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Original Research

Xeriscaping Feasibility as an Urban Adaptation Method for Global Warming: A Case Study from Turkey

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Abstract

Green spaces are of great importance in the image of a city. But water resources are gradually decreasing due to the increase in world population, climate change related to global warming, unconscious consumption of water resources, and pollution. In landscaping, incorrect plant choices and the use of grass in expansive areas may also increase pressure on limited water resources. In summer, scenes of yellow, dry, and even dead landscaping designs are increasingly common where correct landscaping designs are not employed. This study consists of data collected to obtain a better understanding of the study area, Antalya/Konyaalti, regarding its natural features and xeriscape, and a cost estimate of construction and maintenance of a proposed design project. It was prepared taking into consideration the existing landscape design and the xeriscape principles of the pilot park. Results were compared in terms of economic and environmental contributions. From the perspective of the literature review to date, this study is one of the first aimed at determining the construction and maintenance costs of xeriscape practices to be conducted on a park scale in the context of public spaces nationally and internationally. The potential benefits of the xeriscape in Mediterranean conditions have been quantitatively and qualitatively demonstrated. Recommendations are made for the redesign of the existing park based on xeriscaping, which could save 57.24% of the construction costs and 54.91% in annual maintenance costs. We conclude that xeriscaping can contribute to ecology by providing water savings, reducing chemical use, and preventing soil pollution.

Keywords: xeriscape, landscape design, feasibility analysis

Introduction

The development of the art of landscape gardening, dating back to 4000 B.C., shows that historically gardens were made for personal taste and use rather than for public interest or the care of resources. Over time, along with the emergence of public recreational spaces, it has become clear that existing natural resources should also be protected and managed [1]. Although more than 70% of the Earth's surface is covered in water, usable freshwater is extremely limited, comprising just 2.5% of the total. Most of this freshwater exists either underground in subterranean aquifers or locked up in polar ice caps and glaciers. Only 1.2% is available as surface freshwater

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contained in rivers, lakes, streams, and the atmosphere [2].

Choiński et al. [3] emphasize that most water resources are consumed by anthropogenic factors, and this impacts climate conditions. Among the greatest challenges for architects and planners today are reducing operating costs and creating more livable spaces in urban areas through sustainable designs. Efficient water management that simulates the natural hydrological cycle is one of the key elements of sustainable design [4-5].

Some researchers, such as Knox [6], Aklanoğlu [7], Barış [8], and Ertop [9] have pointed out that water resources are gradually decreasing and so water-saving landscape designs should be preferred to classical landscape concepts. Xeriscaping is a holistic approach that uses planning, designing, and selecting appropriate indigenous plant species, water-efficient irrigation techniques, and other practices to make landscaping more sustainable [10]. It has been suggested by many researchers also for capturing a large amount of CO_2 with few irrigation requirements [11-12]. There are a number of strategies, tools, alternatives, and management practices that can significantly reduce or conserve water use in urban landscapes. Use of water-conserving landscape plants and designs suitable for each soil type and climate have been predominantly promoted as foundational components of water conservation [13-15]. These approaches make possible eco-friendly landscaping, which reduces construction and maintenance costs of green areas, favoring both nature and the economy [16]. The U.S. Environmental Protection Agency [17] describes the specific benefits of xeriscaping as:

"Reduced water use, decreased energy use (less pumping and treatment required), reduced heating and cooling costs because of carefully placed trees, decreased stormwater and irrigation runoff, fewer yard wastes, increased habitat for plants and animals, and lower labor and maintenance costs."

The principles of xeriscaping are listed as [18-19]:
- Design the landscape based on a whole site analysis.
- Limit turf areas and use grasses appropriate for the region.
- Amend poor soils to increase water absorption and retention.
- Mulch plantings to reduce evapotranspiration.
- Select plant material that is naturally adaptable to site conditions.
- Use water-efficient irrigation systems.
- Maintain landscapes appropriately.

A number of comparative studies have examined the outcomes of xeriscaping versus traditional methods. Wade and Weatherly [20] designed two imaginary residential gardens – one based on xeriscaping and one on classical landscaping – and then calculated and compared the annual costs of water consumption, maintenance, wastewater, and water bills. Also in the United States, Santo [21] comparatively examined xeriscaping principles and established practices in the region around Atlanta, Georgia (U.S.A.) and other states, and calculated the percentage differential in water savings. Using computer models, Baykan and Birişçi [22] and Şahin [23] selected and designed areas according to xeriscaping methods, emphasizing points that should be taken into consideration: plant selection, massing of plants needing similar growth conditions, mulching, etc. Wade et al. [24] and Welsh [25] examined housing gardens before and after implementing xeriscape practices for plants and irrigation. Researchers such as Taner [26], Çakıroğlu [27], Şahin [23], Keane [28], Welsh [25], and Wade et al. [24] described the xerotolerant (drought tolerant) plant species that can be used in xeriscaping.

A landscape design that is carried out in order to use less water should include [5, 29]:
- Land grading.
- Soil analysis and amendments.
- Appropriate plant selection and proper use of turf.
- Efficient irrigation techniques considering the local climate.
- Use of mulches.
- Suitable fertilizers and pesticides.
- Regular maintenance of planting and irrigation systems.

The objectives of this study, which was conducted in the province of Konyaaltı, Antalya (Turkey), are:
- To demonstrate the feasibility of xeriscaping in Mediterranean conditions using both quantitative and qualitative values.
- To draw the attention of institutions and organizations that are interested in the quantitative benefits of the xeriscape design.
- To increase the efficiency of green areas, especially in summer, and to enable sustainable landscaping designs.
- To contribute to the spread of xeriscaping practices.
- To use natural resources – especially water – economically.
- To obtain outcomes that will contribute to the environment and the economy.

In accordance with the above-mentioned goals, information about xeriscaping was obtained and data was collected on the natural features of the Konyaaltı District, and then the cost of the proposed design projects (construction and maintenance) were calculated based on comparing an existing public space selected from the Konyaaltı area and a proposed xeriscape plan. The resulting data were analyzed in terms of their economic and environmental contributions. Some suggestions are made for Mediterranean conditions on the basis of the Konyaaltı case, and then the feasibility of the Xeriscape is discussed for Mediterranean conditions in general.

Material and Methods

Material

The Konyaaltı District is one of the five central districts of Antalya – the tourism capital in southern

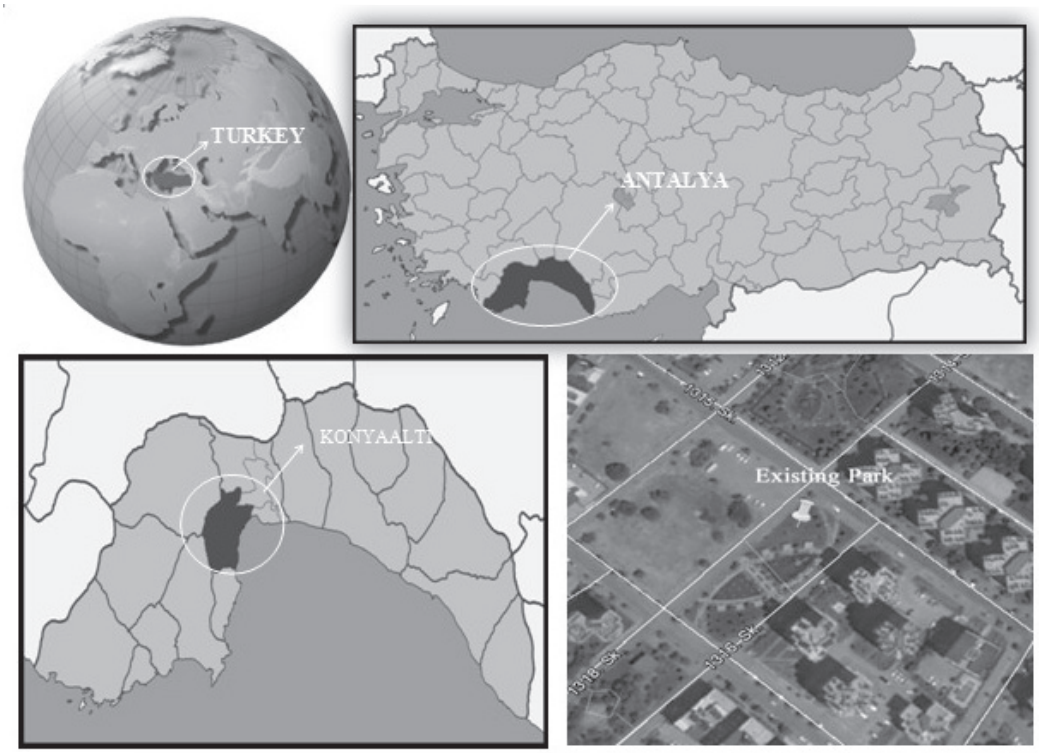

Fig. 1. Location of study area.

Turkey known for its world-famous coast – and from among the public spaces in that region that focus on the park in its Siteler Neighborhood (Fig. 1).

Konyaaltı, with a surface area of 562.4 km^2, has a population of 145.648 according to 2014 census figures [30-31] and features 127 parks, two squares, five outdoor sports venues, and other green areas within its municipal borders [32]. The geological structure of the research area was obtained from the 1/100,000-scale geological map prepared by the General Directorate of Mineral Research and Exploration [33]. The soil properties of the study area were determined using the map prepared by the General Directorate of Rural Services [34], and its report, Antalya Land Assets [35]. In order to determine the climatic characteristics, data for 2007-14, prepared by the Fourth Regional Directorate of MGM (Directorate General of Meteorology) [36], have been utilized and research data from "Antalya Region" climate station No. 17302, which is located 47 m above sea level and at a latitude of 36 and longitude of 30. The overall cost of developing the current park was calculated based on data obtained from Konyaaltı Municipality [37]. The annual maintenance costs of the existing and proposed projects have been calculated by obtaining a price quote from three landscaping companies: CRN Peyzaj, Mavi Peyzaj, and Tetikler Peyzaj. The annual maintenance schedule of the existing and proposed landscape design projects was determined by consulting specialists of these companies and also Seki Peyzaj, Antalya Forest Nursery, Pey Art Peyzaj, and Damla Peyzaj companies, who submitted quotes for the plantation supply of the proposed project.

Method

Research was carried out in four stages in the field and in the office (Fig. 2).

First, a literature review was conducted about the xeriscape and data were collected on the natural structural properties (geology, morphology, soil, hydrology, and climate) of the Konyaaltı District. Then a small park in the Konyaaltı area was re-envisioned based on xeriscaping principles, and the costs of

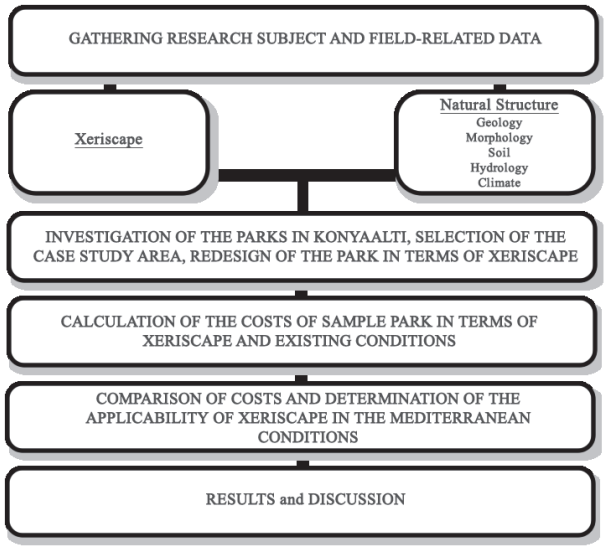

Fig. 2. Research method flow diagram.

construction and maintenance (irrigation, fertilization, mulching, pruning, mowing, spraying) of the existing and proposed projects were calculated. Comparisons were made based on these calculations. Finally, the study demonstrated qualitatively and quantitatively the benefits of xeriscaping in Mediterranean conditions. Suggestions were made on the basis of these findings. Although the structural arrangement of the park, which is the study area, remained untouched, we conceived a new design in accordance with xeriscaping principles based on the natural properties of the area. In selecting plants, those most suitable for the park were chosen from a chart detailed in a study conducted by Çetin, which elaborates upon various studies on Mediterranean conditions and forest nurseries [38]. The general cost of the existing park design was determined from data obtained from Konyaaltı Municipality [37] (Fig. 3).

Following the method employed by the municipality in determining cost estimates, annual maintenance outlays for the existing and proposed projects were calculated by averaging the proposal prices of the three firms. For the proposed project, fair market prices were calculated by averaging those for plant and turf materials and the mulching materials for additional landscaping, from the same firms. Only these three companies could offer bids, because appropriate plants, or those of desired size and specifications, were not available elsewhere.

Microsoft Excel 2010 software was used for calculations. To make prices more comparable, particular attention was paid to plant size and pot size in the proposed project in order that they match those of the existing project to avoid discrepancies. As Autocad software was used for imaging the existing project, it was used also for the proposed project's illustrations in order to equalize the designs aesthetically.

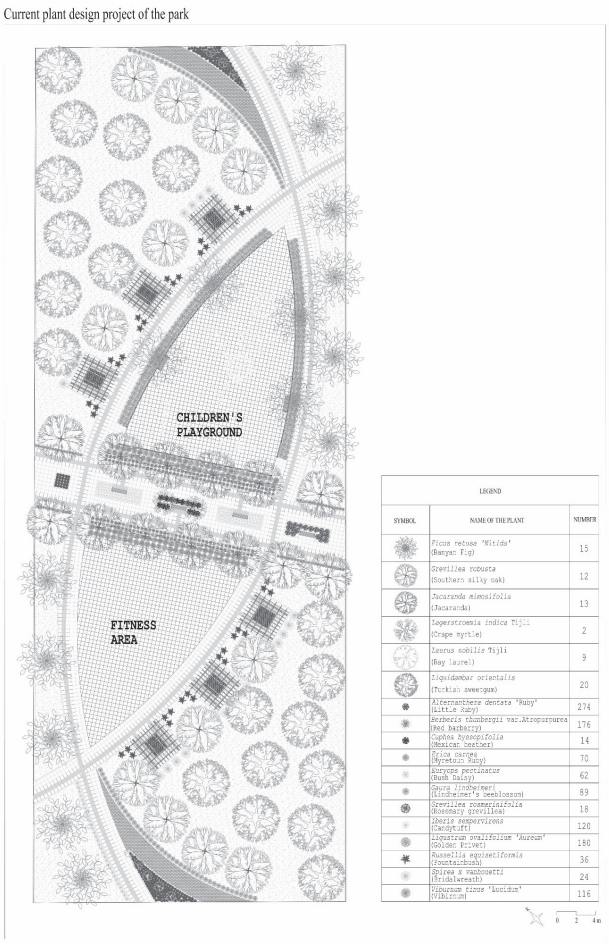

Fig. 3. Study area: existing park.

Results and Dıscussıon

Results

Xeriscape

"Xeriscape" is a modern compound word that emerged in the early 1980s in the city of Denver, Colorado, U.S.A. [25, 39]. It combines "xeros," which means arid in Greek, and "landscape," which includes "terrain" among its connotations in English.

Xeriscaping offers ecological, economic, and aesthetic benefits. Ecological advantages include ensuring water savings, contributing to water resources, creating habitats for plants and wildlife, protecting biodiversity, improving soil, inhibiting erosion, reducing chemical use, and preventing groundwater pollution. Reducing maintenance and labor costs; saving energy, time, and effort; and decreasing water bills are among its economic advantages. Improving the visual quality of the environment along with diversity in design are among its aesthetic rewards [9, 25-26, 40-41].

Natural (Structural) Properties

In landscaping practices, in order to achieve sustainable results it is necessary to know the components that comprise the natural structure of the area and to make vegetative and structural determinations based on this data. Those of the park under study were mapped and the results of the analysis summarized below.

The geological structure of Konyaaltı District includes various formations. Limestone comprises the largest part, with a percentage of 26.76% of the study area. Red Mediterranean soils (83.13%), shallow soils (0-20 cm) (52.37%), Class VII soils (48.82%), and a majority of lands with soil insufficiency and slope and erosion damage (40.84%) are also noteworthy. Topographically, 46.59% of the expanse is steep (with 30% or more sloping land), while 21.02% of the terrain is flat (or almost flat: 0-2%). The coastal terrain is nearly flat, while the sloping areas increase in the terrestrial zones. Therefore, land where there is not any dominant direction/vector occupies the largest area with a percentage of 17.44%. The streamlets of Boğaçayı, Arapsuyu, and Sarısu are the primary water sources [35].

According to Antalya Regional Station data, the average temperature is 19.9ºC, the average high temperature is 24.2°C, and the average low temperature is 16.9°C. The highest temperature was 43.8ºC on the 24 July 2007, while the lowest temperature was 0.6ºC on the 19 February 2008. The hottest months in Konyaaltı are June, July, and August, while the coldest months are December, January, and February. Analyzing the hydrometric diagram drawn based on these data reveals that there is an arid period that lasts approximately five-and-a-half months from mid-April until the end of September.

Designing the Proposed Plant Project Suitable for Xeriscaping

The park was redesigned according to xeriscaping principles, but without any structural changes. At this stage, the natural structural properties of the area where the park is located (geology, morphology, soil, hydrology, climate) were taken into consideration. Plants were selected from a comprehensive list of two hundred prepared for this study based on literature. The selection process paid particular attention to species naturally resistant to drought; plant species appropriate to designated locations, and the grouping of varieties with the same maintenance requirements. In addition, in areas unsuitable for functional use, ground cover plants – which consume less water, require less maintenance, are more sustainable, and offer a more colorful and aesthetic appearance – were preferred to lawns. The plan calculated 15 succulent ground cover plants per square meter. Mulching was recommended for its many advantages for certain plant beds (tree, shrub, bush, perennial, and succulent plants), especially with respect to water savings (Fig. 4). In the case of irrigation, a water-saving drip system was recommended. In short, an effort was made toward an aesthetic design following xeriscaping principles in order to contribute to the environment and reduce both construction (start-up) and maintenance costs.

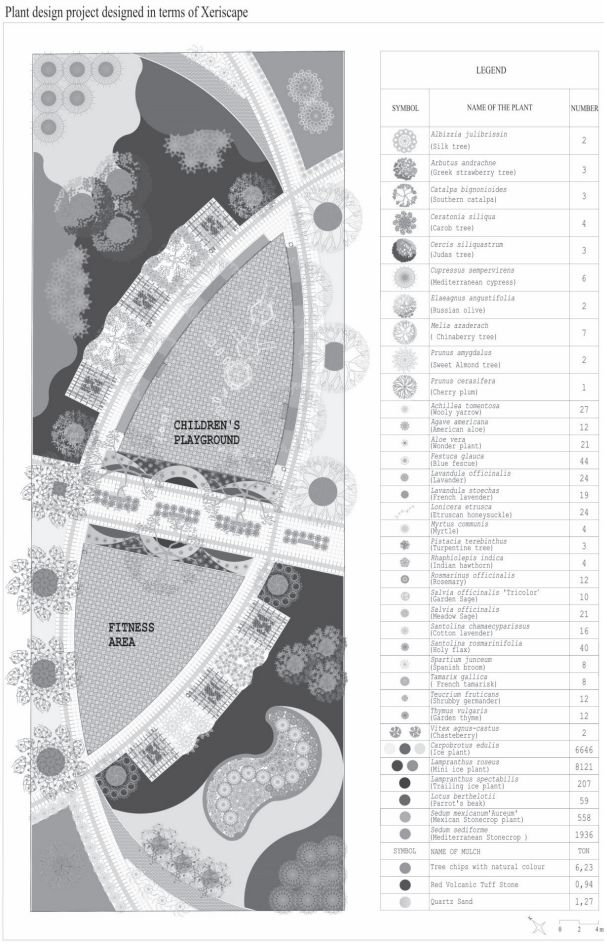

Fig. 4. Study area: proposed project.

Calculating Supply and Annual Maintenance Costs of Existing and Proposed Projects

The existing project utilizes 71 trees-shrubs and 1,179 bush perennials. It features 1,477.28 m2 of lawn area employing 49.07 m3 of turf. The total cost for tree-shrubs was €6,118.52, for bush-perennials €3,233.90, and for the lawn €400.93. The total cost of the turf was €1,126.59. The estimated cost of the plant supply was €10,879.94 (Table 1).

The proposed project was designed based on the xeriscape to include 44 tree shrubs (€735,280), 312 bush perennials (€515.99), 17,527 ground-cover plants (€2,500.23), and 49.07 m^3 turf, for an estimated total cost of €4,652.52 (Table 2).

The annual maintenance procedures applied to both the existing and the proposed projects are shown in Table 3. The annual cost of the existing project is €10,471.37, while that of the proposed project is €4,721.15.

Unlike the existing project, the proposed project utilizes mulching materials (quartz sand, woodchip, volcanic tuff) in accordance with xeriscaping principles due to their numerous benefits – especially water savings. Therefore, an additional cost amounting to €510.24 arose in the structural application item of the budget (Table 4).

Discussion

Antalya has been experiencing an unusually long arid period of five and a half months, and it is projected that this arid period is likely to continue for the time being. Data indicate that there has been a decline in precipitation and an increase in temperature in recent years, i.e., drought has increased and the designs and practices that ensure water savings such as xeriscaping are needed.

Xeriscape landscaping practices, rather than using plants that require more care or that are non-indigenous, employ drought-tolerant species, decrease seasonal plant use, reduce lawn areas as much as possible or use drought tolerant grasses, and as ground cover turn to succulent species with low water consumption.

Table 1. Current project plant supply summary [37].

Item No.	Pose number	Explanation	Unit	Total amount	Price (€)	Total price (€)
1	Market value	*Ficus benjamin*, 2m of Tijli, CLT50, 14-16 cm, 300-350 cm	Number	15	82.51	1,237.62
2	Market value	*Grevillea robusta*, CLT50, 14-16 cm, 300-350 cm	Number	12	76.77	921.22
3	Market value	Jacaranda mimosifolia, CLT50, 14-16 cm, 300-350 cm	Number	13	83.23	1,081.93
4	Market value	*Lagerstromia indica* Tijli, CLT50, 14-16 cm, 250-300 cm	Number	2	99.73	199.45
5	Market value	*Laurus nobilis* Tijli, CLT50, 12-14 cm, 150-200 cm	Number	9	112.64	1,013.78
6	Market value	*Liquidambar orientalis*, CLT70, 16-18 cm, 400-450 cm	Number	20	83.23	1,664.51
7	Market value	*Spirea* x *vanhouetti*, (min. 50 cm çap), CLT10, 80-100 cm, fully textured	Number	24	3.80	91.26
8	Market value	*Alternanthera dentata* 'Ruby', CLT 3, 25-30 cm, fully textured	Number	274	1.29	353.85
9	Market value	*Berberis thunbergii* var. Atropurpurea, CLT 5, 40-50 cm, fully textured	Number	176	2.58	454.58
10	Market value	*Cuphea hyssopifolia*, CLT 7, 50-70 cm, fully textured	Number	14	2.08	29.13
11	Market value	*Erica carnea*, CLT 4, 30-35 cm, fully textured	Number	70	4.95	346.53
12	Market value	*Europs pectinatus*, CLT 4, 40-45 cm, fully textured	Number	62	2.58	160.14
13	Market value	*Gaura lindheimeri*, CLT 5, 45-50 cm, fully textured	Number	89	1.43	127.71
14	Market value	*Grevillea rosmarinifolia*, CLT 7, 50-70 cm, fully textured	Number	18	7.53	135.60
15	Market value	*Iberis sempervirens*, CLT 3, 25-30 cm, fully textured	Number	120	3.09	370.21
16	Market value	*Ligustrum ovalifolium* 'Aureum', CLT 9, 60-80 cm, fully textured	Number	180	2.22	400.34
17	Market value	*Russelia equisetiformis*, CLT 9, 60-80 cm, fully textured	Number	36	2.51	90.40
18	Market value	*Viburnum tinus* 'Lucidum', CLT 7, 50-70 cm, fully textured	UNIT	116	5.81	674.13
19	Market value	*Lollium perenne* (35% 60 gr per m²)	KG	31.02	3.52	109.05
20	Market value	*Festuca rubra rubra* (35% 60 gr per m²)	KG	31.02	3.44	106.83
21	Market value	*Cynodon dactylon* (30% 60 gr per m²)	KG	26.59	6.96	185.05
22	Market value	Peat (double harvested, sieved, disinfected) (3cm)	m³	49.07	22.96	1,126.59
Prepared according to 2013 market values			TOTAL			10,879.94€

Accordingly, this study generally used indigenous plants. Introduced species are comparatively expensive and require fertilization that can harm indigenous plants by transmitting new diseases and pests. The use of native species is of great importance in ensuring their long-term ecological survival and in reflecting regional identity and culture. Lending themselves to reduced start-up construction and maintenance costs, especially irrigation, natives have shown that it is possible to make designs that are as aesthetic as they are practical and sustainable.

The existing park uses a very limited number of species – all of them introduced. The proposed park aims to increase ecological richness by utilizing a wide variety of compatible plants. While the existing park employs some drought-tolerant plants, for xeriscaping their numbers are insufficient to reduce irrigation and other maintenance needs. Moreover, irrigation does not consist solely of water costs, but also includes those for system requirements for irrigation pipes, lines, etc. in significant amounts in a large-scale park [42].

This study shows: 1) that when comparing the construction outlays of the existing park to those of the proposed park based upon xeriscape principles, the proposed park would save €6,227.42 (57.24%) and 2) in terms of annual maintenance, comparison with the existing park shows that the proposed park would save €5,750.22 (54.91%). When calculated in Turkish lira, it was projected that a 46.23% savings would be achieved for construction and a 43.31% savings would be achieved for maintenance, taking into account that calculations made in euros were based on exchange rates during the period of this study. In the existing park, 51.38% (1,477.28 m²) of the area is composed of lawns, which is the main reason for the higher maintenance cost. Lawn areas always need regular maintenance such as irrigation, fertilization, mowing, sowing, and spraying to maintain

Table 2. Proposed project plant supply summary

Item No.	Pose number	Explanation	Unit	Total	Price (€)	Total price (€)
1	Market value	*Albizzia julibrissin*, CLT 50, 12-14 cm, 250-300 cm	Number	2	19.63	39.26
2	Market value	*Arbutus andrachne*, CLT 35, 10-12 cm, 150-200 cm	Number	3	11.75	35.26
3	Market value	*Catalpa bignonioides*, CLT 50, 14-16 cm, 300-350 cm	Number	3	16.32	48.96
4	Market value	*Ceratonia siliqua*, CLT 50, 16-18 cm, 300-350 cm	Number	4	18.72	74.86
5	Market value	*Cercis siliquastrum*, CLT 50, 14-16 cm, 300-350 cm	Number	3	34.35	103.05
6	Market value	*Cupressus sempervirens*, CLT 35, 175-200 cm	Number	6	20.43	122.56
7	Market value	*Eleagnus angustifolia*, CLT 50, 16-18 cm, 300-350 cm	Number	2	23.05	46.10
8	Market value	*Melia azaderach*, CLT 50, 14-16 cm, 300-350 cm	Number	7	24.31	170.15
9	Market value	*Prunus amygdalus*, CLT 50, 14-16 cm, 250-300 cm	Number	2	12.78	25.56
10	Market value	*Prunus cerasifera*, CLT 50, 14-16 cm, 250-300 cm	Number	1	20.43	20.43
11	Market value	*Achillea tomentosa*, CLT 2, 20-25 cm, fully textured	Number	27	1.31	35.43
12	Market value	*Agave americana*, CLT 5, 40-50 cm, fully textured	Number	12	4.22	50.67
13	Market value	*Aloe vera*, CLT 2, 20-25 cm, fully textured	Number	21	1.83	38.34
14	Market value	*Festuca glauca*, CLT 2, 20-25 cm, fully textured	Number	44	1.20	52.72
15	Market value	*Lavandula officinalis*, CLT 3, 25-30 cm, fully textured	Number	24	1.31	31.50
16	Market value	*Lavandula stoechas*, CLT 3, 25-30 cm, fully textured	Number	19	1.31	24.94
17	Market value	*Myrtus communis*, CLT 7, 50-70 cm, fully textured	Number	4	3.31	13.24
18	Market value	*Pistacia terebinthus*, CLT 7, 50-70 cm, fully textured	Number	3	3.88	11.64
19	Market value	*Rhaphiolepis indica*, CLT 5, 40-50 cm, fully textured	Number	4	4.91	19.63
20	Market value	*Rosmarinus officinalis*, CLT 3, 25-30 cm, fully textured	Number	12	1.37	16.43
21	Market value	*Salvia officinalis* 'Tricolor', CLT 2, 20-25 cm, fully textured	Number	10	1.26	12.55
22	Market value	*Salvia officinalis*, CLT 2, 20-25 cm, fully textured	Number	21	1.20	25.16
23	Market value	*Santolina chamecyparissus*, CLT 3, 25-30 cm, fully textured	Number	16	1.31	21.00
24	Market value	*Santolina rosmarinifolia*, CLT 2, 20-25 cm, fully textured	Number	40	1.26	50.21
25	Market value	*Spartium junceum*, CLT 4, 30-40 cm, fully textured	Number	8	2.45	19.63
26	Market value	*Tamarix gallica*, CLT 9, 60-80 cm, fully textured	Number	8	4.68	37.43
27	Market value	*Teucrium fruticans*, CLT 5, 40-50 cm, fully textured	Number	12	2.62	31.50
28	Market value	*Thymus vulgaris*, CLT 2, 20-25 cm, fully textured	Number	12	1.31	15.75
29	Market value	*Vitex agnus-castus*, CLT 7, 50-70 cm, fully textured	Number	2	3.99	7.99
30	Market value	*Carboprotus edulis*, in viols.	Number	1,060	0.14	151.21
31	Market value	*Lampranthus roseus*, in viols.	Number	8,121	0.14	1,158.46
32	Market value	*Lampranthus spectabilis*, in viols.	Number	207	0.14	29.53
33	Market value	*Lonicera etrusca*, CLT 2, 20-30 cm, fully textured	Number	24	2.05	49.30
34	Market value	*Lotus berthelotii*, in viols.	Number	59	0.14	8.42
35	Market value	*Portulaca grandiflora*, in viols.	Number	5,586	0.14	796.84
36	Market value	*Sedum mexicanum* 'Aureum', in viols.	Number	558	0.14	79.60
37	Market value	*Sedum sediforme*, in viols.	Number	1,936	0.14	276.17
38	Market value	Peat (double harvested, sieved, disinfected) (3cm)	m^3	49.07	18.36	901.02
Prepared according to 2015 market values			TOTAL			€4,652.52

Table 3. Annual maintenance needs for existing and proposed projects.

Annual maintenance	Existing project	Proposed project
Irrigation	Once a week/April-May	Once every 3 weeks/April-May
	Three times a week/May-September	Once every 2 weeks/May-September
	Once a week/September-November	Once every 2 weeks/ September-November
	Once every 3 weeks/November-April	If needed November-April
Moving Grass	Once every 10 days/May-September	
	Once every 20 days/September-December and in April	
	Depends on the need during other months	
Moving weed	Once every 10 days/May-September	Once every 3 weeks/May-September
	Once every 20 days/September-November	Once every 6 weeks/September-November
	Depends on the need during other months	Depends on the need during other months
Pruning	Twice a year for trees	Once or twice a year for trees
	Pruning for shape for appropriate trees and shrubs	Depends on the need for trees, shrubs, and perennials
	Once every two months for shrubs and perennials	
Fertilization	3 times a year	2 times a year
Disinfection	4 times a year	2 times a year

Table 4. Proposed project additional application supply summary.

Item No.	Pose number	Explanation	Unit	Total	Price (€)	Total price (€)
1	Market value	Quartz sand	m^3	1.27	18.26	23.19
2	Market value	Tree chips with natural colour 8-12 mm	m^3	6.23	67.33	419.47
3	Market value	Red volcanic tuff 8-12 mm	m^3	0.94	71.90	67.58
Prepared according to 2015 market values			TOTAL			€510.24

a healthy appearance. The existing park employs two inappropriate grass species – Festuca rubra rubra and Lolium perenne – which are cool-climate grasses (C3) that require more water and enrichment. The proposed park utilizes ground-cover species as an alternative, which require only limited weed control and irrigation. Furthermore, these plants provide a more colorful and aesthetic appearance.

Xeriscaping is of great interest to landscape architecture studies focused on sustainability [43]. Stringer et. al. [44] points out that a holistic approach that combines xeriscaping principles with rain water harvesting on even a residential scale will facilitate water conservation, money savings, decrease storm water pollution, and increase property values. Bayramoğlu and Demirel [45] add to these advantages a decrease of time spent on fertilization and other maintenance work, and of energy consumption and the expansion of natural habitats for plants and animals.

Mayer et. al. [46] show that it is possible to reduce outdoor water use by 15-65% or more by specific measures such as xeriscaping or soil moisture sensors. Chui [47] measured public perception of visual attractiveness versus water conservation on examples of front yard landscapes, and found that most people who answered the questionnaire considered xeriscaping to be less attractive than lawns, and the sensor system expensive to establish. That study suggests that though people are aware of climate change and the decrease of water resources, it is not yet reflected in their actions. Nonetheless, these results show the significance of studies that calculate the feasibility of water-conserving landscape designs. This study has shown that the sensor system becomes reasonable for a large-scale area such as a public park, which creates a more favorable ratio in cost outlay.

This study's results are supported by those of Wilkinson [48], who analyzed the feasibility of xeriscaping the parks of Pomona, California, USA. Though this showed that xeriscaping all of them at once would be cost prohibitive, the Pomona Parks Department is gradually and methodically replacing plants of exorbitant water need with native and water-conserving

species of grass and succulents. New efficient irrigation systems are projected to save the city 30-50% of current water usage. A 30% reduction alone would save nearly $2 million annually.

Conclusions

This comparative analysis of landscaping methods for the Konyaaltı District of Antalya has demonstrated qualitatively and quantitatively the necessity and applicability of the xeriscape in Mediterranean conditions. It also has shown that determining the natural structural properties of the region in which a design area is located, and planning based on these characteristics, are critical for resource sustainability. This study is one of the first that models how xeriscaping works on a large scale in public spaces in a regional and national park system, and how such a public space can improve sustainability and increase savings within a national system.

It is obvious that from residential gardens to urban public spaces, xeriscaping is more beneficial than conventional methods in economic and ecological terms. To encourage water savings, it is recommended that public institutions in Turkey provide incentive premiums to encourage xeriscaped designs and to curtail grass use, make automatic irrigation systems compulsory, restrict the importation of introduced species, and apply sanctions on those who ignore these stipulations. It also suggests that to encourage xeriscape practices, effective use of media, distribution of educational brochures, and providing training will contribute to public awareness. It should always be remembered that water is a scarce and valuable resource that has a right to life.

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