ECOLOGICAL PERSPECTIVE
An International Academic Journal
e-ISSN:2792-0062

KURAKÇIL PEYZAJ YAKLAŞIMININ SÜRDÜRÜLEBİLİR SU YÖNETİMİ BAĞLAMINDA DEĞERLENDİRİLMESİ

(EVALUATION OF THE XERISCAPE APPROACH IN THE CONTEXT OF SUSTAINABLE WATER MANAGEMENT)

Elif Ela Nur YAVUZ[1]
[1] Süleyman Demirel University, Institute of Applied and Natural Sciences, Department of Landscape Architecture, Isparta/Türkiye
elifelanuryavuz@gmail.com, ORCID: 0000-0003-3401-4614

Doi: https://doi.org/10.53463/ecopers.20250419
Corresponding Author/İletişim yazarı: Elif Ela Nur Yavuz
E-mail: elifelanuryavuz@gmail.com

ÖZET

İklim değişikliği, hızlı kentleşme ve artan iklim değişkenliği altında kentsel su stresi giderek şiddetlenmektedir. Dış mekân peyzaj sulaması—özellikle çim ağırlıklı ve yüksek su gereksinimli bitkilendirme—belediye su kullanımının önemli ve çoğu zaman isteğe bağlı bir bileşenini oluşturmakta; bu durum, onu talep yönlü su yönetimi açısından kritik bir hedef hâline getirmektedir. Kurakçıl peyzaj (xeriscape; kurağa uyumlu peyzaj), iklime uygun planlama, hidrozonlama, toprak iyileştirme, malçlama, verimli sulama ve bakım uygulamaları yoluyla sulama gereksinimini azaltmak için bütünleşik bir tasarım ve yönetim çerçevesi sunar. Bu derleme, sürdürülebilir kentsel su yönetimi ve suya duyarlı kent (WSC) gündemleri bağlamında kurakçıl peyzaja ilişkin uluslararası ve Türkiye literatürünü sentezlemektedir. Kapsam taraması mantığı ve tematik sentez yaklaşımı izlenerek (Arksey & O'Malley, 2005; Peters ve diğerleri, 2020), temel ilkeler, performans kanıtları (su tasarrufu, maliyetler, ekosistem ortak faydaları), olanak sağlayan teknolojiler ve standartlar (ET0 tabanlı su bütçeleri, akıllı sulama), uygulama engelleri ve iklim bölgeleri boyunca uyarlama gereksinimleri incelenmiştir. Literatür, anlamlı su tasarruflarının; bitki seçimi, sulama teknolojisi, toprak/malç uygulamaları ve izleme bileşenleri tek tek değil, entegre bir sistem olarak uygulandığında elde edilebildiğini göstermektedir. Türkiye'de kurakçıl peyzajın ölçeklendirilmesi; standartlaştırılmış su bütçesi hedefleri, karşılaştırılabilir izleme göstergeleri, güçlendirilmiş yerli bitki tedarik zinciri ve teknik rehberliği teşvikler ile kamusal iletişimle birleştiren politika araçlarını gerektirmektedir.

Anahtar Kelimeler: Kurakçıl peyzaj, sürdürülebilir su yönetimi, su koruma, iklime uyumlu peyzaj, kuraklık, sulama.

ABSTRACT

Urban water stress is intensifying under climate change, rapid urbanization, and increasing climate variability. Outdoor landscape irrigation—especially turf-dominated and high-water-demand planting—constitutes a substantial and often discretionary component of municipal water use, making it a critical target for demand-side water management. Xeriscape (drought-adaptive landscaping) provides an integrated design-and-management framework to reduce irrigation demand through climate-appropriate planning, hydro zoning, soil improvement, mulching, efficient irrigation, and maintenance practices. This review synthesizes international and Turkish evidence on xeriscape within sustainable urban water management and water-sensitive city (WSC) agendas. Following a scoping-review logic and thematic synthesis (Arksey & O'Malley, 2005; Peters et al., 2020), we examine foundational principles, performance evidence (water savings, costs, ecosystem co-benefits), enabling technologies and standards (ET0-based water budgets, smart irrigation), implementation barriers, and adaptation needs across climate regions. The literature indicates that meaningful water savings are achievable when plant selection, irrigation technology, soil/mulch practices, and monitoring are implemented as an integrated system rather than as isolated measures. For Türkiye, scaling xeriscape requires standardized water-budget targets, comparable monitoring indicators, a strengthened native plant supply chain, and policy instruments that combine technical guidance with incentives and public communication.

Key words: Xeriscape, sustainable water management, water conservation, climate-adaptive landscaping, drought, irrigation.

1. INTRODUCTION

Urban water systems are being reshaped by climate change, prolonged drought episodes, and increased hydroclimatic variability. In parallel, rapid urbanization expands impervious surfaces and intensifies heat islands, altering the urban water balance and increasing sensitivity to extremes. These trends shift the governance of water from a predominantly supply-focused problem toward a resilience problem that requires demand management, source diversification, and ecosystem-based adaptation.

Outdoor water use has become a strategic focus because it often drives seasonal peak demand and is comparatively amenable to interventions in design, technology, and behavior. Yet irrigation is also socially embedded: turf-centric aesthetics and “always-green” expectations can normalize high consumption even in climates where such landscapes are hydrologically mismatched. In drought periods, restrictions often target irrigation first, creating a practical requirement for landscapes that remain usable and acceptable under lower water inputs.

Xeriscape is one of the most established frameworks for climate-appropriate landscaping. It is not synonymous with eliminating vegetation; rather, it is an integrated approach to delivering landscape functions—recreation, shade, habitat, and visual quality—within realistic water constraints (Denver Water, 2025; St. Hilaire et al., 2008). In water-sensitive city (WSC) agendas, xeriscape is increasingly paired with nature-based stormwater strategies and alternative sources, linking irrigation demand reduction to broader hydrologic performance (Green, Solins, Brissette, & Benning, 2024).

1.1. Problem Statement and Significance

Many cities are confronting increasing water scarcity and increasingly erratic precipitation regimes under climate change. Urbanization disrupts the natural hydrologic cycle, producing drought on the one hand and heightened flash-flood risk on the other, and making urban water management a critical planning problem (Green, Solins, Brissette, & Benning, 2024). In this context, efficient water use and the rapid deployment of nature-compatible solutions in cities are urgent. Recent scholarship has foregrounded water-sensitive urban design (WSUD) and nature-based solutions, which aim to integrate blue–green infrastructure to retain stormwater on site, enable reuse, and enhance ecosystem services (Green, Solins, Brissette, & Benning, 2024).

Within landscape architecture, a prominent water-conservation strategy is drought-adaptive landscaping, widely known internationally as xeriscape. The term was first introduced in 1978 in Colorado (USA) and developed under a “Water-Efficient Landscaping” framework (Çorbacı, Özyavuz, & Yazgan, 2011). Xeriscape refers to a planning approach that maintains landscape functions with minimal water use by prioritizing native and drought-tolerant plants, appropriate soil amendments and mulches, and efficient irrigation techniques (Çorbacı, Özyavuz, & Yazgan, 2011). Importantly, xeriscape can reduce water consumption without sacrificing aesthetic quality, enabling functional green spaces (Çorbacı, Özyavuz, & Yazgan, 2011). Accordingly, this approach—whose relevance has increased under climate change—targets water-wise landscapes that protect environmental resources in water-limited regions (Çorbacı, Özyavuz, & Yazgan, 2011).

Today, cities from North America to East Asia seek innovative solutions to water-management challenges by combining blue–green infrastructure and xeriscape principles. In North America, low-impact development (LID) and green-infrastructure practices manage stormwater at the source to achieve both water savings and flood control (Green, Solins, Brissette, & Benning, 2024). In the Middle East, cities facing severe water scarcity sustain urban landscapes through strategies such as wastewater reuse and desalination. In China, the Sponge City program represents a comprehensive planning approach that targets the capacity to absorb and reuse at least 70% of rainfall in urban areas (Green, Solins, Brissette, & Benning, 2024). Under this program, nature-based solutions—green roofs, rain gardens, permeable pavements, and constructed wetlands—are integrated with gray infrastructure to strengthen urban water resilience (Green, Solins, Brissette, & Benning, 2024).

Despite policy interest, xeriscape implementation is frequently partial. Many projects focus on visible planting substitutions but leave irrigation infrastructure, maintenance routines, and performance monitoring largely unchanged. As a result, savings may be modest, unstable, or unverified. A recurring methodological limitation is the lack of standardized baselines and indicators; without metered data, water-budget targets, and maintenance records, claimed savings remain difficult to compare and scale.

In Türkiye, policy signals have strengthened through national water-efficiency initiatives and regulations that encourage monitoring and efficiency across sectors (Republic of Türkiye Ministry of Agriculture and Forestry, 2024). However, empirical evidence on outdoor water savings from integrated xeriscape interventions remains limited, and municipal practice varies widely by capacity. A synthesis that connects international standards with Turkish climatic and institutional conditions is therefore needed.

1.1.1. Xeriscape in the Context of Urban Drought and Demand Management

As the "severity × frequency" of drought intensifies, contemporary water policy increasingly emphasizes demand management alongside supply augmentation. In urban contexts, outdoor irrigation constitutes a major share of discretionary water use—particularly in arid and semi-arid climates—and landscape interventions are therefore positioned as practical pathways to achieve measurable savings (St. Hilaire et al., 2008; Nazemi Rafi, Kazemi, & Tehranifar, 2020). Beyond household measures, urban open-space strategies that reduce irrigation demand are now evaluated as part of climate-adaptation portfolios. IPCC assessments indicate that climate change will increase hydrologic extremes and intensify drought risk in many regions; accordingly, adaptation options that reduce water demand and enhance local water retention gain strategic value (IPCC, 2022). In Türkiye, the recent national agenda on water efficiency foregrounds "efficient use in all sectors" and encourages water-saving practices; within this policy environment, xeriscape can be operationalized not merely as a planting style but as an integrated set of interventions—plant selection/hydrozoning, irrigation technology, mulch and soil management, and alternative water use—designed to reduce demand pressure at the urban scale (T.C. Tarım ve Orman Bakanlığı, 2024).

1.1.2. Xeriscape, Blue–Green Infrastructure, and the Water Sensitive City Paradigm

When evaluated together with blue–green infrastructure (BGI), nature-based solutions, and the Water Sensitive City (WSC) paradigm, xeriscape should be understood not only as a design approach that reduces water consumption but also as a climate-adaptation strategy with the capacity to retain stormwater on site, reduce evaporative losses, mitigate urban heat-island effects, and strengthen ecosystem services (Green, Solins, Brissette, & Benning, 2024). WSC scholarship seeks a multidimensional balance among water quantity (floods/droughts), water quality, infrastructure resilience, and public benefit; within this frame, urban landscapes are treated as an "active component" shaping the water cycle. For example, reducing impervious surfaces and increasing infiltration through permeable pavements and vegetated areas can decrease runoff, lower flood risk, and help maintain soil moisture. Likewise, when irrigation demand is reduced through appropriate species selection, hydrozoning, and mulching, pressure on potable supply systems declines and urban systems become more resilient during dry periods (St. Hilaire et al., 2008; United States Environmental Protection Agency, 2023). Accordingly, evaluating xeriscape within sustainable water management makes its multiple co-benefits and implementation conditions visible in relation to BGI/NbS strategies.

1.1.3. Water Stress and the Need for Water-Efficient Urban Landscapes

Water stress generally refers to the ratio of water demand to available freshwater resources in a given area and is widely used as an early indicator of water-management risk. UN-Water, referring to SDG indicator 6.4.2, emphasizes an approach that measures water stress as the share of total freshwater withdrawal relative to available renewable freshwater resources (UN-Water, 2024; UNESCO, 2024). This metric should be read alongside broader debates on water security that incorporate not only physical scarcity but also economic and governance capacity. From an urban-resilience perspective, water stress is directly linked to distribution-network flexibility, emergency management, and the climate-adaptation performance of public spaces. The Water Sensitive City approach proposes making water a measurable component of planning and design rather than an "invisible input" to the urban system; in this context, xeriscape stands out as an adaptation tool that can help maintain the quality of public life during periods of heightened water stress (Green, Solins, Brissette, & Benning, 2024).

1.2. Aim, Scope, and Limitations

This review evaluates xeriscape as a strategy for sustainable urban water management, focusing on: (i) conceptual foundations and core principles; (ii) design and operational mechanisms that generate water savings (hydrozoning, irrigation efficiency, soil and mulch practices, alternative supplies); (iii) standardization instruments such as ET0-based water budgets and ordinances; (iv) international and Turkish practice examples; and (v) barriers and enabling conditions. Because methods and metrics differ across the literature, outcomes should be interpreted as context-dependent and influenced by climate, baseline landscape typology, and management regimes.

2. MATERIAL AND METHOD

This study is a thematic review that evaluates the relationship between the xeriscape approach and sustainable water management through a multidisciplinary lens. The literature search was structured in the logic of a scoping review; source selection, classification, and synthesis were conducted according to predefined criteria. The search was updated as of December 2025. The review was organized in line with key scoping-review stages (formulating the research question, comprehensive searching, screening, data extraction, and thematic synthesis) (Arksey & O'Malley, 2005; Peters et al., 2020).

3. RESULT AND DISCUSSION

3.1. Concept, Evolution, and Core Principles of Xeriscape

Xeriscape is an approach to landscape planning, design, and maintenance intended to reduce supplemental irrigation while maintaining landscape quality. It treats irrigation water as a constrained resource that must be allocated strategically through integrated decisions about plant composition, spatial arrangement, soils, and irrigation technology (Denver Water, 2025; St. Hilaire et al., 2008).

Guidelines commonly summarize xeriscape into seven principles: planning and design; soil improvement; appropriate plant selection; practical turf areas; efficient irrigation; mulching; and appropriate maintenance (Denver Water, 2025). These principles interact. Plant changes without irrigation reform rarely stabilize savings; irrigation upgrades without changing water-demanding plant palettes can deliver only limited reductions; and maintenance practices can quickly undo design intent.

Recent WSC thinking highlights that xeriscape should be integrated with the urban water cycle via green infrastructure and source diversification. In this framing, xeriscape is not only an irrigation strategy but a component of an integrated system that influences runoff, infiltration, thermal comfort, and biodiversity (Green et al., 2024).

3.1.1. Origins and Conceptual Framing

The term xeriscape emerged in the early 1980s—particularly in drought-prone U.S. states—as a framework for reducing the pressure of urban landscape irrigation on water demand. In the literature, it is often discussed alongside “water-wise landscaping,” “climate-appropriate landscaping,” and “drought-tolerant landscaping,” all of which share the core idea of properly aligning plant–water relations and adapting maintenance/irrigation regimes to local climate and soil conditions (St. Hilaire et al., 2008). Xeriscape, however, cannot be reduced to selecting low-water plants alone; it proposes a systematic approach in which design decisions are structured through a water-budget logic (inputs–outputs), species and habitat composition are aligned with site microclimate and use intensity, and irrigation plans are calibrated to measurable targets. Accordingly, the value of xeriscape for sustainable water management lies not only in reducing landscape water demand but also in supporting principles of on-site water management (rainwater, graywater, infiltration, and storage) (Nazemi Rafi, Kazemi, & Tehranifar, 2020).

3.1.2. The Seven Xeriscape Principles and Their Water-Management Logic

Xeriscape is commonly defined through seven core principles: (i) sound planning and design, (ii) soil analysis and improvement, (iii) appropriate plant selection and hydrozoning, (iv) limiting turf to functional areas, (v) efficient irrigation, (vi) mulching, and (vii) appropriate maintenance (St. Hilaire et al., 2008). These principles aim to reduce landscape water use not solely through irrigation technology but through the combined effects of species composition, surface materials, soil water-holding capacity, and maintenance intensity. For example, hydrozoning spatially differentiates irrigation needs by grouping species with similar water requirements, while mulch and organic-matter management can reduce evaporation and increase infiltration, thereby extending irrigation intervals (Nazemi Rafi, Kazemi, & Tehranifar, 2020). In this sense, xeriscape is a design-and-management toolkit that addresses “water conservation” (quantity), "system efficiency" (delivering the same service with less water), and "resilience" (maintaining function during drought) simultaneously. The relationship between xeriscape principles and sustainable water management is summarized in Table 1.

Table 1. Linking xeriscape principles to sustainable water-management mechanisms and implementation indicators.

Principle/design component	Water-management mechanism	Implementation indicator	Example sources
Planning and design	Align land use with a site water budget; climate–topography–soil-informed decisions.	Water budget (L/m^2/year), precipitation–ET balance, microclimate analysis	Nazemi Rafi, Kazemi, & Tehranifar, 2020; Denver Water, 2025
Plant selection and hydrozoning	Zone plants by similar water needs; reduce unnecessary irrigation	Hydrozoning scheme; share of native/drought-tolerant species (%)	Çorbacı, Özyavuz, & Yazgan, 2011; St. Hilaire et al., 2008
Soil improvement	Increase water-holding capacity via organic matter/compost amendments	Soil organic matter (%), infiltration rate, compaction indicators	St. Hilaire et al., 2008
Mulching	Reduce evaporation; maintain soil moisture; suppress weeds	Mulch depth (cm), reduction in surface evaporation	Chalker-Scott, 2007
Efficient irrigation and control	Optimize drip/sprinkler systems; sensor/ET-based scheduling; reduce leaks and losses.	Irrigation efficiency (%), sensor use, smart controllers	United States Environmental Protection Agency, 2023; Green et al., 2024
Alternative water sources	Reduce potable demand via rainwater harvesting and greywater/reclaimed-water use.	Storage volume (m^3), reuse rate (%)	Van de Walle et al., 2023; European Union, 2020
Maintenance management	Stabilize water use through correct mowing, pruning, and fertilization regimes.	Maintenance frequency, plant survival rate, cost (TRY/m^2/year)	Nazemi Rafi, Kazemi, & Tehranifar, 2020

3.2. Contributions of Xeriscape to Sustainable Water Management

3.2.1. Plant Selection and Hydrozoning

Hydrozoning groups plants by similar water requirements into distinct irrigation zones, enabling targeted scheduling and reducing chronic overwatering that occurs when heterogeneous plantings are irrigated uniformly. Hydrozoning also supports drought operations by prioritizing zones based on functional value (St. Hilaire et al., 2008).

Species selection emphasizes native plants and drought-tolerant taxa. In practice, drought tolerance is site-relative: soil texture, compaction, rooting volume, and microclimate can shift irrigation needs substantially. Turkish studies evaluating urban green spaces indicate that plant palettes and management can be oriented toward drought-tolerant assemblages while maintaining aesthetic diversity (Çorbacı, Özyavuz, & Yazgan, 2011; Çorbacı & Ekren, 2022).

A key implication is that plant selection must be coordinated with soil improvement and mulching. Drought-adapted species can underperform in compacted soils with low infiltration, while improved soils and mulch can expand the range of species that can be sustained under strict water budgets. Therefore, xeriscape is most effective when implemented as a system rather than as an isolated plant substitution.

3.2.2. Efficient Irrigation Systems and Smart Technologies

Irrigation efficiency involves both infrastructure and operations. Hardware improvements include drip irrigation for shrub/groundcover zones, filtration and pressure regulation, and high-uniformity sprinklers where turf remains. Operational improvements include seasonal schedule adjustment, avoiding irrigation during peak evaporative hours, and routine inspections to prevent leaks and overspray.

Smart irrigation controllers are a major recent development. ET-based controllers estimate plant demand using reference evapotranspiration, while soil-moisture sensors provide feedback on plant-available water. These tools can reduce over-irrigation and help sustain savings, but they require commissioning and user literacy; miscalibration can negate benefits (United States Environmental Protection Agency, 2023).

From a WSC governance perspective, efficient technology delivers the strongest results when coupled with explicit targets and accountability. Monitoring and feedback loops—comparing water use against defined allowances—are necessary to prevent "drift" back toward overwatering (Green et al., 2024).

3.2.3. Soil Improvement and Mulching

Urban soils are often compacted and low in organic matter, limiting infiltration and plant-available water. Soil improvement through compost and organic amendments can enhance water-holding capacity and reduce irrigation frequency, especially during establishment (St. Hilaire et al., 2008).

Mulching consistently emerges as a high-leverage practice. Evidence indicates that mulches reduce evaporation, moderate soil temperature, suppress weeds, and protect soil structure, improving moisture retention and plant performance (Chalker-Scott, 2007). Implementation details matter: mulch type, depth, and renewal frequency influence both effectiveness and potential trade-offs (e.g., nitrogen immobilization, fire risk in certain climates).

3.2.4. Rainwater Harvesting and Alternative Water Sources

Sustainable water management increasingly stresses source diversification alongside demand reduction. Rainwater harvesting captures runoff and stores it for landscape use, reducing potable demand and attenuating runoff peaks. Key design variables include storage sizing relative to rainfall patterns and landscape demand, first-flush management, filtration, and integration with irrigation delivery.

Greywater and reclaimed water reuse can further reduce potable irrigation, but quality constraints become central. The European Union's Regulation 2020/741 provides a risk-management and quality framework for water reuse (European Union, 2020). Adoption is also shaped by acceptance and risk communication, particularly in residential contexts (Van de Walle et al., 2023).

Integrating alternative supplies into xeriscape requires plant–soil compatibility and monitoring. Where salinity is elevated, designers may need salt-tolerant species and soil management to mitigate accumulation; where nutrient loads are high, fertilization regimes should be adjusted.

3.2.5. Surface Design and Microclimate Management

Surface design influences irrigation demand indirectly through microclimate. Extensive heat-absorbing hardscape can increase local temperatures and evaporative demand, raising irrigation needs for adjacent planting beds. Conversely, canopy layering, shading, and permeable surfaces can reduce heat stress and improve soil moisture dynamics.

In xeriscape practice, this implies that plant palettes should be coordinated with material decisions. Reducing unnecessary paved area, selecting cooler or permeable materials where appropriate, and designing shaded pedestrian routes can support both water efficiency and thermal comfort.

3.2.6. Permeable Surfaces, Rain Gardens, and Green Infrastructure Synergies

Green infrastructure elements—permeable pavements, rain gardens, and bioretention—create synergies between xeriscape and stormwater management. By increasing infiltration and temporary storage, they reduce runoff peaks and can support groundwater recharge while sustaining soil moisture in adjacent plantings (Green et al., 2024).

These measures also contribute to water-quality protection by filtering pollutants, reducing first-flush loads, and improving the ecological performance of receiving waters. Their performance depends on soil media design, maintenance, and appropriate siting within the catchment.

3.2.7. Water Quality and Risk Considerations in Reuse

Alternative irrigation supplies can contain salts and other constituents that affect soil structure, infiltration, and plant health. Long-term reuse can lead to salinity accumulation, requiring monitoring and mitigation strategies.

Risk-management frameworks emphasize fit-for-purpose quality classes, operational monitoring, and site-specific risk assessment (European Union, 2020). For xeriscape, these considerations translate into species selection, soil management, and irrigation system design that align with the quality of the alternative source.

3.2.8. Establishment Irrigation and Adaptive Management

Establishment-phase irrigation is a decisive determinant of long-term performance. Even drought-tolerant species may require consistent irrigation during the first one to two seasons to develop root systems. Poor establishment management can increase mortality and trigger replacement cycles that raise both water use and costs.

Adaptive management—adjusting schedules based on monitoring, seasonal conditions, and observed plant response—is integral to xeriscape success (St. Hilaire et al., 2008).

3.2.9. Maintenance Practices as a Water-Management Intervention

Maintenance practices can create or undermine water savings. Appropriate pruning, weed control, mulching renewal, and soil care affect evapotranspiration and plant stress. Over-fertilization can increase growth and water demand. For turf, mowing height and frequency influence water needs.

Because maintenance is often delivered by teams separate from designers, aligning maintenance specifications with water-efficiency targets is a governance challenge. Clear performance targets and monitoring help sustain design intent (Nazemi Rafi, Kazemi, & Tehranifar, 2020).

3.2.10. Life-Cycle Costs and Economic Performance

Xeriscape conversion may require upfront investment in design, soil improvement, plant material, and irrigation retrofits. Long-term benefits can include reduced water bills and, in some contexts, lower mowing and fertilizer needs, but these benefits depend on plant survival and redesigned maintenance regimes.

Evidence from turf removal and incentive programs indicates that economic instruments can accelerate adoption and yield measurable demand reductions, while program design influences equity and persistence of savings (Brelsford & Abbott, 2021).

Life-cycle cost analysis (LCCA) is therefore useful to compare upfront and operating costs over time. Operating costs include water, labor, replacement planting, and irrigation system maintenance; reliable municipal record-keeping enhances the quality of such evaluations.

3.2.11. Turf Management: Functional Limitation and Conversion Strategies

Turf is valuable in high-use recreational areas, and for certain microclimatic benefits, but in many cities, turf extent exceeds functional needs. Xeriscape therefore emphasizes “right turf, right place”: retain turf where justified by use intensity and convert other areas to drought-tolerant groundcovers and layered plantings (St. Hilaire et al., 2008).

Program experience suggests that turf removal rebates can reduce outdoor demand, but rebound effects may occur if replacement landscapes are mismanaged or if users compensate elsewhere. Combining conversion with design guidance, irrigation education, and monitoring improves persistence of savings (Brelsford & Abbott, 2021; Green et al., 2024).

3.2.12. Landscape Water Budgets and Standardization

Landscape water budgets convert conservation goals into measurable allowances. A budget defines an annual maximum applied water allowance using ET0, landscape area, adjustment factors, and conversion coefficients, enabling design-stage evaluation and post-installation auditing.

The U.S. EPA WaterSense program promotes water-efficient landscape approaches and tools that support budgeting and efficient irrigation (United States Environmental Protection Agency, 2023). California's Model Water Efficient Landscape Ordinance (MWELO) operationalizes budgeting through MAWA and ETWU, enabling compliance and comparability across projects (California Department of Water Resources, 2024).

Operationally, budgeting requires baseline data, metering, and reporting. Without these, water budgets risk remaining aspirational rather than enforceable. For Türkiye, establishing regionally adaptable budgeting standards could enable benchmarking and align with national water-efficiency directions (Republic of Türkiye Ministry of Agriculture and Forestry, 2024).

3.2.13. Ecosystem Services and Climate Adaptation: Beyond Water Savings

Urban landscapes deliver ecosystem services including thermal regulation, habitat provision, carbon storage, stormwater management, and recreation and mental-health benefits. Xeriscape can contribute to these services while reducing irrigation demand, especially when combined with green infrastructure and diverse plant communities (Green et al., 2024; Nazemi Rafi et al., 2020). A key planning tension is that strong cooling benefits are often associated with higher evapotranspiration. Under water constraints, the goal becomes optimizing water allocation to sustain targeted services rather than minimizing irrigation to zero. This logic aligns with WSC frameworks that treat the city as an integrated water–ecosystem–social system (Green et al., 2024).

3.3. Practice Examples from International Contexts and Türkiye: Comparative Insights

Across reviewed cases, xeriscape and integrated landscape water strategies have produced meaningful outcomes when supported by standards, incentives, and monitoring. Table 2 summarizes selected examples and illustrates how different governance mechanisms shape implementation outcomes.

Table 2. Xeriscape and urban water-management strategies and outcomes in selected cases (2021–2025).

Case/program	Context	Implementation elements	Reported/expected effects	Sources
Las Vegas 'Water Smart Landscapes' (USA)	Arid climate; residential landscape conversion	Turf removal rebates, water-budget framing, and consumption monitoring	Meaningful reductions in outdoor residential water use; strong role of economic incentives	Brelsford & Abbott, 2021

California MWELO (USA)	Regulation-based water-budget standard	ET0-based water budget, maximum applied water allowance, and efficient irrigation requirements	Standardization of landscape water efficiency; inspection and reporting mechanisms	California Department of Water Resources, 2024
Sponge City (China) – illustrative framework	High imperviousness; flood and water-quality pressures	Permeable surfaces, rain gardens, bioretention, green infrastructure	Reduced flood risk; improved water quality and groundwater recharge potential	Green et al., 2024
Urban parks in Tokat (Türkiye)	Continental climate; public open green spaces	Suitability assessment using xeriscape principles (Likert)	Many parks show low compliance; neighborhood parks score relatively higher	Hassamancıoğlu et al., 2025; Ünsal & Çelik Çanga, 2023

3.3.1. Türkiye: Policy Signals and Emerging Practice

Türkiye's recent emphasis on water efficiency strengthens the policy context for mainstreaming water-efficient landscaping. National guidance and regulation under the water-efficiency agenda provides a framework for planning and monitoring, creating an enabling environment for municipal action (Republic of Türkiye Ministry of Agriculture and Forestry, 2024).

Diagnostic studies in Türkiye have begun to evaluate the suitability of existing public green spaces under xeriscape principles. Park-based assessments in Tokat indicate uneven compliance and emphasize that plant selection, irrigation design, and maintenance must be integrated as a coherent system (Hassamancıoğlu et al., 2025; Ünsal & Çelik Çanga, 2023). These findings suggest that technical potential exists, but standardization and monitoring are necessary to move from qualitative evaluation to performance-based management.

3.3.2. International Patterns: Standards, Incentives, and Cultural Acceptance

International experience indicates that scaling often depends on three interacting mechanisms: standards or restrictions that define performance expectations, economic incentives that reduce upfront barriers, and communication strategies that shift aesthetic norms. Turf removal rebate programs in arid U.S. cities demonstrate how incentives can accelerate adoption and reduce outdoor demand (Brelsford & Abbott, 2021).

Regulatory standards such as California's MWELO illustrate how ET0-based water budgets can be institutionalized. MWELO sets a maximum applied water allowance (MAWA) and requires that estimated total water use (ETWU) remain within MAWA, supported by efficient irrigation requirements and documentation (California Department of Water Resources, 2024). This approach is valuable because it ties design decisions (plant factors, hydrozones, irrigation type) to a quantified target, enabling both compliance checks and comparative learning across projects.

WSC and sponge-city frameworks embed landscape design within stormwater capture, infiltration, and reuse strategies, expanding the framing from irrigation savings alone to urban hydrology management (Green et al., 2024). From a global perspective on urban greening, professional guidance increasingly emphasizes that green infrastructure must be designed in tandem with water security and long-term climate constraints (AIPH, 2025).

3.3.3. Climate-Region Adaptation in Türkiye

Türkiye’s climatic diversity implies that xeriscape must be operationalized as a flexible framework. In Mediterranean regions with pronounced summer droughts, hydrozoning, mulching, soil improvement, and alternative-source integration are especially important. In continental interiors, frost tolerance and seasonal precipitation patterns constrain species selection and influence irrigation scheduling. Transition zones with high interannual variability require monitoring-led adaptive management and flexible irrigation programming.

3.4. Barriers to Implementation

The literature discusses barriers that limit the mainstreaming of xeriscape across economic (up-front costs, plant supply chains, and maintenance knowledge), social (aesthetic norms and the expectation of “green lawn”), institutional (fragmented authority and responsibility), and regulatory (lack of standards and incentives) dimensions. It is also noted that the spatial distribution of water-efficient landscapes can align with socioeconomic patterns and that differences in information, income, and neighborhood-level implementation shape transition dynamics (Green, Solins, Brissette, & Benning, 2024).

3.4.1. Economic and Cost Barriers

Transitioning to xeriscape—especially in retrofits where existing turf is removed and redesigned—may be delayed because of perceived up-front investment costs. Upgrading irrigation infrastructure, soil rehabilitation, mulch, and suitable plant material can entail short-term expenses; where water unit prices remain low or tiered pricing is limited, payback periods may not be persuasive for users. Accordingly, many successful cases coordinate rebate/incentive mechanisms with water-pricing policies (Chalker-Scott, 2007).

3.4.2. Aesthetic Norms and Social Acceptance

One of the most decisive factors for the diffusion of xeriscape is the widespread association of a “well-kept landscape” with turf-dominated, continuously green aesthetics. Reading public landscapes as signals of status and prestige can lead water-saving planting compositions to be perceived as “dry” or “neglected.” This requires water-efficient designs to be configured to maintain aesthetic quality through plant composition, color, texture diversity, and coherent maintenance strategies. Studies of user preferences show that acceptance of water-wise landscapes increases with variables such as visual quality of planting design, shading/thermal comfort, and regularity of maintenance (Nazemi Rafi, Kazemi, & Tehranifar, 2020).

3.4.3. Institutional and Regulatory Barriers

In local governments, fragmented organization of project delivery and maintenance processes, weak coordination between water management and landscape management, and the lack of technical guidance/standards can undermine xeriscape implementation. Irrigation projects are often prepared independently of meteorological data (ET0) and explicit water-budget targets, which reduces operational efficiency. By contrast, national regulations focusing on water efficiency create an opportunity to develop local standards (T.C. Tarım ve Orman Bakanlığı, 2024).

3.4.4. Technical and Operational Barriers

The most common technical problems include inappropriate species selection (mismatch with microclimate/soil), failure to apply hydrozoning, clogging and maintenance deficiencies in drip systems, and misprogramming of smart controllers. Meta-analytic findings indicate that although smart controllers have substantial water-saving potential, outcomes are sensitive to "human factors" such as commissioning and user behavior (United States Environmental Protection Agency, 2023; Brelsford & Abbott, 2021). Therefore, technical training, standardized maintenance protocols, and monitoring systems should be treated as integral components of xeriscape.

3.4.5. The Human Factor and Capacity Building

In the long-term performance of xeriscape, the "human factor" is decisive: the technical knowledge of designers and maintenance staff, users' aesthetic perceptions and water-use habits, and managers' commitment to performance targets shape whether water savings persist. Implementation should therefore integrate technical training (irrigation commissioning, sensor maintenance, species selection), standardization of maintenance protocols, and user communication. Social-acceptance research indicates that the risk of water-wise landscapes being perceived as "unkempt" can be reduced through appropriate planting composition, edge/boundary elements, informational signage, and participatory processes (Nazemi Rafi, Kazemi, & Tehranifar, 2020). For local governments, this implies establishing regular coordination mechanisms between parks/landscape departments and water/infrastructure units, monitoring post-project performance, and reporting transparently to the public. Such transparency also facilitates public understanding that xeriscape generates benefits not only in "savings" but also in quality of life and climate adaptation (Green, Solins, Brissette, & Benning, 2024).

3.5. Discussion: Toward Evidence-Based, Water-Sensitive Xeriscape

3.5.1. Evidence and Context Dependence

The literature supports xeriscape as an effective strategy, but outcomes depend on baseline conditions, climate, and management. Integrated interventions anchored in water budgets are generally more stable than isolated measures. This aligns with the logic of WaterSense and MWELO frameworks that link design, operation, and compliance to measurable allowances (California Department of Water Resources, 2024; United States Environmental Protection Agency, 2023).

3.5.2. Monitoring as Governance

Monitoring is often the missing link. Metered irrigation data and simple system checks enable diagnosis of drift, leaks, and mis-scheduling. A minimal indicator set (Table 3) can be scaled to local capacity and used for benchmarking across projects and municipalities.

Table 3. A minimal monitoring indicator set for evaluating xeriscape performance.

Indicator	Unit/metric	Measurement/calculation	Assessment purpose	Recommended sources
Landscape water use	L/m²/year	Meter data; water-budget accounting	Quantify water savings performance	United States Environmental Protection Agency, 2023; California Department of Water Resources, 2024
Irrigation efficiency	%	System performance, pressure, and distribution uniformity checks	Track irrigation-system effectiveness	St. Hilaire et al., 2008
Surface permeability	% of area	Permeable-surface inventory; GIS-based calculations	Evaluate stormwater retention potential	Green et al., 2024
Plant composition	% native/drought-adaptive species	Plant list; hydrozone mapping	Assess the climate appropriateness of the planting design	Nazemi Rafi, Kazemi, & Tehranifar, 2020; Çorbacı, Özyavuz, & Yazgan, 2011
Soil moisture and organic matter	% / g kg⁻¹	Sensor measurements; laboratory analyses	Assess soil water-holding capacity	Chalker-Scott, 2007
Alternative water use	%	Records of greywater/rainwater/reclaimed-water use	Assess the reduction in potable demand	Van de Walle et al., 2023; European Union, 2020
Maintenance cost	TRY/m²/year	Annual maintenance budget and labor records	Evaluate life-cycle cost and sustainability	Brelsford & Abbott, 2021

3.5.3. Integrating Demand Management with Source Diversification

Demand management alone may not ensure resilience under severe scarcity. Integrating xeriscape with rainwater harvesting, stormwater infiltration, and regulated reuse can increase resilience, but reuse requires risk management and public acceptance. The EU reuse regulation illustrates governance requirements for safe scaling (European Union, 2020), while adoption studies highlight acceptance dynamics and risk communication needs (Van de Walle et al., 2023).

3.5.4. Social Value, Health, and Co-Benefits

Xeriscape should not be framed as a simple trade-off between water savings and urban livability. The challenge is to maintain inclusive, thermally comfortable, and socially valued green space under climate constraints. Public-health guidance highlights the importance of supportive environments and accessible quality spaces for health promotion (World Health Organization, 2006). Designing drought-adaptive landscapes that are legible, attractive, and well-maintained can thus be interpreted as both a water-management and a public-value intervention.

3.5.5. Research Gaps and Future Agenda

Research gaps recur across contexts. First, long-term, meter-based evaluations are limited, especially for public landscapes. Second, locally calibrated plant coefficients and performance data for native species are sparse, limiting accurate budgeting. Third, social acceptance and behavioral responses remain understudied relative to technical measures. Addressing these gaps would strengthen evidence-based policy and improve the design of incentives and standards.

3.6. Implementation Framework: A Design-and-Management Roadmap

A practical roadmap can translate xeriscape principles into operational practice across the project life cycle: (i) set a climate- and site-informed water budget; (ii) design hydrozones, surfaces, and plant palettes aligned with that budget; (iii) implement and commission irrigation systems; (iv) monitor consumption and system performance; and (v) align maintenance and communication with performance goals.

Commissioning is central: pressure and flow are verified by zone, sensors are calibrated, and controllers are programmed to local conditions. Monitoring then functions as governance: deviations from targets trigger corrective actions such as schedule adjustments, repairs, re-mulching, or plant replacement. Communication tools (signage, digital outreach, participatory programs) help users interpret and accept drought-adaptive aesthetics, increasing social legitimacy and long-term persistence.

For Türkiye, national emphasis on water efficiency and monitoring provides an enabling context to institutionalize such roadmaps at the municipal scale (Republic of Türkiye Ministry of Agriculture and Forestry, 2024). At minimum, routine reporting of irrigation consumption relative to ET0-based targets is a prerequisite for evidence-based landscape water management (United States Environmental Protection Agency, 2023; Green et al., 2024).

4. CONCLUSION AND RECOMMENDATİONS

Xeriscape can be a high-impact component of sustainable urban water management when implemented as an integrated system. Water savings and co-benefits depend on combining hydrozoning and climate-appropriate planting with efficient irrigation, soil and mulch management, water-budget targets, and monitoring. International experience indicates that standards, incentives, and cultural acceptance strategies jointly determine scaling success.

For policy-makers in Türkiye: develop regionally adaptable ET0-based water-efficient landscape standards; phase measures that limit high-water turf where functionally unjustified; and design incentives that reward verified savings. For municipalities and practitioners: institutionalize commissioning and monitoring, modernize irrigation infrastructure, expand pilot xeriscape projects in public spaces, and strengthen native plant supply chains through procurement and nursery partnerships. For researchers: prioritize long-term evaluations across climate regions, calibrate plant coefficients for native species, and analyze social acceptance and behavioral responses. Together, these steps can turn xeriscape from isolated good-practice projects into a standardized, evidence-based pillar of climate adaptation and water security.

Three directions appear particularly critical for future work. First, long-term monitoring of water use in pilot sites across Türkiye's major climate regions (Mediterranean, continental, and transitional) is needed to quantify the real-world savings potential and variability of xeriscape interventions. Second, experimental studies should establish water-requirement coefficients and hydrozoning parameters for native species so that plant selection can be supported by a more quantitative decision framework (Nazemi Rafi, Kazemi, & Tehranifar, 2020). Third, the social-acceptance and behavioral dimension (aesthetic norms, perceptions of maintenance, and risk communication) should be examined at both residential and public-space scales using mixed methods; xeriscape communication strategies should be "designed into" projects rather than treated as an add-on (Nazemi Rafi, Kazemi, & Tehranifar, 2020; WHO, 2006; European Union, 2020). Taken together, these axes can place xeriscape's contribution to Türkiye's climate-adaptation and water-security objectives on a stronger evidence base.

For practitioners, it is recommended that components such as hydrozoning, ET/sensor-based smart irrigation, mulching, and soil improvement be designed as an integrated system, and that performance be monitored using water consumption, cost, and ecological indicators. For researchers, priority topics include long-term field monitoring of water use and ecosystem-service performance of native drought-tolerant species in Türkiye, quantitative assessment of user preferences and social acceptance, and improved life-cycle cost analyses.

A critical condition for the feasibility of these recommendations is recognizing that landscape design does not end with project delivery. In xeriscape, "performance" is produced through post-implementation maintenance and irrigation management; therefore, the capacity of municipalities and site administrations to commission irrigation infrastructure, train maintenance teams, and report water consumption regularly is as important as design itself (Green, Solins, Brissette, & Benning, 2024). International standards (e.g., the WaterSense water-budget approach, MWELO) facilitate pre- and post-implementation comparison by quantifying water targets. Developing a similar water-budget framework in Türkiye and integrating it into project specifications and maintenance contracts would accelerate the institutionalization of xeriscape as a durable practice culture (United States Environmental Protection Agency, 2023; California Department of Water Resources, 2024; T.C. Tarım ve Orman Bakanlığı, 2024).

In sum, a sustainable urban future requires a holistic approach in which water is prioritized as a design input and ecological, innovative landscape solutions are implemented. Successful international examples demonstrate that this transition is feasible; adapting comparable practices to local conditions can help build water-resilient and livable cities.

REFERENCES

AIPH. (2025). The AIPH World Green City Awards (Riyadh – Saudi Arabia). Erişim tarihi 25 Aralık 2025, https://fgc2024.com/aiph/

Arksey, H. ve O'Malley, L. (2005). Scoping studies: Towards a methodological framework. International Journal of Social Research Methodology, 8(1), 19–32. https://dx.doi.org/10.1080/1364557032000119616

Avrupa Birliği. (2020). Regulation (EU) 2020/741 of the European Parliament and of the Council of 25 May 2020 on minimum requirements for water reuse. Official Journal of the European Union, L 177, 32–55. Erişim tarihi 25 Aralık 2025, https://eur-lex.europa.eu/eli/reg/2020/741/oj

Brelsford, C. ve Abbott, J. K. (2021). How smart are "Water Smart Landscapes"? Journal of Environmental Economics and Management, 106, 102402. https://dx.doi.org/10.1016/j.jeem.2020.102402

California Department of Water Resources. (2024). Model Water Efficient Landscape Ordinance (MWELO). Erişim tarihi 25 Aralık 2025, https://water.ca.gov/programs/water-use-and-efficiency/landscape-ordinance

Chalker-Scott, L. (2007). Impact of mulches on landscape plants and the environment—A review. Journal of Environmental Horticulture, 25(4), 239–249.

Çetin, N. ve Mansuroğlu, S. (2018). Akdeniz koşullarında kurakçıl peyzaj düzenlemelerinde kullanılabilecek bitki türlerinin belirlenmesi: Antalya/Konyaaltı örneği. Ege Üniversitesi Ziraat Fakültesi Dergisi, 55(1), 11–18. https://dx.doi.org/10.20289/zfdergi.390690

Çorbacı, Ö. L., Özyavuz, M. ve Yazgan, M. E. (2011). Peyzaj mimarlığında suyun akıllı kullanımı: Xeriscape. Tarım Bilimleri Araştırma Dergisi, (1), 25–31.

Denver Water. (2025). Xeriscape: Seven principles. Erişim tarihi 25 Aralık 2025, https://www.denverwater.org/your-water/water-use/xeriscape

Green, J. C., Solins, J. P., Brissette, F. P. ve Benning, T. M. (2024). Shifting currents: A synthesis of urban water management and green infrastructure to inform planning at multiple scales. Journal of Urban Ecology, 10(1), juae003. https://dx.doi.org/10.1093/jue/juae003

Hassamancıoğlu, V. M., Yılmaz, G., Çelik, A. ve Erdoğdu, S. (2025). Kentsel açık yeşil alanların kurakçıl peyzaj tasarımına uygunluğunun değerlendirilmesi: Tokat kenti örneği. Research in Agricultural Sciences, 56(1), 50–65. https://dx.doi.org/10.17097/agricultureatauni.1508760

IPCC. (2022). Climate Change 2022: Impacts, adaptation and vulnerability. Cambridge: Cambridge University Press.

Karaca, E. ve Kuşvuran, A. (2012). Çankırı kenti peyzaj düzenlemelerinde kullanılan bazı bitkilerin kurakçıl peyzaj açısından değerlendirilmesi. Türk Bilimsel Derlemeler Dergisi, 5(2), 19–24.

Kaylı, A. ve Gölbey, A. G. (2020). Yeşil altyapı ve yeşil bina bileşeni olarak kurakçıl peyzaj uygulamaları. Ege Üniversitesi Ziraat Fakültesi Dergisi, 57(2), 303–311. https://dx.doi.org/10.20289/zfdergi.669799

Nazemi Rafi, H., Kazemi, F. ve Tehranifar, A. (2020). Xeriscaping: A review of principles and plant selection. Urban Forestry & Urban Greening, 52, 126699. https://dx.doi.org/10.1016/j.ufug.2020.126699

Öztaş Karlı, R. G. ve Artar, M. (2021). Kentsel su yönetiminde araç olarak su ayak izi ve mavi-yeşil altyapı. Kent Akademisi, 14(2), 158–175. https://dx.doi.org/10.35674/kent.887408

Peters, M. D. J., Marnie, C., Tricco, A. C., Pollock, D., Munn, Z., Alexander, L., … Khalil, H. (2020). Updated methodological guidance for the conduct of scoping reviews. JBI Evidence Synthesis, 18(10), 2119–2126. https://dx.doi.org/10.11124/JBIES-20-00167

Saher, N. M., Bazaid, A. S., Alharbi, M., Alotaibi, N. A., Eid, E. M. ve Dhahri, A. A. (2022). Microclimate effects on irrigation needs in different vegetation types in Saudi Arabia. Hydrology, 9(6), 104. https://dx.doi.org/10.3390/hydrology9060104

St. Hilaire, R., Arnold, M. A., Wilkerson, D. C., Devitt, D. A., Hurd, B. H., Lesikar, B. J., … Zoldoske, D. F. (2008). Efficient water use in residential urban landscapes. HortScience, 43(7), 2081–2092.

Su Verimliliği Yönetmeliği. (2024, 27 Aralık). T.C. Resmî Gazete. Erişim tarihi 25 Aralık 2025, https://www.resmigazete.gov.tr/

T.C. Tarım ve Orman Bakanlığı. (2024). Kurakçıl peyzaj uygulama rehberi. Erişim tarihi 25 Aralık 2025, https://www.suverimliligi.gov.tr/

UN-Water. (2024). Water stress. Erişim tarihi 25 Aralık 2025, https://www.unwater.org/water-facts/water-stress

UNESCO. (2024). United Nations World Water Development Report 2024: Water for prosperity and peace. Paris: UNESCO. Erişim tarihi 25 Aralık 2025, https://www.unesco.org/reports/wwdr/2024/en

United States Environmental Protection Agency. (2023). WaterSense Water Budget Tool: User guide. Erişim tarihi 25 Aralık 2025, https://www.epa.gov/watersense/water-budget-tool

Ünsal, O. ve Çelik Çanga, M. (2023). Tokat şehir parklarının kurakçıl peyzaj tasarımına uygunluklarının belirlenmesi. Bartın Orman Fakültesi Dergisi, 25(2), 200–208. https://dx.doi.org/10.24011/barofd.1306076

Van de Walle, J., Hill, C., Ali, S., Callahan, K. ve Erfani, R. (2023). Regulations and guidelines for residential greywater reuse: A critical review. npj Clean Water, 6, 20. https://dx.doi.org/10.1038/s41545-023-00236-6

Volo, T. J., Vivoni, E. R. ve Ruddell, B. L. (2015). An ecohydrological approach to conserving urban water through optimized landscape irrigation schedules. Landscape and Urban Planning, 133, 127–132. https://dx.doi.org/10.1016/j.landurbplan.2014.09.012

World Health Organization. (2006). Guidelines for the safe use of wastewater, excreta and greywater: Volume 4. Excreta and greywater use in agriculture. Geneva: WHO.