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Sustainability and Water Management of Public Gardens in the Emirate of Abu Dhabi

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Abstract Preservation of water resources and sustainable design of public parks are crucial aspects of a living city's urban identity, especially in hot arid regions. In Abu Dhabi, landscape design is changing from classical style gardens to desert landscaping, which integrates more organically with existing monuments and is sustainable in terms of the scarcity of water. Sustainable landscaping design merges two aspects of UN's eleventh Sustainable Development Goal, to promote sustainable urbanization and to protect cultural and natural heritage. An important component, which becomes even more critical for Gulf cities, is that due to the heat, people's activities are restricted to indoor spaces and hence public spaces promote inclusivity and participation of a city's population. The research approach emphasizes cross-disciplinary integration of design theory and water management principles, investigating the evolving role of vegetation in the enhancement of public parks in Abu Dhabi. Water budget calculations were conducted, indicating water savings of over 57% for a redesigned desert park of equivalent areal size compared to one with a traditional European garden. This is especially critical for the Gulf region, where water is a limiting resource, and even desalinated water is utilized to maintain public parks. The authors confirm that this work is original and has not been published elsewhere. The paper should be of interest to readers in the areas of landscape architecture, landscape planners, and urban planners.

Keywords Abu Dhabi, Desert Landscaping, Water Scarcity, Park Water Management, UN SDG 11

1. Introduction

Urbanization in Gulf desert cities has posed challenges in their efforts to attract new residents from diverse cultural, social, and ethnic backgrounds. One means of facilitating the attraction of western expats in the region, who were needed to spearhead the developing Gulf oil economies, was by advancing forms of urban landscape with green, open spaces following a paradigm of well-being and healthy lifestyle familiar to them. In the Gulf region that witnesses extremely high temperatures and poor air quality as a result of the desert environment, green spaces in proximity or within newly urbanized neighborhoods were perceived as a means to improve the quality and appeal of living conditions.

The oil boom and subsequent rapid urbanization of the Gulf states in the late 1970s led to the creation of modern cities, which were planned on a grid system with urban movement based on automobiles. The influx of people into the Gulf states led to the development of high-rise buildings, parks with nonnative trees, and expansive green lawns. Abu Dhabi was planned on a grid street pattern to facilitate automobile movement, and within this urban environment, early generations of public gardens, dating to the 1980s, were designed. Abu Dhabi's urban planners in the 1970-80s attempted to balance rapidly sprawling housing programs and urban density with European-style parks and gardens along the waterfront (Corniche) that provided residents with recreational areas. These parks included nonnative trees and large grass/open lawn areas mimicking European and U.S. landscaping, and ignoring climatic differences and water resources availability.

Introduction of lawns was primarily aesthetic, intended for human enjoyment rather than environmental suitability. Abu Dhabi's public parks' large green areas (Figure 1) represented communal spaces of gathering in the city's downtown area. These urban parks were designed based on theories of picturesque gardens, blurring the boundaries between art and nature and playing a crucial cultural and social role for expats from different countries to congregate, socialize, and entertain. While these parks took their inspiration from nature, they also consumed significant amounts of water [1, 2].

Figure 1. Waterfront park in Abu Dhabi (Source Google maps, photograph by authors)

The parks are always required in urban areas but repair is the key feature that enriches parks with visitors. The facilities, beauty, along with a combination of colors, textures, and forms are essential for the maintenance of parks and landscapes. However, this is becoming an area of major concern for today's landscapers due to the cost of maintaining large green grass areas in rapidly urbanizing desert cities [3]. Recent developments toward desert landscaping in Abu Dhabi (Figure 2) are motivated by an acknowledgement of the extreme scarcity of water, with Abu Dhabi relying on desalinated water for 46% of its parks' water needs [4]. Redesigned parks have replaced large green lawns with designated playing areas and walking trails, reinstating within the urban fabric the desert landscape that is outside its perimeter. Thus, the Abu Dhabi Department of Municipalities and Transport has added 740,000 m^2 in the form of 104 desert parks/public spaces that include local trees, native plants, multi-use sports courts, playgrounds, and social gathering areas [5]. Abu Dhabi's new parks include shaded walking and bicycle tracks and pedestrian walkways with explanatory panels to foster communication of the new ecosystem's values with educational ambitions. Even though much smaller in scale than the original parks, the new desert-style/sustainable gardens are more numerous and more accessible to residents of each neighbourhood, hence play a key role in supporting biodiversity and other important urban planning factors, such as improvement of living conditions in hot arid climates and ecosystem services [6, 7]. The new desert-style parks in Abu Dhabi represent transformations of residual spaces/leftover spaces mainly in urban expansions in Mohamed bin Zayed City, Mussafah, and some areas in Downtown Abu Dhabi. The parks created mainly in residual/leftover spaces aim to serve in community problem-solving, such as local communities and their children's needs for outdoor spaces [8]. The current article assesses water savings in the hot arid climate of Abu Dhabi accomplished through desert-style parks. Our research highlights the importance of landscape planning in desert cities and offers insight for other urban centers with similar environmental conditions. At the same time, an interdisciplinary dialogue with the communities in Abu Dhabi is needed in order to enhance the effectiveness of environmental assessment and of a public space design that would facilitate transformative change towards sustainability [9].

Figure 2. Abu Dhabi's new desert parks replacing traditional parks (Source: Google Earth maps and photographs by authors)

2. Literature Review

Urban landscape solutions can serve important social functions of communities, not only enhancing the identity of urban space but also having the potential of reducing air pollution and regulating microclimatic conditions [10]. Green open areas are psychologically associated with a state of fertility (a fertile soil gives rise to plant life), optimism (after winter nature wakes up in spring), comfort (nature can provide the food staple needed), and hence with calmness and serenity. The extent of green space in a city and accessibility of these areas significantly influence the health, well-being, comfort, safety, and security of residents. Residents' perception of city gardens and landscapes is of great importance in terms of their public spaces and living conditions, especially in hot arid environments [11]. Green spaces also provide critical social and psychological benefits that enhance the livability of modern cities and the well-being of their residents. Landscape design is a vital component of urban planning, offering alternatives to private gardens while creating spaces for social interaction and community life. Enhancing quality of life, promoting human well-being, and supporting biodiversity have become central policy priorities in metropolitan areas and contemporary cities. Increasingly, both professionals and the public are embracing naturalistic approaches to landscape design. In such planting schemes, native and exotic species each play important roles. However, ensuring long-term sustainability—particularly through the careful preservation of water resources—is essential for gaining broad community acceptance of public landscapes [12]. Sustainability, a multidisciplinary field emphasizing the understanding of dynamic human-nature relationships, has become an increasingly important aspect of landscape architecture planning and practice [13]. According to the American Society of Landscape Architects (ASLA), "Sustainable landscapes are responsive to the environment, regenerative, and can actively contribute to the development of healthy communities. Sustainable landscapes sequester carbon, clean the air and water, increase energy efficiency, restore habitats, and create value through significant economic, social and environmental benefits". In response to this, new parks in arid environments are transitioning away from large, water-intensive lawns, embracing diverse desert-adapted landscapes [14].

Traditional public parks with large open lawns require extensive water use to maintain. Gulf states had relied on desalinated water, made accessible by their proximity to the sea and abundant energy resources, to sustain urban greenery. Parks in Abu Dhabi consumed 482 Mm^3 of water in 2009, of which 46% came from desalination, 23% from groundwater, and 31% from recycled water [4]. Such water use was expended in a country with an average annual precipitation of about 100mm and an evaporation rate that exceeds 2.5m/yr. In addition, the UAE does not have any surface water bodies, and about 82% of its surficial aquifers are brackish, saline, or brine, making this water unsuitable for drinking or irrigation purposes. According to the Environment Agency Abu Dhabi (EAD), 58% of the water in the Emirate of Abu Dhabi is utilized by agriculture, 15.5% by amenity, 11.2% by forestry, 10.7% for domestic use, and the remaining for commercial and industrial uses. The EAD reported a 2017 daily domestic water consumption of 590L/capita/day (EAD, 2017), which compares very poorly with, for example, the 2020 domestic water use in the European Union (EU), which had an average of 120L/capita/day with a high of 243 L/capita/day in Italy and a low of 50 L/capita/day in Malta [15]. The discrepancy between annual natural aquifer replenishment and groundwater overdraft, which is predicted by EAD to lead to groundwater depletion within the next fifty-five years, has led many wells to become dry. Areas of maximum groundwater depletion concentrate on the upper eastern and southern parts of the country, with groundwater level drops, during the period of 2000 to 2016, exceeding forty meters at locations of intense farming [16]. Clearly, the above situation requires intense water conservation measures in all economic sectors, and the recent drive toward desert landscaping recognized the country's water limitations and attempts to adapt to this reality. Providing a sustainable and resilient living environment through native, nature-based solutions has become a central goal for many cities in the wake of rapid urbanization and to mitigate climate change [17,18,19]. Climate change has been and remains a serious challenge in urban environments, especially in modern Arab cities that are rapidly urbanizing in desert regions. The built environment accounts for around a third of worldwide CO_2 emissions, which encompasses emissions generated from automobiles as a result of transportation, energy usage, and land/building development [20]. The growing effects of climate change have elevated urban resilience as a central focus for cities. In desert regions, these factors increase in the wake of increasing temperatures, prolonging heat waves, and altering rainfall patterns, which together accelerate evaporation rates and exacerbate chronic water scarcity. Reduced and more erratic precipitation, combined with rising groundwater depletion and soil salinization, threatens ecosystems, agriculture, and human settlements in arid and hyper-arid landscapes [21]. Climate change intensifies water scarcity in desert and arid environments by altering fundamental hydrological processes that these regions already struggle with. Rising temperatures and changing precipitation patterns lead to increased evapotranspiration, reduced surface water availability, and a greater variability in rainfall, which together diminish the already limited water resources and challenge sustainable irrigation and groundwater recharge efforts [22]. Such climatic shifts requiring adaptive water management strategies led Abu Dhabi to revise its urban planning and public landscape regulations with a shift towards water savings in public parks, native plants, and drought-tolerant native species in open areas [23]. This has been mandated in new public parks and government projects. Aligning with these priorities, Abu Dhabi is reshaping its public parks and plazas along municipal sustainability guidelines that aim to conserve water while enhancing the country's heritage. New landscape design language that gives preference to forms of oasis motifs with the use of turfgrass strategically placed and surrounded by native trees and shrubs, incorporates the dynamic character of urban biotopes, and is expected to be understood and appreciated by people [24] as well as enhance the country's heritage [25]. Desert-style public parks suggest that the UAE in tandem with other initiatives towards UN's sustainable development goals (SDGs), is implementing sustainable urbanism and landscaping strategies to promote SDG11's goal to make cities "inclusive, safe, resilient and sustainable." In particular, Target 3 of SDG11 calls for enhancing "inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement," and Target 4 refers to strengthening efforts "to protect and safeguard the world's cultural and natural heritage." Climate-responsive desert parks and the cultivation of drought-tolerant native species reflect an adaptation of sustainability to the growing impacts of climate change in relation to scarce water resources.

Water production in 2016 in the Emirate of Abu Dhabi from desalination plants on the Arabian Gulf was 887 Mm^3, with another 342 Mm^3 being imported from the Fujairah station that accesses the Gulf of Oman. Of the total 1,229 Mm^3 of desalinated water, 90.8% or 1,116 Mm^3 were consumed, with 297 Mm^3 utilized in Al Ain, which means that the Fujairah station fully covered the needs for desalinated water of Al Ain [26]. Reintroducing modern versions of the Falaj system, such as drip irrigation systems, has been applied in new parks and landscapes surrounding local heritage monuments such as Qasr Al-Hosn Plaza/Park and Al-Muwaiji, because this minimizes water loss from evaporation, making it particularly well suited to the hot desert climate of the UAE. Falaj irrigation systems in the UAE and the region have a long history because they represent a traditional and sustainable water management practice that has been used for centuries to support agriculture in arid environments. *Falaj* (Figure 3) is an underground or surface channel that transports groundwater from aquifers, springs, or mountain catchments to agricultural fields and settlements using gravity flow. The Oasis in Al Ain has a falaj canalization system that distributes water through its networks via gravitational slope. The *falaj* irrigation system existing historically in Al Ain, obtains its water from relatively high precipitation in the mountainous area between UAE and Oman, with wells tapping groundwater found in fractured rock formations, but now it is supplemented by pumping wells and desalinated water transported from the Fujairah desalination plant [25].

Modern applications of traditional desert-style landscaping can be seen in the newly renovated Qasr Al-Muwaiji, completed in 2020. This fort in the city of Al Ain in the emirate of Abu Dhabi was built about 150 years ago and played a significant historical role as it served as the home and administrative center of the country's founding government. The desert landscape surrounding Qasr Al-Muwaiji (Figure 4) highlights the UAE's shift in landscape design from green open lawn areas towards arid landscapes. Reconstructed desert landscaping gives preference to new forms that advocate native and desert-adapted trees and shrubs, creating a balance in terms of natural resource conservation and open-space character preservation [27]. The landscape design at Qasr Al-Muwaiji gives reference to traditional forms of water usage, highlighting traditional irrigation systems such as the *falaj*, and reducing the presence of open lawns. It serves as an example of the potential of designing spontaneous and ecologically functional urban landscapes in the Gulf region [28].

Figure 3. Al-Ain Oasis falaj system Al-Ain Oasis and drip irrigation system in new landscape/parks (photos by authors)

Figure 4. Qasr Al-Muwaiji, Al Ain: After restoration and sustainable/desert landscape referencing the falaj irrigation system (Images by authors and google maps)

Desert-style landscaping, especially around its local heritage in the Emirate of Abu Dhabi, puts them in their urban context and addresses climate change, scarcity of water resources, and sustainability paradigms [29]. The redevelopment of the area around Qasr Al-Hosn and the Cultural Foundation has introduced a new perception of public space in Abu Dhabi's downtown area, highlighting an evolution from a traditional, European notion of public park to one that relies on local elements that have reference to cultural and geographical aspects [30]. Creating community-acceptable desert-style landscapes requires a multifaceted approach that addresses diverse contexts, including aesthetics, community engagement, cost, environmental education, safety, and sustainability. In hot arid climates, creating landscapes with naturalistic vegetation capable of withstanding the harsh environment is challenging [31]. Abu Dhabi's introduction of desert plants reflects a growing recognition of the ecological, cultural, and climatic value of its native arid environments. After decades of intensive urbanization and the widespread use of water-demanding exotic plant species, recent planning and landscape strategies increasingly emphasize desert restoration, native vegetation, and climate-responsive design. This shift supports biodiversity, reduces irrigation water consumption, and enhances ecosystem resilience in the face of climate change and water scarcity. By reintroducing indigenous plants such as *ghaf* trees and desert grasses, and by adopting natural landforms and sand-based ecologies, the UAE is reconnecting contemporary development with its desert heritage while promoting sustainable land management that aligns with long-term environmental and resource conservation goals. The aim of co-existence between various forms of landscape, ranging from green, open lawn gardens and newly emerging desert landscapes, is one that demands critical reconciliation between old and new landscape design approaches. One of the key benefits of urban greenery lies in the opportunities it provides for people to engage with nature, the sense of relaxation, and tranquillity they transmit. However, such types of parks face limitations in locations where water availability is a critical factor for their maintenance. Traditional open-lawn gardens are also less effective than indigenous landscapes as an educational resource for ecosystem services and local environmental constraints. At the same time, public preferences and perceptions of urban natural areas are of importance, particularly with the rising emphasis on biodiversity policies in cities. For public spaces to be appreciated and accepted, landscaped urban parks must be designed, having in mind both sustainability considerations and aesthetic principles and preferences of a city's residents [32].

This shift in promoting awareness of the ecological and environmental constraints of harsh arid locations has become pronounced in the Gulf region. In the Gulf cities, the presence of different socio-cultural and ethnic groups with different concepts and use of public space suggests that the creation of open places should not simply be a return to a natural desert environment, but follow a more flexible approach, merging perhaps elements of both styles of landscaping [33, 34]. Communal perception of public gardens can vary depending on factors like design, maintenance, accessibility, and personal experiences [35]. Most people view public gardens as peaceful retreats from urban life [36]. Green landscaping appears to reflect a human inner need for connection with nature, perceived as an image of lush vegetation with trees and green grass. A challenge to this can be made for people who are parts of a community that has resided for a long time on a land and for whom a desert land has become part of their identity. Other examples of landscape in challenging environments, such as in the cities of Phoenix and Tucson, Arizona, manifest that modifications in irrigation practices and xeriscaping, can assist the resilience of the city towards water stresses from droughts and population pressures [37]. Placing water restrictions and strict pricing policies have been some of the tools that have been seen to affect individuals and communities. The new desert parks manifest that sustainable water consumption habits have started to be slowly implemented in the Emirate of Abu Dhabi [38].

Sustainable landscaping application being introduced on a large scale in Abu Dhabi Emirate is important as it merges two aspects of UN's eleventh Sustainable Development Goal, to promote sustainable urbanization and to protect cultural and natural heritage. An important component, which becomes even more critical for Gulf cities, where, due to the heat, people's activities are restricted to indoor spaces, constitutes the inclusiveness and participatory aspects of the redesigned public spaces. The success of desert-style public spaces remains a debated issue because effectiveness is not solely determined by architects, urban designers, or planners but depends on how people engage and use them, as well as how they perceive the image of a city through them [13, 39]. In some cases, spontaneous, ecologically functional urban landscapes are undervalued for their social and aesthetic appeal [40]. In order for local landscapes to succeed, campaigns must be conducted to educate the public about the limitations of arid environments and perhaps use more innovative elements in the parks' design that extend beyond the simple insertion of desert plants and hard, artificial surfaces. Thus, for example, water constraints in the American Southwest led many cities to favour indigenous, native landscaping. Tucson, Arizona put together many initiatives and measures to restrict water use for the watering of yards [41]. Semi-natural desert plants are emerging as alternatives to monoculture landscapes motivated by principles of sustainable planning and water resource management [42]. However, acceptance of desert landscapes by the public in the Gulf Region, as well as their effectiveness to serve social functions, is an open question, and this aspect will be explored in the following sections of this article [43]. A key challenge for public gardens conservation, design, and management is balancing human perceptions and needs with the environmental constraints placed by the climate and context of a desert city [31].

Planting using indigenous species to create a landscape in line with the climatic, water, and soil conditions of a location cannot only reduce water management costs and be more sustainable in the long run but can also create new visual forms in urban landscapes [44]. In the Gulf region, where there exists little understanding of the extreme water scarcity situation, there exists the need for an intense educational campaign that would highlight the relation between desert-style landscaping and water limitations. The recent embodiment of desert/spontaneous landscaping is manifested in local heritage monuments within public space since desert-style landscaping bases its designs on old aerial photographs of local heritage from the 1960-70's. Abu Dhabi is attempting to revive the surrounding downtown area by emulating elements identified by historic aerial views of a time when the site was part of the desert environment. Qasr Al-Hosn and the nearby Cultural Foundation represent important historic and modern heritage landmarks of Abu Dhabi. The former is the oldest intact heritage monument in the city of Abu Dhabi, while the latter is part of Abu Dhabi's modern history. The redevelopment of the landscape surrounding Qasr Al-Hosn and the Cultural Foundation reintroduced a fresh urban layer into Abu Dhabi's downtown (Figure 5). The redesigned landscape highlights the dialogue between historic and contemporary urban identities, seeking to reconcile modern interpretations of the desert landscape with the city's oldest surviving monument, Qasr Al-Hosn (1793). The design created a vast, open desert experience with an artificial water pond facing the monument. Perceptions and memories contribute to shaping such meanings, especially the distinguished character of rapidly developing cities like Abu Dhabi and Dubai. The redesign of the plaza surrounding Qasr Al-Hosn manifests a character of place as the general atmosphere of the place can increase place attachment, which is defined as an emotional bond between place and people and causes vitality, involvement, safety, and sense of responsibility towards the existing desert context [45]. The new landscape pays tribute to the existence of Qasr Al-Hosn in the desert sands before modern times; the paved and structured area with selected trees and water features around the Cultural Foundation nearby creates a juxtaposition between the desert landscape and the modern high-rise towers in Abu Dhabi [46]. The redevelopment of Qasr Al-Hosn created new perceptions of desert landscape and social spaces compatible with a desert environment that conserves water resources while promoting functionality, in line with Abu Dhabi's Urban Planning Estidama Pearl Rating/Community Rating System [47]. Here, new planting styles highlight diverse sustainability-related outcomes, dynamism, and diversity, integrating native desert plants of the hot and arid climate of the UAE [48].

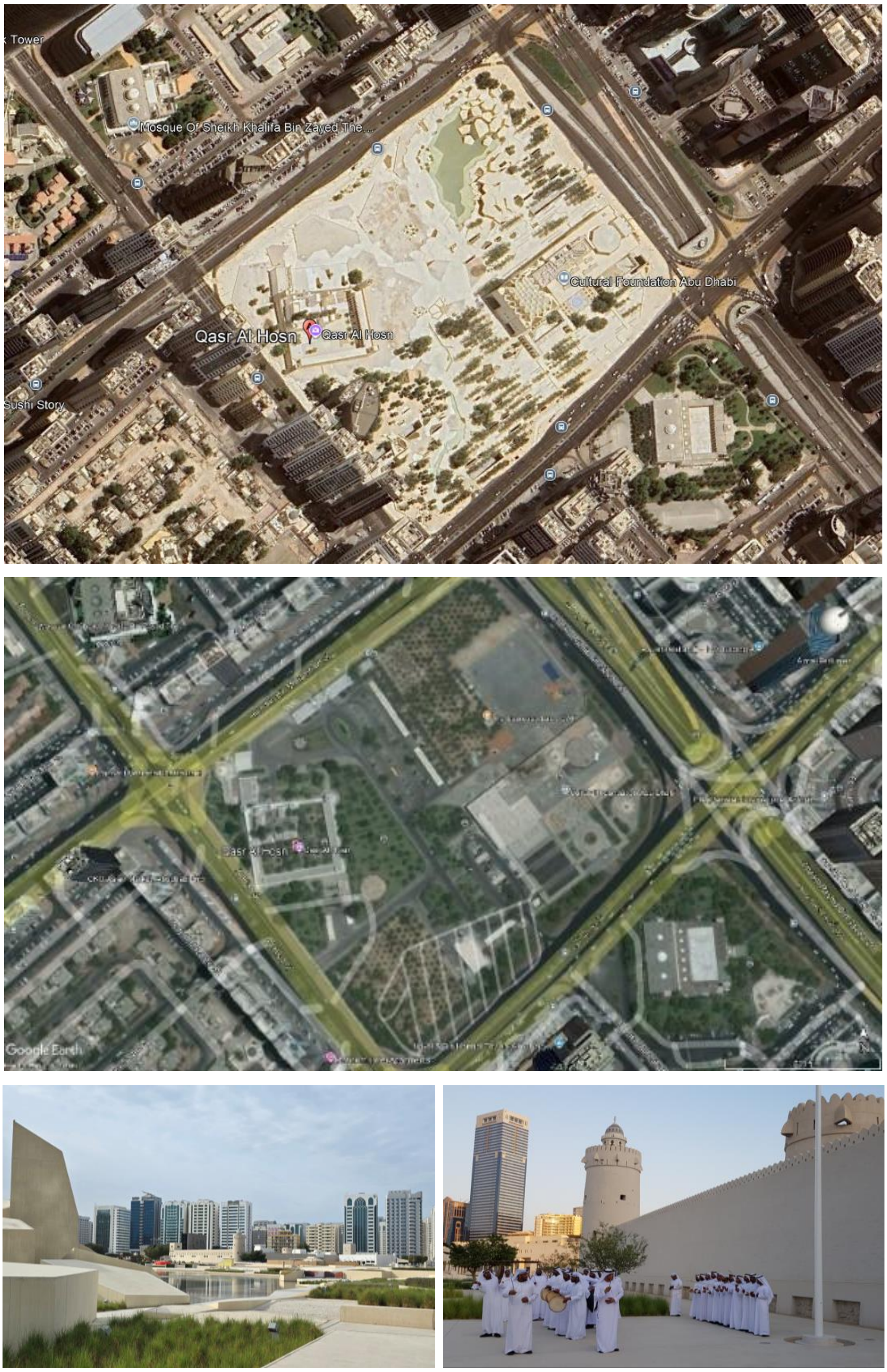

Figure 5. Qasr Al-Hosn Plaza's new landscape versus traditional open lawn landscape representing the shift in landscape trends in Abu Dhabi (Google-Earth and photos by authors)

3. Methodology

The growing emphasis on sustainable landscape development has driven the UAE to revise its urban landscape planning regulations, resulting in a strategic shift toward environmentally responsive public open spaces. This shift prioritizes the extensive use of native and climate-adapted plant species and the systematic replacement of high-water–demand turfgrass lawns with drought-tolerant native shrubs and groundcovers [25]. These sustainability principles have been formally mandated in the design and implementation of newly developed public parks and are now being widely implemented across government-led landscape projects. In parallel, targeted efforts have been undertaken to retrofit selected traditional public parks—previously characterized by water-consuming green grass/turf into desert landscape parks with substantially lower water demand, thereby achieving water conservation objectives (e.g., Qasr Al-Hosn Plaza/Park). Collectively, these efforts aim to establish resilient, low-input landscape ecosystems that are better integrated within the existing urban context of Abu Dhabi.

This study employs a quantitative methodological approach to evaluate and compare the irrigation water requirements of traditional park typologies and desert landscape parks in order to quantify potential water savings associated with sustainable landscape transformation. To ensure a rational and controlled comparison, detailed landscape water budget calculations were conducted for two public parks of comparable size: Al-Jahili Park (Figure 6), representing a conventional park typology dominated by open turfgrass areas, and Qasr Al-Hosn Plaza/Park (Figure 5), a former traditional park that has been retrofitted into a desert landscape typology. Each site occupies an area of approximately 140,000 m^2 (33 acres), enabling a direct comparison of irrigation water demand under contrasting landscape design and planting strategies.

Adequate irrigation scheduling, through the application of appropriate water quantities at suitable intervals, is essential for sustaining plant physiological functions and long-term landscape performance. Plant water requirements are governed by multiple interacting factors, including plant species, seasonal and climatic conditions, soil physical properties, and irrigation system characteristics. These requirements can be quantified through site-specific estimates of evapotranspiration, landscape water budgets, and irrigation system performance. The irrigation water requirements of the two investigated parks were estimated using field-based data on native and adaptive plant species commonly used in UAE landscapes, including their crop coefficients and associated irrigation practices. Evapotranspiration and plant water requirements were determined using the well-established Penman–Monteith method, as standardized in the FAO-56 methodology [49]. The method provides robust estimates of evapotranspiration when local environmental conditions are considered. To further assess temporal dynamics and seasonal variability in landscape water demand, a statistical time-series analysis was conducted using the Auto Regressive Integrated Moving Average (ARIMA) model [50, 51]. This analysis enabled the characterization of periodic fluctuations and long-term trends in irrigation water requirements for both traditional and desert landscape parks, offering insight into seasonal demand patterns and the relative stability of water consumption associated with each landscape typology.

The Penman–Monteith method is derived from classical combination evaporation models originally developed for open water surfaces [52]. Evaporation from an open water is controlled by two fundamental processes: the availability of energy to supply the latent heat of vaporization and the efficiency of turbulent transport mechanisms required to remove water vapor from the evaporative surface [53]. Solar radiation is the main source of heat energy, while wind velocity and specific humidity gradient between the water surface and the overlying air are responsible for vapor transport. Evapotranspiration represents the combined flux of evaporation from the soil surface and transpiration from vegetation. Although governed by the same atmospheric controls that regulate open water evaporation, evapotranspiration additionally depends on soil moisture availability and vegetation canopy characteristics [54]. Consequently, evapotranspiration can be estimated using formulations analogous to those developed for open water evaporation, with appropriate modifications to account for vegetation aerodynamic resistance and soil moisture conditions [55].

Numerous comparative studies of measured and computed evapotranspiration across diverse climatic regions have demonstrated that combination methods provide the most reliable estimates, provided that vapor transport parameters are appropriately calibrated for local climatic, soil, and vegetation conditions [56, 57]. In practice, actual evapotranspiration (Et) is commonly derived from potential evapotranspiration (Etp), defined as the evapotranspiration from a well-watered uniform grass surface when moisture supply is not limiting, through the application of a crop coefficient that adjusts Etp to reflect specific vegetation and soil properties. Actual evapotranspiration may exceed potential evapotranspiration for tall or dense vegetation with greater aerodynamic roughness, while it may fall below Etp under sparse vegetation cover or conditions of soil moisture deficit. In general, Et exhibits strong temporal variability in response to seasonal climate fluctuations, soil water availability, and vegetation phenology, with water demand typically decreasing as vegetation matures or enters senescence.

Figure 6. Al Jahili fort and park with large areas of green lawns (Images by authors and Google Earth)

Evaporation from the water surface and evapotranspiration can be estimated from the following equations:

Evaporation due to energy balance (mm/day) as

$$E_r = 0.0353 R_n \quad (1)$$

Evaporation due to aerodynamic (mm/day) as

$$E_a = B_1(e_{as} - e_a) \quad (2)$$

Combined evaporation from energy and aerodynamic (mm/day) as

$$E = \frac{\Delta E_r + \gamma E_m}{\Delta + \gamma} \quad (3)$$

Evapotranspiration from soil and plants (mm/day) can be estimated from

$$E_t = k_c E_{tp} \quad (4)$$

In Eqs. (1 to 3), Rn is net radiation (W/m^2), B1 is the vapor transfer coefficient for water surfaces (mm/day/Pa) estimated from $B_1 = 0.102 u_2 [\ln(z_2 / z_0)]^{-2}$, in which u2 and z2 are the wind velocity (m/s) and elevation (m), respectively two meters above of the water surface, and z0 is the roughness height of the surface (m); eas is the saturated vapor pressure (Pa) at the surface estimated from $e_{as} = 611 \exp[17.27T / (237.3 + T)]$ and ea is the ambient vapor pressure in air (Pa) at height z2 estimated from $e_a = R_h e_{as}$, in which T and Rh are the ambient air temperature in oC and relative humidity, respectively; γ is the psychrometric constant (Pa/ oC) equals 66.8, and Δ is the gradient of the saturated vapor pressure curve (Pa/ oC) estimated from $\Delta = 4098\, e_{as} / (237.3 + T)^2$.

In Eq. (4), kc is the crop coefficient, collectively accounting for soil texture, moisture, plant type, life cycle of the crop and weather seasonal variation with typical values in the range of 0.2 to 1.3; and Etp is the potential evapotranspiration, defined as that would occur from a well vegetated surface with mature grass when moisture supply is not limiting, to be estimated from Eqs. (1 to 3) replacing the vapor transfer coefficient in Eq. (2) by $B_2 = 2.7 \times 10^{-3}(1 + 1.157 \times 10^{-4} u_2)$ as given by Doorenbos and Pruitt (1977) for soil and vegetation cover.

In this study, crop coefficient (kc) values and corresponding monthly water demand estimates for the various plant types, as well as evaporation rates for ornamental ponds, were estimated using the methods outlined in the FAO-56 report for arid and semi-arid regions, reflecting the climatic conditions of the UAE [49]. The estimated values, summarized in Table 1, are consistent with those reported in previous regional studies [58], and constitute the basis for estimating the irrigation water requirements of Al-Jahili and Qasr Al-Hosn Plaza/Park. To standardize landscape water demand calculations, it was assumed that each tree or palm occupies an effective irrigated area of 25 m ? Net plant water requirements were initially computed from reference evapotranspiration using Equation (4) and subsequently adjusted to account for irrigation system efficiency in order to estimate gross irrigation water requirements. Sprinkler and drip irrigation systems are the most widely applied methods in the Gulf region, reflecting the need to optimize water use under arid climatic conditions. In sprinkler systems, water is distributed under pressure over the plant canopy, whereas drip irrigation systems deliver water directly to the plant root zone at low discharge rates [59]. Drip irrigation systems are generally more suitable for trees and shrubs, while sprinkler systems are commonly used for turfgrass and lawn areas. Because of their reduced evaporative and conveyance losses, drip irrigation systems are more efficient than sprinkler systems. Accordingly, irrigation efficiency values of 0.90 for drip systems and 0.75 for sprinkler systems were adopted in this study. These efficiency factors were incorporated into Equation (4) to convert net plant water requirements into gross irrigation water demands for each landscape component.

Table 1. Monthly potential evaporation, crop coefficient, and water demand for various plants and water pond evaporation rate in the UAE

Potential evaporation E_{tp} and crop coefficient k_c												
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
E_{tp} (m)	0.099	0.112	0.174	0.219	0.282	0.321	0.353	0.341	0.285	0.226	0.156	0.112
Trees, k_c	0.50	0.55	0.60	0.65	0.70	0.75	0.75	0.75	0.70	0.65	0.55	0.50
Palms, k_c	0.70	0.75	0.85	0.95	1.00	1.05	1.05	1.05	1.00	0.90	0.80	0.75
Grass, k_c	0.80	0.85	0.90	0.95	1.00	1.05	1.05	1.05	1.00	0.95	0.85	0.80
Evaporation, k_c	1.05	1.10	1.15	1.20	1.25	1.30	1.30	1.30	1.25	1.20	1.10	1.05
Water requirement												
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Trees (m^3 per tree)	1.380	1.710	2.895	3.955	5.485	6.690	7.365	7.105	5.540	4.085	2.385	1.550
Palms (m^3 per palm)	1.929	2.333	4.100	5.779	7.838	9.363	10.31	9.946	7.917	5.658	3.467	2.325
Grass (m^3/m^2)	0.106	0.127	0.208	0.277	0.376	0.449	0.495	0.477	0.380	0.287	0.177	0.119
Evaporation (m^3/m^2)	0.104	0.123	0.200	0.263	0.353	0.417	0.459	0.443	0.356	0.272	0.172	0.117

4. Results and Discussion

Although Al-Jahili and Qasr Al-Hosn Plaza/Park occupy comparable areas of approximately 140,000 m^2 (33 acres), their landscape compositions differ substantially, resulting in markedly different irrigation water requirements. To estimate park-level water demand, the spatial distribution and quantities of vegetation types and water features were first quantified. Al-Jahili Park comprises a total of 920 trees in the form of palms and parterre/shrubs, in addition to approximately 27,300 m^2 of turfgrass. In contrast, Qasr Al-Hosn Plaza/Park consists of 550 trees in the form of palms and parterre/shrubs, with substantially reduced turfgrass coverage of approximately 2,000 m^2 and the inclusion of ornamental water features occupying about 4,600 m^2. Table 2 summarizes the differences in landscape composition between Al-Jahili Park and Qasr Al-Hosn Plaza/Park. Monthly irrigation water requirements were estimated by integrating plant-specific water demand and evaporation rates derived from Table 1 with the corresponding landscape inventory data presented in Table 2. The resulting monthly and annual water demand estimates are summarized in Table 3, which provides a comparative assessment of irrigation requirements for Al-Jahili Park and Qasr Al-Hosn Plaza/Park based on landscape typology. The results indicate that irrigation demand peaks during the summer months (June–August), reaching approximately 56,000 m^3 for Al-Jahili Park and 24,000 m^3 for Qasr Al-Hosn Plaza/Park. These peak values account for nearly 40% of the total annual water demand for each park, reflecting the strong influence of seasonal climatic conditions on evapotranspiration. The total annual irrigation water requirement for Al-Jahili Park was estimated at 145,794 m^3, compared to 57,946 m^3 for Qasr Al-Hosn Plaza/Park. Thus, the transformation of Qasr Al-Hosn Plaza/Park into a desert-oriented landscape dominated by native trees and minimal turfgrass resulted in an approximate 60% reduction in annual water consumption relative to the conventional park typology represented by Al-Jahili Park. Through these seemingly small but effective measures, Qasr Al-Hosn Plaza/Park water consumption was cut to about one-half.

Table 2. Vegetation and water bodies of Al-Jahili Park and Qasr Al Hosn Plaza/Park

Plants and Water bodies	**Al-Jahili Park**	**Qasr Al-Hosn Plaza/Park**
Number of trees	700	150
Number of palms	220	400
Grass area (m^2)	27,300	2000
Pond/Water area (m^2)	60	4600

Table 3. Comparison between the monthly water requirements (m^3) of the Al-Jahili and the Qasr Al-Hosn Plaza/Park

Al-Jahili Park													
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Trees (m^3)	966	1197	2027	2769	3840	4683	5156	4974	3878	2860	1670	1085	35,102
Palms (m^3)	424	513	902	1271	1724	2060	2268	2188	1742	1245	763	512	15,612
Grass (m^3)	2894	3467	5678	7562	10265	12258	13514	13022	10374	7835	4832	3249	94,949
Evaporation (m^3)	4	5	8	11	14	17	18	18	14	11	7	5	131
Total (m^3)	4288	5182	8615	11613	15843	19017	20955	20201	16008	11950	7271	4850	145,794
Qasr Al-Hosn Plaza/Park													
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Trees (m^3)	207	257	434	593	823	1004	1105	1066	831	613	358	233	7522
Palms (m^3)	772	933	1640	2312	3135	3745	4123	3978	3167	2263	1387	930	28,385
Grass (m^3)	212	254	416	554	752	898	990	954	760	574	354	238	6956
Evaporation (m^3)	478	566	920	1210	1624	1918	2111	2038	1638	1251	791	538	15,083
Total (m^3)	1669	2010	3410	4669	6334	7565	8329	8036	6395	4701	2890	1939	57,946

Figure 7 illustrates the monthly water requirements of individual landscape components and pond evaporation for both parks using bar charts. The results show that turfgrass constitutes the dominant water-consuming element in Al-Jahili Park, whereas palm trees represent the primary water demand component in Qasr Al-Hosn Plaza/Park due to the limited extent of lawn areas. Peak irrigation demand coincides with periods of maximum evaporative stress during the summer months, confirming the climatic sensitivity of landscape water budgets in arid environments. Overall, the dataset demonstrates that strategic landscape design, through reduced turf areas, increased use of native vegetation, and controlled water features, can yield substantial and defensible reductions in urban park irrigation demand under desert climatic conditions.

Figure 8a presents the monthly irrigation water requirements for both parks, illustrating a pronounced seasonal pattern with peak demand occurring during the summer months. Maximum monthly water requirements reach approximately 20,000 m^3 for Al-Jahili Park and 8,000 m^3 for Qasr Al-Hosn Plaza/Park. Both parks exhibit strong seasonal variability, with summer irrigation demand approximately four times higher than winter demand, reflecting the combined effects of elevated temperatures, increased solar radiation, and higher atmospheric evaporative demand during the summer season.

Figure 8b illustrates the proportional contributions in percentage of different landscape components to total annual water demand for each park using pie charts, with the chart size scaled to total water consumption. In Al-Jahili Park, turfgrass represents the dominant vegetative water consumer, accounting for approximately twice the combined water use of trees and palms. This pattern is primarily attributed to the extensive turf coverage and shallow root systems of grass, which result in high evapotranspiration rates and frequent irrigation requirements. In contrast, Qasr Al-Hosn Plaza/Park exhibits a markedly different distribution of water demand. Palm trees represent the largest vegetative water consumer, with water requirements approximately double those of trees and turfgrass. This reflects their numerical dominance within the landscape and their larger individual canopy and rooting volumes.

Despite the limited extent of water features, evaporation losses from ornamental ponds account for nearly 25% of the total annual water demand at Qasr Al-Hosn Plaza/Park, a share comparable to that of either trees or turfgrass. This highlights the significant contribution of open-water evaporation to urban landscape water budgets in arid climates. Notably, turfgrass demand in Qasr Al-Hosn Plaza/Park remains relatively modest despite its inherently high-water requirement per unit area, owing to its restricted spatial coverage.

Overall, the results indicate that trees are comparatively water-efficient landscape components, delivering shading and microclimatic benefits while contributing only approximately one-quarter of total water demand in Al-Jahili Park and one-eighth in Qasr Al-Hosn Plaza/Park. These findings underscore the effectiveness of landscape strategies that prioritize trees and native desert vegetation while minimizing turfgrass and open-water surfaces in achieving substantial reductions in irrigation water demand under arid environmental conditions.

A survey of desert-adapted plant species currently implemented in Abu Dhabi public parks as alternatives to intensively irrigated turfgrass has demonstrated that the use of native trees, palms, and arid-adapted shrubs can yield substantial reductions in landscape irrigation demand under the emirate's hyper-arid climatic conditions. Table 4 summarizes the plant types presently utilized in Abu Dhabi parks and their key hydraulic and ecological characteristics. Turfgrass exhibits particularly high-water demand due to its relatively elevated crop coefficient (kc), associated evapotranspiration rates (Et), and reliance on irrigation systems with comparatively lower application efficiency. Consequently, current park design guidelines prioritize minimizing turfgrass coverage wherever feasible.

In contrast, desert grasses such as Cenchrus spp., while providing a visually comparable groundcover function, generally require substantially less irrigation over their life cycle owing to lower evapotranspiration rates and reduced crop coefficient values, particularly outside the establishment phase. Even greater water savings are achieved by replacing turfgrass with drought-tolerant shrub species such as Atriplex semibaccata, whose sparse canopy architecture and efficient physiological water-use mechanisms result in markedly reduced Et values, often less than half those of conventional turfgrass. Native tree species such as the Ghaf (Prosopis cineraria) further decrease irrigation demand, as their deep and extensive root systems, combined with low kc and Et values, enable long-term survival with minimal supplemental irrigation once established.

Although palm species exhibit moderate to relatively high crop coefficients and evapotranspiration rates during peak growth periods, their spatially distributed planting patterns and partial canopy coverage reduce overall water consumption on an area-normalized basis compared to continuously irrigated lawns. In addition, both trees and palms are typically irrigated using high-efficiency drip systems, further enhancing water-use efficiency relative to turfgrass areas that rely primarily on sprinkler irrigation. Collectively, these plant substitutions and irrigation strategies substantially lower landscape water demand, demonstrating that the transition from water-intensive lawns to desert-adapted planting palettes represents an effective and sustainable approach to long-term water conservation in arid urban park environments.

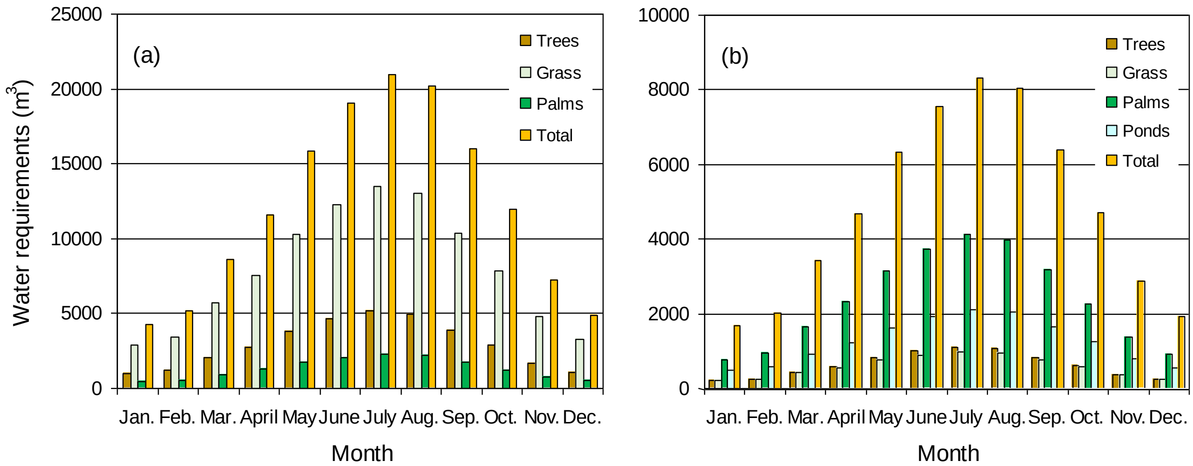

Figure 7. Monthly water requirements: a) Al-Jahili Park; b) Qasr Al-Hosn Plaza/Park

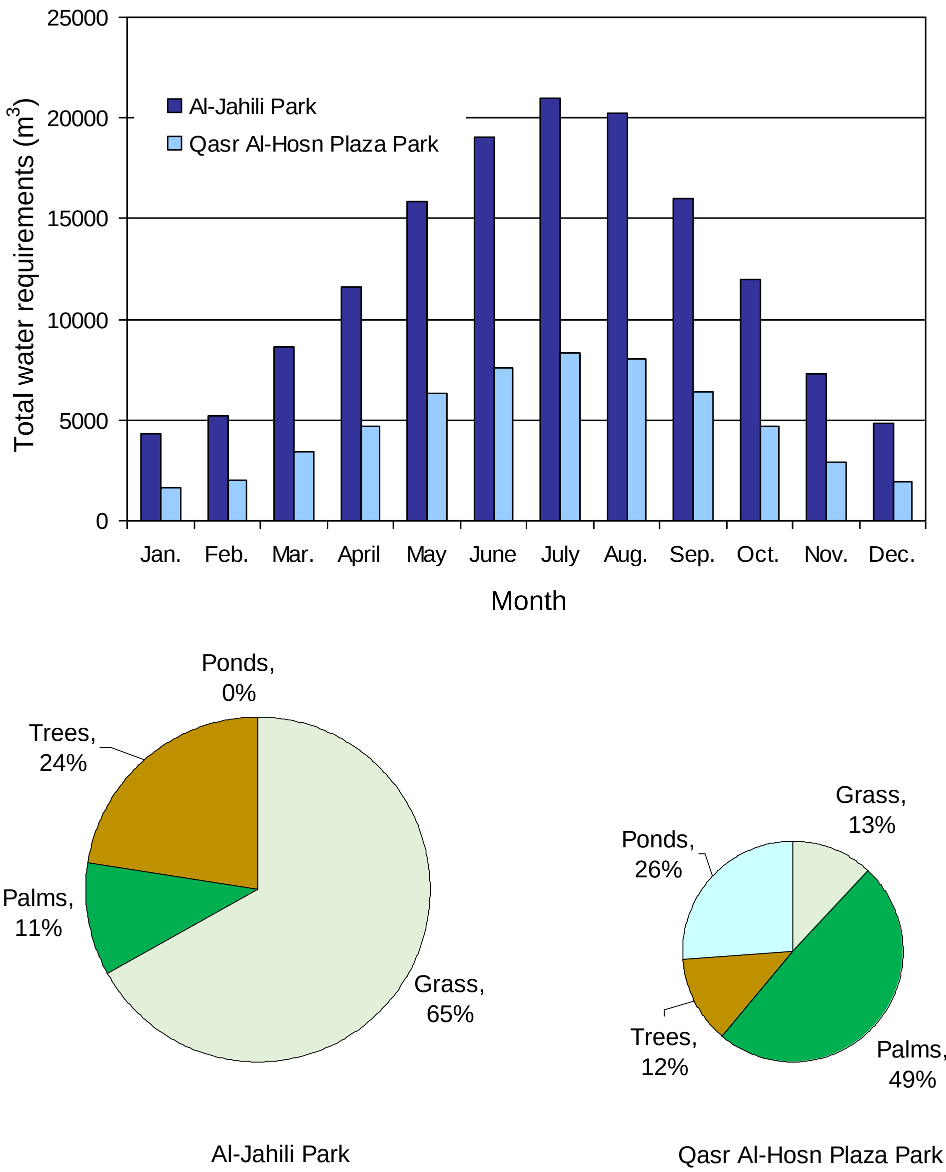

Figure 8. Total water requirements for Al-Jahili and Qasr Al-Hosn Plaza/Park: a) Monthly in cubic meters; b) Percentage by plant and pond, the size of the pie charts reflects the amounts of water required for each park

Table 4. Characteristics of plants and artificial ponds currently being used in Abu Dhabi landscapes (photos by authors)

	Evapotranspiration and water requirement for turf grass are generally high. On average, potential evapotranspiration (E_{tp}) is approximately 0.22 m/month for grass in Abu Dhabi's classic park. Using a typical crop coefficient (k_c) of 0.85 for healthy turf grass and an irrigation system efficiency of 0.75, the resulting monthly average evapotranspiration rate (E_t) is about 0.22 m^3/ m^2, equivalent to roughly an average monthly water demand of around 290 liters per square meter.
	Evapotranspiration and water requirement for fountain grass are generally moderate, reflecting their grass morphology and partial ground cover, typically with a crop coefficient (k_c) ranging from about 0.5–0.7 during early establishment and increasing to approximately 0.8–0.9 at full growth. This corresponds to a monthly average evapotranspiration rate (E_t) of about 0.17 m^3/ m^2 and an average monthly water demand of around 230 liters per square meter.
	Evapotranspiration and water requirement for Atriplex semibaccata (Australian saltbush) remain relatively low due to its drought tolerance, salt tolerance, and efficient water-use physiology. Particularly, Australian saltbush is generally low compared to turf grass, reflecting its sparse canopy and reduced transpiration rates. Typical crop coefficient (k_c) values range is low, about 0.3–0.5 during establishment and can reach approximately 0.5–0.7 at full canopy development. This corresponds to a monthly average evapotranspiration rate (E_t) of about 0.14 m^3/ m^2 and an average monthly water demand of around 185 liters per square meter.
	Evapotranspiration and water requirement for the Ghaf tree (Prosopis cineraria) are relatively low due to its exceptional drought tolerance, deep root system, and ability to access subsurface moisture. For Prosopis cineraria, crop coefficient (k_c) values are typically low compared to other used landscape plants, generally ranging from about 0.2–0.4 during establishment and increasing to approximately 0.4–0.6 at mature stages, depending on planting density and irrigation method. This corresponds to a monthly average evapotranspiration rate (E_t) of about 3.76 m^3 and an average monthly water demand of around 4200 liters.
	Evapotranspiration and water requirement for palm trees in desert terrains are generally higher than those of other trees but lower than those of large areas covered by grass due to their spaced planting and partial canopy cover. Their crop coefficient (k_c) values vary seasonally, typically ranging from about 0.8 to 1.0 during peak growth and fruiting periods, and lower during early growth or dormancy. This corresponds to a monthly average evapotranspiration rate (E_t) of about 5.32 m^3 and an average monthly water demand of around 6000 liters.
	Evaporation and water requirement for artificial ponds in landscapes are generally high in the Gulf region due to the hot arid climate. Their equivalent crop coefficient (k_c) values vary seasonally, typically ranging from about 1.05 during winter to 1.15 during summer. This corresponds to monthly average evaporation rate (E) of about 0.27 m^3/ m^2 and an average monthly water demand of around 270 liters per square meter.

An ARIMA (p, d, q) model was estimated on the 12 monthly observations for each park, where p denotes the number of autoregressive (AR) terms, d the number of differences required to induce stationarity, and q the number of moving average (MA) terms. A compact hyperparameter grid was explored with $p, q \in \{0,1,2\}$ and $d \in \{0,1\}$. Across this grid, the AR(1) and AR(2) coefficients were highly significant for both parks (p-values <0.001), indicating a strong short lag autoregressive structure detectable even within a single annual cycle. With the exception of MA(1) for Al Jahili Park (p-value =0.019), MA coefficients were insignificant (p-values >0.5). Taken together, these patterns suggest that short lag AR dependence is the most stable and identifiable feature from a single annual cycle, whereas MA effects are weak or unstable, particularly for Qasr Al Hosn. Selected ARIMA (2,1,2) specification minimized the Akaike Information Criterion (AIC) for both series (Al Jahili Park: AIC =141.8; Qasr Al Hosn Plaza/Park: AIC =122.4). The integrated component (d=1) removes the dominant low-frequency trend, while second-order AR and MA terms provide sufficient flexibility to represent short lag dependence within the single year of data. Although the same orders were selected for both parks, the underlying dynamics differ in both magnitude and composition of demand (e.g., grass/turf dominance at Al Jahili vs palms and open water at Qasr Al Hosn), which is reflected in the parameter estimates and error scales.

Standardized residual diagnostics for ARIMA (2,1,2) are acceptable for Al Jahili and borderline at short lags for Qasr Al Hosn (Table 5). For Al Jahili, Ljung–Box tests do not reject the null of white noise residuals at compact lags (lag 6: p=0.146; lag 10: p=0.165), indicating that the model captured most short lag dependence. By contrast, Qasr Al Hosn exhibits a borderline signal at lag 6 (p=0.049) that dissipates by lag 10 (p=0.122), suggesting a modest amount of residual short-lag dependence left unmodeled. Residual normality is not rejected for either series as verified by the Jarque–Bera tests (Al Jahili p=0.917; Qasr Al Hosn p=0.834). As a check on differencing, Augmented Dickey–Fuller (ADF) tests on the first difference series yield high p-values (Al Jahili p=0.853; Qasr Al Hosn p=0.858), implying failure to reject the unit root null; however, with only 11 post-difference observations, these unit root tests are low power and should not be over-interpreted. Notwithstanding this limitation, differencing removed the dominant low-frequency drift and produced well-behaved residuals for Al Jahili and near-white residuals for Qasr Al Hosn at longer lags.

Within-year forecast behaviour was assessed via expanding one step ahead cross-validation constrained by the 12-month sample. For Al Jahili, cross validated Mean Absolute Error (MAE), Root Mean Square Error (RMSE), and Mean Absolute Percentage Error (MAPE) are approximately 3,687 m^3, 4,290 m^3, and 27.85% (7 steps), respectively; for Qasr Al Hosn Park/Plaza, they are 1,896 m^3, 3,016 m^3, and 36.64% (7 steps), respectively. These estimates should be interpreted cautiously: with only one annual cycle, cross-validation is low power, and the metrics are statistically weak, but they nonetheless provide a transparent baseline for model adequacy.

In absolute magnitude, Al Jahili Park exhibits roughly 2.3–2.5 times the monthly demand of Qasr Al Hosn Park/Plaza across most of the year, culminating in a forecast July peak of approximately 20,000 m^3 versus 8,000 m^3. This scale difference naturally yields larger absolute forecast errors for Al Jahili (MAE/RMSE in m^3), even though its MAPE is smaller (28% vs 37%). The diagnostics corroborate this contrast: Al Jahili's residuals do not display significant short lag autocorrelation at the tested lags, whereas Qasr Al Hosn Park/Plaza shows a borderline signal at lag 6, indicating some short-run dependence remains unmodeled. These differences align with the distinct landscape compositions: Al Jahili's demand is turf-dominated (diffuse evapotranspiration with frequent irrigation), while Qasr Al Hosn Park/Plaza is more influenced by palms and open water evaporation. The latter introduces higher frequency month-to-month variability relative to the smoother turf-driven signal, plausibly contributing to the higher relative error and residual autocorrelation at short lags in the Qasr Al Hosn fit.

No seasonal terms were estimated, yet the ARIMA (2,1,2) forecasts reproduce the observed summer rise and winter decline within the limited 12-month window. Figure 9 shows the observed and forecasted patterns with a 95% confidence level. Confidence intervals (uncertainty bands) widen outside the high information region (late spring to late summer), reflecting variance inflation from differencing and the absence of repeated seasonal cycles for parameter stabilization. While the point forecasts are suitable for short-term planning, the interval widths warrant caution, particularly when sizing for peak demand contingencies; these intervals should bound operational expectations rather than serve as precise design values.

Operationally, the results indicate that Al Jahili's peak season requirements are larger but more predictable in percentage terms than those of Qasr Al Hosn, which carry higher relative uncertainty and mild residual dependence. For Al Jahili, the 95% prediction interval around peak months remains within a narrower relative band (e.g., about ±11% around July's point forecast), whereas for Qasr Al Hosn Park/Plaza the relative intervals are wider. From an inference standpoint, both series contain only one annual cycle (n=12), limiting the reliability of purely stochastic time series inference and precluding robust seasonal identification. Accordingly, the ARIMA outputs should be treated as baseline or illustrative forecasts—useful for near-term operations but insufficient as the sole basis for long-term capacity or policy decisions. Strengthening the analysis would require multiyear monthly records (≥3–5 years) and/or augmenting the stochastic specification with exogenous climatic drivers (e.g., reference evapotranspiration, temperature, relative humidity) in an ARIMA framework to anchor the seasonal signal and reduce residual autocorrelation, particularly for Qasr Al Hosn.

Table 5. Residual-diagnostic tests for selected ARIMA

Series	Selected ARIMA	AIC	p- value			
			Ljung–Box lag-6	Ljung–Box lag-10	Jarque–Bera	ADF
Al-Jahili Park	(2,1, 2)	141.8	0.146	0.165	0.917	0.853
Qasr Al-Hosn Park/Plaza	(2,1, 2)	122.4	0.049	0.122	0.834	0.858

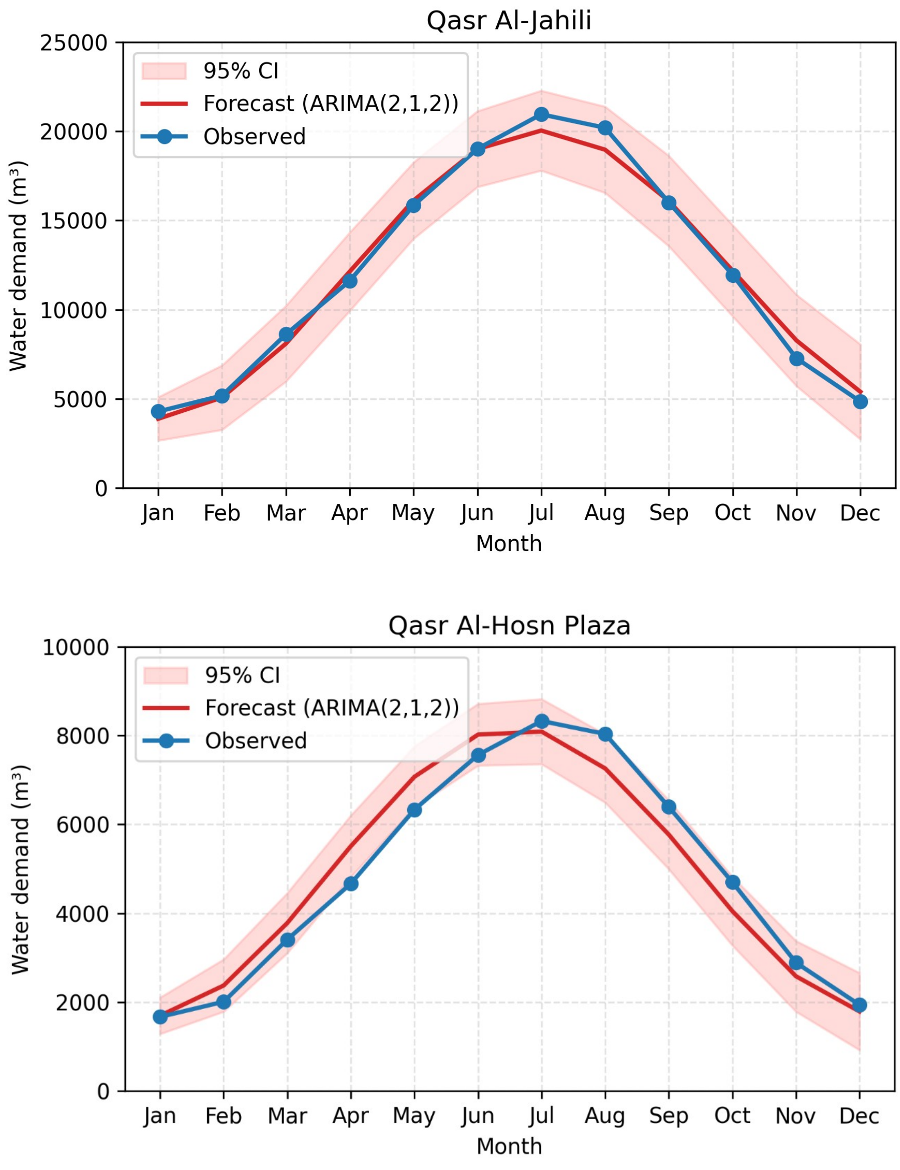

Figure 9. Observed versus ARIMA forecast for monthly water demand of Al-Jahili and Qasr Al-Hosn Park/Plaza

5. Conclusions

Public green spaces and parks can be fluid, interacting dynamically with the environment and introducing fauna and flora in the urban environment. Metropolitan landscape's dual character– spatial fragmentation and functionally-driven processes – gives rise to the existence of the interstitial spaces within it. The current study highlighted the necessity of cross-disciplinary integration of design theory, water management principles, and public expectations and acceptance. The aim was to critically evaluate how vegetation is changing in terms of spatial, ecological, and interpretive landscapes between classical green lawn gardens and desert gardens, as in the case of Abu Dhabi. Water management systems and sustainable parks provide significant water savings, yet are challenged by user perception of the classical garden with large green lawns. The transformation of Qasr Al-Hosn Plaza/Park provides an example of how sustainable landscape architecture can preserve cultural heritage while addressing modern environmental challenges. It may serve as a model for future urban projects seeking to harmonize tradition, ecology, and urban development in the desert environment of the UAE. Thus, the desert landscape in the case of Qasr Al-Hosn Plaza/Park reinstated the symbolic meaning of the cultural monument by paying tribute to its existence before the modern city of Abu Dhabi. Taking more sustainable landscape approaches and educating the community to gradually accept change is especially important in the wake of scarce water resources in hot arid regions like the UAE. Throughout this research, the water management resources in the case of Qasr Al-Hosn Plaza/Park were investigated to assess the implementation of Targets 3 and 4 of SDG 11 in the city of Abu Dhabi, both in terms of promoting sustainable, inclusive, and participatory urbanization as well as highlighting the city's cultural and natural heritage. The new trends in designing sustainable public parks in Abu Dhabi, as a modern desert city, were presented, as well as the efforts in water resource management to shift landscape design in desert cities towards sustainable parks. Our study found that the new Qasr Al-Hosn Plaza/Park sustainable urban desert landscaping with native palm trees and shrubs had resulted in significant water savings relative to that at Al-Jahili park, which is approximately the same size but follows a traditional, open lawn design. Through a comparative water budget and time-series analysis of the two parks, this research highlights that replacing turf-dominated landscapes with native and drought-tolerant vegetation, supported by efficient irrigation systems, can reduce annual irrigation water demand by approximately 57–60%. Beyond measurable water savings, the transformation of Qasr Al-Hosn Plaza illustrates how desert landscaping can reinforce cultural heritage and set an example of urban resilience to climate change in rapidly urbanizing Gulf Cities. An important aspect that must be attended to by landscape architects and planners is communal acceptance of these new forms of desert parks. Desert landscaping and public space reinstating the symbolic meaning of the desert must be accompanied by intense education of the public toward the realization of the environmental and water constraints posed by hot and arid sites.

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