more appropriate strategy is to redistribute playgrounds according to age groups, strengthen their direct relationship with green areas, and replace synthetic surfaces with natural and permeable play surfaces such as bark mulch, wood chips, stabilized soil, sand, gravel, or other lower-impact alternatives. Design emphasis should shift toward nature-based and sensory play through sloped lawns, grassy mounds, vegetative tunnels, climbing and sliding landforms, and ecology-based educational components. Selected playground areas should also incorporate shaded and rain-protected canopy systems built from recycled or natural materials. Inclusive play should be integrated into this general system rather than isolated under segregating labels, and accessible WC provision should support universal use.

Equestrian area reprogramming. The equestrian area occupies 2,236 m^2 and includes two riding arenas, one open and one seasonally enclosed. Although the topography already supports spectator use, the area is underutilized and part of it has been repurposed for dog training. Given its southern location and proximity to the greenhouse zone, this area should be reprogrammed for urban hobby gardens, sustainable agriculture, and permaculture-based activities. Such a transformation would represent a more climate-responsive land use,

diversify visitor experience, and strengthen interaction with productive landscapes without increasing pressure on the wetland edge.

Planting, biodiversity, and adaptive governance. Planting strategy is one of the areas where the ecological ambitions of Mogan Park can be most clearly strengthened. A total of 236,420 m^2 has been landscaped, yet much of the existing planting does not adequately respond to sunlight conditions, shoreline character, microclimatic exposure, or the ecological requirements of native species. The extensive use of imported species, turf, and chemically supported maintenance increases water and energy demand and creates avoidable risks for soil quality, Lake Mogan, and the wetland system. By contrast, the presence of *Centaurea tchihatcheffii* Fisch. & C.A.Mey. (Love Flower), identified in the study as critically endangered (CR), together with rare species such as *Euphydryas orientalis*, demonstrates that Mogan Park must be managed as a biodiversity-sensitive landscape. Planting should therefore prioritize native, local, riparian, and slope-stabilizing species; reduce turf cover, particularly on slopes; increase the use of perennial groundcovers; and expand mulch and compost-based maintenance. Species such as *Tamarix tetrandra* (Pall. ex M. Bieb.), *Elaeagnus angustifolia* L., *Juniperus horizontalis* Moench, *Sedum* spp., and *Cotoneaster* spp. are especially relevant in this regard because they respond more effectively to waterfront conditions, slope stabilization, and lower-input maintenance. Conservation management should also include protection and rehabilitation zoning, temporary closure decisions during bird-breeding periods, waste separation and composting systems, and periodic monitoring of energy and water performance. In this framework, Mogan Park Improvement Standards should be established by the relevant institutions so that interventions remain controlled, measurable, and ecologically accountable over time while also offering a transferable model for other urban park retrofits.

Implementing this retrofit agenda in Mogan Park requires an adaptive governance and phased implementation framework in which hydrology, biodiversity, and wetland-edge integrity remain non-negotiable decision thresholds. In practice, this means prioritizing green infrastructure and stormwater management, reducing impermeable surface dominance through permeable and ecologically compatible materials, strengthening the use of native, local, and riparian plant species, preventing further reed-bed removal, integrating waste separation and compost-based maintenance practices, and improving energy and water performance through site-responsive monitoring. Because the park functions as both a public recreation landscape and a biodiversity-sensitive wetland system, future interventions should

be guided by controlled development principles, seasonal protection measures during critical breeding periods, and institutionally supported improvement standards that can coordinate planning, design, maintenance, and long-term performance evaluation. Taken together, the Mogan Park case suggests that SITES-based improvement decisions can support a transferable retrofit framework for ecologically sensitive urban parks, particularly in contexts where hydrological vulnerability, biodiversity protection, recreational pressure, and infrastructure-related drainage problems must be resolved within the same planning and management system.

Supplementary Materials and Declarations

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Appendix A

Table A1. Endemic plants identified in the GSEPA Region (SEPA, 2015).

Familya Adı	Takson Adı
Acanthaceae	*Acanthus hirsutus* Boiss.
Asteraceae	*Achillea phrygia* Boiss. et Bal. *Achillea wilhelmsii* C. Koch *Anthemis armeniaca* Freyn & Sint. *Centaurea tchihatcheffii* Fisch.& C. A. Mey. *Cousinia iconica* Hub.-Mor. *Jurinea pontica* Hausskn. & Freyn ex Hausskn. *Tripleurospermum callosum* (Boiss. & Heldr.) E.Hossain
Boraginaceae	*Moltkia aurea* Boiss. *Onosma isauricum* Boiss. et Heldr. *Onosma lycanum* Hub.-Mor.
Brassicaceae	*Alyssum blepharocarpum* Dudley&Hub.-Mor. *Alyssum huetii* Boiss. *Alyssum pateri* Nyar ssp. *Camelina hispida* Boiss. var. *grandiflora* (Boiss.) Hedge *Boiss. var. grandiflora* *Erysimum torulosum* Hub.-Mor.
Caryophyllaceae	*Dianthus anatolicus* Boiss. *Dianthus ancyrensis* Hausskn.&Bornm. *Gypsophila eriocalyx* Boiss.
Convolvulaceae	*Convolvulus galaticus* Rotsan ex Choisy
Cistaceae	*Helianthemum nummularium* (L.) Miller ssp. *lycaonicum* Coode et Cullen.

Fabaceae	*Astragalus acicularis* Bunge *Astragalus gymnolobus* Fischer. *Astragalus lycius* Boiss. *Astragalus lydius* Boiss. *Astragalus micropterus* Fischer. *Astragalus plumosus Willd. var.* *pulumosus Astragalus podperae* Sirj. *Astragalus vulnerariae* DC. *Ebenus hirsuta* Jaub. *Onobrychis argyrea* Boiss. ssp. *argyrea Onobrychis fallax* Freyn .& Sint *Onobrychis oxydontha* Boiss.ssp. *armena* (Boiss. et Huet.) Aktoklu *Trifolium pannonicum* Jacq.ssp. *elongatum* (Willd.) Zoh. *Vicia caesarea* Boiss.et Bal.
Lamiaceae	*Phlomis armeniaca* Willd. *Salvia cryptantha* Motbret. et Aucher.ex Benth. *Salvia wiedemannii* Boiss. *Stachy cretica* L. ssp. *anatolica* Rech. Fil. *Wiedemannia orientalis* Fisch. et Mey.
Liliaceae	*Allium cappadocicum* Boiss. *Bellevalia tauri* Feinbrun
Linaceae	*Linum flavum* L. ssp. *scabrinerve* (Davis) Davis. *Linum hirsutum* L. ssp. *anatolicum* (Boiss.) Hayek. var. *anatolicum*
Ranunculaceae	*Consolida raveyi* (Boiss.) Schröd.
Rubiaceae	*Crucianella disticha* Boiss.
Solanaceae	*Lycium anatolicum* A. Baytop & R. Mill.*,Linaria corifolia* Desf.

Scrophulariaceae	*Linaria corifolia* Desf. *Linaria iconia* Boiss.et Heldr. *Verbascum caudatum* Freyn.& Bornm. *Verbascum cherianthifolium* Boiss. var. *asperulum* (Boiss.) Murb. *Verbascum vulcanicum* Boiss.& Heldr. var. *vulcanicum Veronica multifida* L.

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