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Rethinking Water Use in Urban Landscaping: A Review of Sustainable Strategies in the United Arab Emirates

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Abstract. The United Arab Emirates (UAE) faces the problem of water scarcity. The aim of this paper is to provide clear evidence that can be adopted currently. As urban landscaping contributes a substantial share of municipal water demand, this paper reviews four approaches sustainable water use in urban landscaping under the arid climate, which are predictive water demand modeling, native and drought tolerant plant selection, city scale water budgeting, and retrofitting through xeriscaping. Suitability for the UAE context, cost-effectiveness, and implementation challenges of each strategy are analyzed. Through analysis, the author puts forward an integrated approach. It is recommended that the UAE should implement these strategies by standardizing plant selection criteria, optimizing approval procedures, rolling out phased retrofitting projects, upgrading relevant infrastructure, and engaging the public. With operation in sequence and transparent metrics, they are able to reduce municipal water demand. This study not only offers solutions for the UAE to mitigate water scarcity and enhance the livability of urban landscapes but also provides valuable references for cities in arid regions globally.

Keywords: Urban landscaping, Water demand modeling, Plant selection, Budgeting, Xeriscaping, The United Arab Emirates

1. Introduction

The United Arab Emirates is one of the most water scarce countries in the world, and urban landscaping contributes a substantial share of municipal water demand. Green spaces improve public health, thermal comfort, and social cohesion, yet some of the species historically planted in cities across the UAE evolved in milder and wetter climates. They survive only through heavy irrigation, which pushes up water consumption and long term maintenance costs. Over the last two decades, researchers and practitioners have converged on four approaches that can realign landscape design with the realities of an arid climate, including predictive water demand modeling, native and drought tolerant plant selection, city scale water budgeting, and retrofitting through xeriscaping. The four approaches are chosen in that they could be operated at complementary scales. Modeling lowers waste by aligning irrigation with need. Plant selection lowers the baseline demand of the landscape itself. Budgeting links numerous sites to a citywide plan. Xeriscaping delivers measurable savings where water use is high. Considering their advantages, the four strategies could form a practical toolkit that can be sequenced from planning to delivery. This review synthesizes peer

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reviewed evidence on them individually, explaining the reasons that each approach fits the UAE context, evaluates costs, benefits, and implementation hurdles. Additionally, it makes the case for a combined strategy that prioritizes native species and uses modeling and targeted retrofits to accelerate savings while citywide budgeting anchors long term planning. Landscape water demand is one of the few levers that can reduce municipal water use without sacrificing livability. The objective of this paper is to present a clear evidence-based path that can be adopted at present, while identifying the gaps that future research should address. The broader aim is to invite readers to see landscape design not as a fixed aesthetic choice but as an adaptable system that can conserve water and deliver shade, beauty and community value.

2. Analysis on four approaches

2.1. Modeling and predicting landscape water demand

Modeling uses local climate, plant type, and system efficiency to forecast how much irrigation is actually needed and to set schedules that prevent routine overwatering. The WUCOLS system classifies species into water use groups and the LIMP method translates those classifications into irrigation programs that account for weather and irrigation efficiency. Applied in Abu Dhabi, the combination of WUCOLS and LIMP reduced seasonal irrigation demand by about thirty percent when paired with low water species and better scheduling [1]. This result matters as sites water are based on tradition rather than need.

2.1.1. Costs and capacity

Modeling requires staff training, basic data management, and periodic verification. The direct costs are small when compared with hardware upgrades, since most inputs are already available from weather services and plant lists. The main investment is the time spent in building site inventories and converting rules of thumb into schedules. As modeling can be deployed before construction or during routine maintenance, it scales quickly across lots of sites.

2.1.2. Practical impact in the UAE

Modeling aligns well with a municipal context where treated water is precious and metering is common. It helps public agencies justify irrigation budgets and detect leaks or malfunctioning valves when water use deviates from model expectations. The chief difficulty is the compliance. Schedules only save water when crews follow them and when controllers are programmed correctly. Hence, modeling works best with simple monitoring such as monthly checks of meter readings against the modeled target and short staff refreshers at the start of each season.

2.2. Selecting native and drought tolerant plants

Plant choice sets the baseline for water usage that a landscape will need over its entire life. Research comparing ornamental species shows that native trees such as Acacia tortilis and Prosopis cineraria require roughly sixty five to seventy percent less water than exotic ornaments such as Ficus benjamina that are common in city streetscapes [2]. A review of UAE native flora documents broad tolerance for heat, drought, and salinity, traits that reduce irrigation needs and lower risk under extreme weather [3]. Building on that foundation, a doctoral study proposed a palette of about thirty

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species selected for low water demand and urban design value, making it easier for designers to specify native options that still meet aesthetic goals [4].

2.2.1. Costs and capacity

Using native plants is capable of reducing long term inputs such as fertilizer, pest control, and pruning. Upfront costs vary with nursery availability. Where supply is limited, municipalities can stimulate production by publishing forward orders and by partnering with nurseries to propagate priority species. The main capacity need is the updated guidance. Designers and maintenance teams benefit from species sheets that state size at maturity, spacing, irrigation establishment schedules, and acceptable forms thus native plantings look orderly.

2.2.2. Practical impact in the UAE

Native planting is the most durable form of conservation in that it reduces demand daily without relying on constant enforcement. The chief challenge is the perception. Some residents associate conservation with barren spaces. Demonstration gardens that show native canopies and shrubs as green, structured, and shade producing help shift expectations. The second challenge is the salinity where treated water is used. The solution is to select proper species and seasonal leaching to prevent salt from generating.

2.3. Urban water budgeting and policy planning

Budgeting connects numerous sites to a shared plan so that city leaders know how much water landscapes will need as districts grow so they are able to evaluate the benefits of conservation policies. A dynamic model for Abu Dhabi projected seventeen percent reduction in outdoor use by 2030 when native vegetation and greywater reuse are integrated into development scenarios [5]. The strength of budgeting is not instant savings but appropriate coordination. It ensures that limited treated water is available for the landscapes that deliver the greatest public value, such as shaded streets and school yards.

2.3.1. Costs and capacity

Building a budget requires data integration across agencies. Metered use, area of irrigated landscapes, plant mixes, and climate data should be brought together. The outlay is justified by the decisions the budget supports, including where to extend treated water mains, how to prioritize retrofits, and how to set seasonal targets. Once established, the model can be updated annually with modest effort.

2.3.2. Practical impact in the UAE

Budgeting is well suited to an emirate structure with strong municipal authorities. It provides a stable framework for phasing conservation measures and for aligning investments in piping and smart metering. The typical difficulty is the data quality and ownership. Clear roles, a shared data dictionary, and quarterly dashboards could help maintain momentum. Budgeting also creates transparency. When agencies publish liters per square meter for public landscapes, managers can compare similar sites and learn from the best performers.

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2.4. Retrofitting urban spaces with Xeriscaping

Xeriscaping redesigns existing landscapes to perform in an arid climate by reducing turf, selecting drought tolerant species, and arranging plantings to retain water and shade. In the case of a UAE university, retrofits reduced irrigation by forty one percent and lowered maintenance costs simultaneously [6]. This approach addresses the legacy of turf and high water ornaments that are installed when water scarcity received less attention.

2.4.1. Costs and capacity

Xeriscaping retrofits require capital for demolition, soil preparation, drip irrigation, and new planting. Payback periods depend on water tariffs and maintenance savings. Phasing retrofits during scheduled renovations or when turf is already failing can reduce disruption and cost. The skill demands are manageable. Crews need training on drip layout, mulch depth, and seasonal pruning to maintain tidy forms.

2.4.2. Practical impact in the UAE

Xeriscaping is the most direct path to large savings at existing high use sites such as parks, schoolyards, and institutional campuses. Additionally, it is highly visible, which helps build public understanding of the appearance of a water efficient landscape. The risks are mainly aesthetic concerns and short term establishment watering, both of which can be managed with clear design templates, three dimensional visualizations during community meetings, and establishment plans that gradually taper irrigation over the first seasons.

2.5. Additional research and alternative approaches

Studies that focus on planting soils and management confirm that details matter but priorities are highlighted. One investigation found that while compost and mulch improve plant health, the single largest driver of savings is switching from exotics to native species [7]. Another review stressed the need to design for evaporation, wind exposure, and rainfall patterns so that plant layers and hardscape work with the climate rather than against it [8]. These findings complement the four core strategies by showing how site level choices amplify or diminish their effects.

3. Comparative analysis

An effective strategy should balance impact, feasibility, cost, and time horizon. Modeling has strong early impact as it can be deployed before construction and across several existing sites. It is inexpensive per hectare and reveals hidden overspray, misprogrammed controllers, and leaks, therefore its weakness is behavioral. Without routine checks, old watering habits resurface. For this reason, modeling performs best when paired with simple compliance steps, such as comparing monthly meter readings to modeled targets and correcting deviations. Native plant selection delivers the deepest structural change as it rewrites the water demand of the landscape. It saves water for the full life of the planting and reduces operational inputs. The constraint is the supply. Nurseries may not stock the full palette at the scale cities require, which can be solved with forward purchase agreements, seed collection programs, and municipal propagation partnerships that reduce the risk of production for growers. What is more, there is a design learning curve. Standard details and photo rich casebooks help designers and maintenance teams achieve clean and ordered results with native

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species. Xeriscaping focuses on capacity where it matters most, which is the strong tool for legacy turf and high water beds in highly visible sites. It requires capital and careful staging. The public will judge the success of retrofits on both appearance and function, which means designs have to deliver shade, seating, and clear walking routes along with lower water bills. When these human needs are designed from the start, acceptance will rise and the savings will be sustained. City scale budgeting makes the above three strategies coherent. It answers questions that no single site can answer, such as how much treated water can be allocated to landscapes next year; which districts will grow most and need shade the most; where will retrofits yield the largest combined benefits for water saving, comfort, and equity. Budgeting is therefore a policy tool that turns some site level decisions into a citywide program with measurable goals.

On combinations and sequence, the evidence and practicalities suggest a clear order of operations. Firstly, a native first baseline for all new projects and for replacements in existing beds should be adopted, which could reset demand permanently. Secondly, it is proposed to implement modeling to set irrigation schedules and build a habit of comparing meter readings with modeled targets. Thirdly, it is better to direct xeriscape retrofits to the highest use sites where payback is fastest and public benefit is greatest. Fourthly, a living water budget at the municipal level should be maintained so that investments in treated water distribution, smart meters, and maintenance staff follow need rather than habit. Although few studies test all four elements in a single program, the literature support each link in the chain and the logic of their combination. Where studies are missing, cities can run pilots that use discrepancy in differences evaluation to quantify gains while controlling for weather.

Based on the above analysis, the author's position is therefore straightforward. A native first strategy supported by model based irrigation and targeted xeriscape retrofits, all guided by a transparent city budget, is the most effective and defensible path for the UAE. It yields deep savings at the plant level and quick wins through better scheduling, meanwhile visible step changes at priority sites and long term coordination across districts.

4. Recommendations for the UAE and suggestions for future research and practice

Municipal specifications is recommended to require native and drought tolerant species for public and private landscapes, reserving high water turf for functional sports use. This change locks in lower baseline demand and reduces recurring inputs such as fertilizer and pruning. Permitting should include submission of model based irrigation schedules and a simple plan for seasonal verification, which institutionalizes good practice and guards against the drift back to old watering habits. Cities is suggested to launch rolling retrofit programs that start with the ten percent of parks and school campuses that use the most water per square meter, replacing turf with native shrubs and trees on drip irrigation. This operation concentrates capital where it yields the largest returns. Infrastructure for treated water is ought to be extended to priority landscapes, with soil salinity monitoring and selection of salt tolerant species to manage risk. Finally, public engagement should accompany design and delivery. Demonstration gardens, open planting days, and quarterly publication of liters per square meter build trust, teach care practices, and create the feedback that keeps savings on track. Jointly, these steps reduce municipal water demand, lower maintenance costs, and improve thermal comfort for residents.

Future work should test combinations of strategies in controlled and real world pilots. For example, a program could compare four site types: turf with sprinklers, turf with subsurface drip, native shrubs with surface drip, native shrubs with subsurface drip. Each site would be monitored for at least two years for water use per square meter, plant survival, maintenance hours, and user

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comfort in shaded areas. Open data on costs and outcomes would allow other municipalities to replicate the designs. Researchers had better build a shared database of local evapotranspiration, species coefficients, and controller settings so that modeling is grounded in local performance rather than imported assumptions. On the supply side, partnerships with nurseries is able to expand the availability of priority native species. At last, training modules for designers and maintenance teams should be created and updated each season so that practice evolves with evidence.

5. Conclusion

The UAE is able to conserve water while enriching its public realm if it treats landscape design as a system. Predictive modeling, native plant selection, xeriscaping, and urban water budgeting are not competing ideas. They are complementary steps that work best together. Making native species the default lowers demand at its source. Modeling keeps irrigation aligned with need and catches waste before it accumulates. Retrofitting shows residents that beauty and function do not depend on wasteful turf. Budgeting gives leaders a map and a timetable for scaling what works. If adopted in sequence and tracked with simple and transparent metrics, these strategies can deliver measurable savings and make the UAE a better place to live. The UAE is well positioned to lead arid cities globally by showing how evidence based design and policy can turn water scarcity from a constraint into a catalyst for innovation.

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