The role of afforestation in the sustainability of the natural landscape of the university campus - University of Kufa

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Abstract

Interest in the design of the university campus, its landscape, and its sustainability has emerged as a new trend that enriches the connection between the campus buildings and their natural landscapes on one hand, and between humans and their environment on the other. This provides an opportunity for contemplating nature, making the campus site less consumptive of available natural resources, and enhancing safety and security for site occupants while maintaining the same level of quality and efficiency in its function. It also aims to achieve environmentally compatible design to meet the requirements of the current generation and ensure the rights of future generations, and to achieve a state of balance within the university environment that more effectively serves environmental, social, and economic aspects, and considers the integration of the landscape with the buildings to achieve a sustainability system. This integration makes the university environment understandable and provides a sense of security, orientation, and beauty, which requires designing sustainable natural landscapes with a suitable function for university members' use and distinctive environmental characteristics that achieve human comfort and renew vitality. The study's problem was the lack of interest and knowledge in the sustainability of the natural landscape and its connection to global sustainability standards, which resulted in a failure to achieve thermal comfort and an increased depletion of energy sources and available resources. Additionally, many problems suffered by the university campus were observed, as well as problems affecting the achievement of sustainability from environmental, social, and economic aspects, with a clear deficiency in the natural landscapes achieving their environmental, economic, social, and aesthetic goals due to neglect, weak planning, disregard for their environmental needs, and the lack of complementary components in most natural landscapes. Therefore, a proposed design was suggested that addresses a number of mechanisms that can be implemented to overcome these problems and achieve the sustainability of the natural landscape for the University of Kufa campus.

Keywords: Afforestation, Sustainable Landscape, Sustainable Landscape Design Goals

Introduction

Afforestation is a component of the urban landscape, possessing specific standards and multiple functions. Afforestation has gained widespread attention since early times in ancient civilizations, as well as for its impact on climatic components such as temperature, relative humidity, wind speed, solar radiation, and other environmental phenomena. It is impossible to ignore the importance of trees in protecting humans from direct sunlight in our country with its hot and dry climate, as they contribute to enhancing the atmosphere with the water vapor they produce, in addition to protecting cities from sandstorms and

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strong dust-laden winds when planted as a green belt around the city, or acting as windbreaks in areas from which winds blow, especially those laden with dust. The landscape is the art of architecture's relationship with its surroundings, and this term naturally aligns with the concept of art as it reflects the integration of landform, water, plants, artificial elements, and others, provided they interact with each other and none operates in isolation, which makes them appear as a whole like a work of art [1]. It is also considered a natural land area designated for a specific activity, representing as an art a picture or scene that can be seen at one time and one place to describe reorganized or altered natural scenes in order to achieve an aesthetic appearance [2]. As for the concept of landscape design on campus in particular, it is defined as the art of designing the multiple layers of earth and sky, and the natural and artificial components that make up the landscape and are intertwined, which is the main factor for preparing a green environment with visual impacts that are clearly reflected on its users in universities [1]. Sustainable landscape design on campus is defined as a process by which environmental quality considerations are taken into account in the design, planning, and management of campus natural scenes with the aim of achieving environmentally friendly spaces that consume resources to the extent that they provide a healthy environment for their users and do not prejudice the right of future generations to meet their needs from natural resources [3]. Therefore, the study aimed to identify the problems hindering the achievement of sustainability for the landscape and propose designs that address these problems to achieve a sustainable landscape for the University of Kufa campus.

The elements of a sustainable landscape on campus can be divided into main elements:

Natural elements

1.Plants: Plants are among the most influential natural elements in the landscape. Their seasonal changes, continuous growth and vitality lend spaces a sense of dynamism in addition to their role in achieving sensory enjoyment. Plants exist in a variety of types and shapes and they are characterized by their coordinating characteristics which landscape designers rely on in creating their designs. This makes natural scenes appear at their most beautiful like artistic paintings that evoke joy and pleasure and provide psychological comfort. These characteristics include:

a. Sensory Features of Plants: Plants are important sensory elements. Visually, they possess diverse shapes, colors, and textures. Aurally, they produce sounds due to their movement in the air, in addition to the texture of their leaves, branches, and various flowers. Beyond the visual, auditory, and tactile effects of plants, designers can rely on other senses when using plants in the landscape, such as their aromatic features. Stimulating non-visual sensations can enhance signals received by the eyes, and these sensations work together; the color of spring flowers is intensified by their fragrance. Plants affect humans and provide comfort, which is a

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key sensory issue in plant design. The sense of hearing also plays a significant role, as the sound of trees or their leaves moving creates a sense of plant dynamism [4,5].

b. Temporal Aspect of Plants: Plants are characterized by their ability to grow and continuously change in size and characteristics through changes in the state of their leaves, colors, and textures. Plants have reciprocal relationships with time, evident through seasonal features that clearly show the impact of seasons on the plant's shape, leaves, and flowers. Plants are divided into deciduous plants, which display the features of the four seasons: in summer, they are green, leafy, and somewhat dark in color; in autumn, their colors change to yellow, creating a kind of color excitement, and then they begin to shed; in winter, they are bare without leaves, revealing the texture of the trunk and branches. Some plants in spring produce colorful flowers with some green, yellow, or colored leaves. As for evergreen plants, the change of seasons is evident through their flowers; they always appear leafy with dark colors and begin to display the bright colors of their flowers or leaves in spring, but generally, they are less affected by seasonal features than deciduous plants [4,6].

c. Movement in Plants: Movement in plants is represented by the movement of their leaves and branches due to wind and gentle breezes. This type of movement is effective in the landscape, as it transfers to other surfaces like the ground or surfaces surrounding the plants, creating different shadow patterns due to this movement, which generates a kind of complex dynamism for those spaces. It is observed that in cold weather, this movement adds a kind of life to static and still scenes, and also in hot weather, it emphasizes air movement and creates a sense of psychological comfort for the viewer.

d. Plants as a Complementary Element: Plants are used to complete the image of a building or space within a building's fence, and they are also used to highlight beautiful elements and artworks, hide building flaws, or conceal undesirable views, or they may direct attention to a garden, space, or distinctive location in the landscape.

e. Plants as an Artwork (Pictorial Model): Some plants have this characteristic, either in their natural form or through pruning and shaping. These plants are distinguished by being an attraction point due to the beauty of their appearance and their significant impact on the process of garden coordination and design.

f. Adding Nature to the Place: Plant elements are used to break the sharpness of boring geometric lines resulting from streets, buildings, and walkways, and to give a natural image to the design by beautifying buildings with a green plant belt surrounding them, showcasing their beauty and connecting them with adjacent gardens and spaces to provide integration to the site and make it appear as a single piece of art.

2. Water: Water is a flexible and variable design element. It is a non-static element that takes shape according to the influencing factors and can change without the designer's ability to control it, which is the challenge the designer faces to achieve the desired visual and aesthetic effect. It also plays a significant role in

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environmental functions, as it contributes to maintaining biological balance on the Earth's surface, in addition to the design's role in reinforcing the importance of water by using it within the design in a way that serves as a reminder to humans of the importance water plays.Water, in its various forms, is one of the natural components widely used in the landscape and an essential element in its design due to its positive effects in improving environmental conditions by increasing relative humidity and achieving thermal environmental balance based on wind movement and evaporation rate, in addition to its aesthetic role and its impact on the senses of sight and hearing, as well as its symbolic status that has enriched heritage as it represents life for these spaces, and is an important attraction point. Water itself has no design features that allow us to deal with it independently without the presence of what contains it. Therefore, water in its designs depends on the environmental context that contains it. The visual characteristics of water include flexibility, movement, reflectivity, and dynamism. These characteristics are affected by the size, shape, and texture of the container, the ambient air temperature and movement, and also the existing lighting, whether natural or artificial [4,7].

Industrial elements:

1. Lighting: It is one of the important elements in achieving the functional performance of these scenes, especially at night, which is an extension of space activities and highlights coordination elements, especially if designed carefully and precisely. Through lighting, the value of university natural scenes can be raised, as lighting has several functions on campus, including providing safe movement for pedestrians and cars and environmental protection, in addition to its importance in focusing on some aesthetic elements and sculptural forms. It also allows the use of the land from dawn until the end of the night to decorate the buildings and green areas it contains, and lighting can be arranged to attract people and thus achieve the desired behavior and appropriate activities for the natural scene. Moreover, appropriate lighting is also classified among the aesthetic aspects to complete the features of the natural scene to be one of the distinctive landmarks on campus by creating beautiful views at night [1].

2.Seating: It is an essential element in enhancing the effective use of the natural scene within the campus. The styles of these seats can vary, as they can be individual under trees or next to walls, or grouped around a fountain, or arranged along paths, or surrounding flower beds, or placed on edges in green areas or at building thresholds. It is essential that the number of seats is sufficient to accommodate at least 20% of the users of the natural scene at one time. Also, the aesthetic features of the seating attract users to sit on them, allowing them to interact with the coordination of the natural scene and the beauty of the design. These seats also contribute to providing a comfortable environment for relaxation, sitting, and talking in natural spaces for long periods, and the more the seats face each other, the greater the opportunities for dialogue and interaction between different groups of the university community. They also allow viewing beautiful scenery and observing people's movement. Seats and benches must be simple to use, strong, comfortable, and resistant to various climatic factors, in

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addition to their design being compatible with the surrounding [1,8].

3. Stairs, Bridges, and Terraces: These are design elements that connect different ground levels in natural scenes and give them variety and diverse visual effects. Most gardens are almost never without them, especially in natural areas with undulations or mountainous regions, as they help in free and safe movement from one place to another within the natural scene, in addition to being connecting elements between different levels of spaces. They are also used to define spaces and determine the degree of space enclosure, in addition to their role in achieving specific functions such as being used as seating areas. The purpose of introducing stairs into the design is to increase the aesthetic value of gardens. Small bridges are also used over streams or lakes, and these bridges take modern forms in the natural scene, such as beautiful stairs or terraces, which gives significant aesthetic and visual value to these natural scenes. As for terraces, they are supposed to be modern in their forms and features and blend with the natural slope to obtain a safe ground. Terraces are also supposed to integrate with green areas to prevent noise and add beauty to the terrace through their colors and shapes to give a wonderful sense of place [9].

4. Shading Elements: These are used to provide protection from strong sunlight and rain and can be natural through trees or artificial made from various materials depending on the need and desired design. These materials may include concrete, wood, plastic, tiles, or iron. Climbing plants can also be utilized, and these structures are used in pedestrian areas, seating and waiting areas, and parking lots, thus having a direct impact on the comfort of users of the university campus's natural scene, which enhances the efficiency of various activities and events. In addition, these structures are used to define spaces, and their shapes, coordination, and placement are influenced by the type of activity performed and their relationship with other natural elements [10].

5.Signage and Directional Signs: These have a significant visual impact on the natural scene and require careful study in selecting their shapes and placement to provide clarity and a positive impact on their function. Among the criteria to be observed in signage and directional signs to achieve sustainability in the natural scene: They must be clear in their lettering and use common and well-known languages and symbols, while avoiding any visual obstructions in front of them. It is also preferable to allocate specific areas for advertising on designated boards that do not go beyond their scope, while carefully studying them to attract attention. It is preferable to place them on pedestrian paths and in active scenes.In addition, advertising and directional signs should be installed with simple supports, such as fixing them to walls or floors, and lightweight materials should be used in their manufacture, taking into account the wind direction to prevent them from falling. It is preferable to group signs in unified locations as much as possible to ensure that attention is not distracted and to maintain the general appearance of the spaces [10]

6. Sculptural elements and artworks: These are features that distinguish natural landscapes, as they express something that may be religious, a personality, or an abstraction that expresses something related to the area where they will be placed. They are an aesthetic element with different forms and can be static or

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mobile, providing visitors to the natural scene with artistic enjoyment through the sensation of mass and its symbolic value. Sculptural formations also provide formative properties through movement
7.**Waste bins:** Their function is to maintain the cleanliness of the natural landscape and prevent waste from being thrown into it, which preserves its beauty. Care should be taken to choose a suitable design for them so that they are compatible with the other elements of the natural landscape and are characterized by
8. Other elements: These are functionally attractive elements as they meet the basic needs of natural landscape users and increase their stay in the place, thus increasing opportunities for interaction and communication. These include drinking water taps, cafeterias, restaurants, food and beverage kiosks, as well as restrooms, observation decks, flags, mailboxes, communication devices,

directed towards space and a visual and aesthetic impact that helps create relationships between them and the surrounding buildings, giving them a distinctive character [11].
simplicity, ease of use, and durability. Their placement locations should be chosen so that they are close to active areas and along movement paths, taking into account that there is an appropriate distance between them and seating areas to avoid their negative impact [10].

fountains, water basins, plant containers, movement barriers, clocks, and others. These elements must be consistent with the general character of the place, and their locations must be chosen so that they do not obstruct the view of other elements, with the necessity of having signs or directional indicators showing their locations [12].

Materials and methods

The University of Kufa was established in 1987 in the city of Najaf Al-Ashraf after the expansion of higher education and scientific research in Iraq, to establish a scientific and cultural edifice that contributes to the development of scientific and educational cadres. The University of Kufa is astronomically located between latitudes 29.50° and 32.15° North and longitudes 42.50° and 44.44° East, as shown in Figure (1).
Through a field survey of the site and its natural landscape, and conducting personal interviews with officials from the agricultural and engineering departments, several problems affecting the sustainability of the natural landscape were identified (Table 1). From the master plan

of the university campus (Figure 2), which contains several gardens, three of them (Zone 3, Zone 4, Zone 6) were selected to provide a design proposal that meets the requirements of the site's occupants and is compatible with the nature of the university environment. These gardens were chosen for several reasons, including :
1. These gardens are considered primary for the study site as they are a gathering place for university students from various scientific departments, as well as for holding parties, events, and special activities.
2. Their area is larger than the other gardens, such as the garden in front of the university presidency building (the Grand University Garden)

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Subsequently, an initial design was carried out for the three selected sites for the university campus landscapes according to the opinions of experts. After that, the design was sent to a sample of experts to express their opinions and suggestions regarding the proposed design. Their observations were recorded, and the design was finalized. .

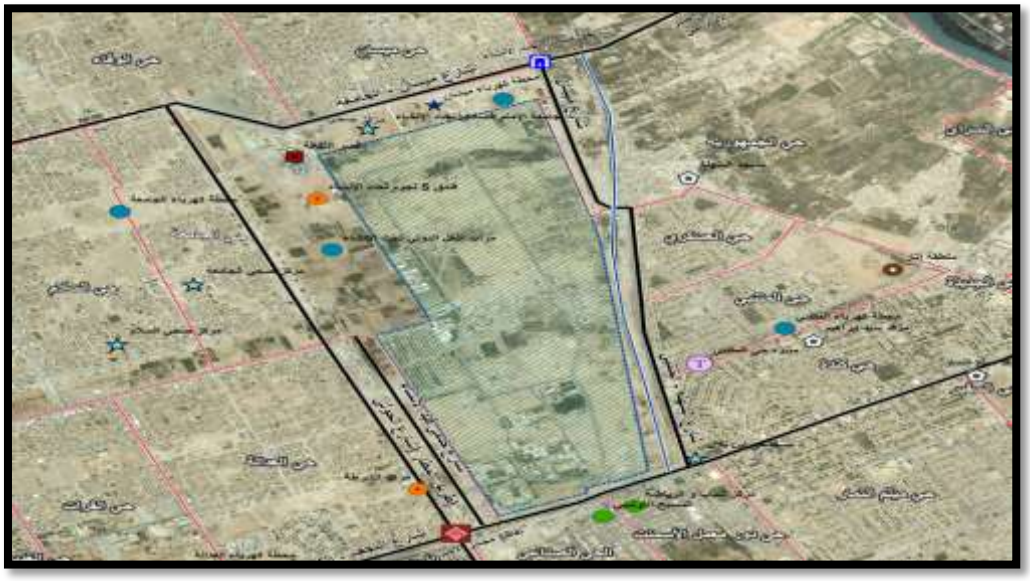

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Figure 1. The astronomical location of the University of Kufa

Zone 3 The heart of the university's green area, zone 4 An area dedicated to various youth activities, Zone 6 The garden in front of the university presidency

Figure 2. Illustrates the three landscape zones of the University of Kufa campus

Results and Discussion:

Results:

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Through a field survey of the study site, many problems related to the sustainability of the university campus landscape were observed from environmental, economic, social, and design perspectives, as shown in Table (1).

Table 1. Problems and obstacles affecting the quality and standers of the campus from various aspects

Environmental Aspects	Social Aspect	Economic Aspect	Design Aspect
Lack of Thermal Comfort	The campus lacks many important basic services.	Lack of use of alternative sources for electricity generation	Lack of parks and green spaces
Failure to Maintain Potable Water	Some buildings and landscapes on campus do not reflect the city's identity.	Lack of interest in waste recycling	A large number of parks are suffering from deterioration
Spread of Waste	The campus lacks a location that utilizes natural resources.	Use of expensive raw materials on-site	Failure to adhere to basic planning and design standards
Exposure of the Site to Different Wind Types	Weak communication between decision-makers and campus users.	Lack of joint cooperation mechanisms	Lack of irrigation water
Increased Gas Pollution			Lack of water in its various forms
Increased Water Consumption			
Lack of Greywater Treatment			
Lack of Visual Comfort			

Environmental aspect:

This includes the lack of thermal comfort for humans in natural landscapes due to the lack of green landscapes and plant diversity, especially shading and water elements. This causes high temperatures due to increased exposure to solar radiation and low relative humidity in the summer. Potable water is also not preserved due to its use in irrigating green landscapes. Waste is also widespread due to the random distribution of industrial components, such as waste bins. The site is exposed to various types of winds, especially hot, dusty westerly and northwesterly winds, due to the lack of afforestation and windbreaks around the university site, especially in the directions from which the prevailing winds blow. Furthermore, there is a lack of afforestation within the campus. Furthermore, there is

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increased gas pollution and a lack of oxygen due to the lack of plants. Furthermore, there is the impact of heavy vehicle and pedestrian traffic, especially at the northern entrance to the campus, which faces the prevailing winds. This generates heat and gases emitted by vehicle traffic, which are carried into the campus by westerly and northwesterly winds due to the lack of windbreaks and the lack of afforestation surrounding parking areas. The use of outdated methods for irrigating landscapes increases water waste and consumption. There is also the lack of a system for treating the site's gray water and reusing it for irrigating the landscape and cleaning the site. Furthermore, visual comfort is lacking at night, as most landscapes lack lighting.

Social Aspect:

The lack of use of alternative sources for generating electricity, such as solar, wind, and water. Despite the establishment of small solar power plants, these are insufficient to meet the university campus's electricity needs. Consequently, greater reliance is placed on diesel generators and the electricity received from national power plants in the governorate. There is also a lack of interest in recycling and separating waste, which is then disposed of despite containing a large amount of recyclable materials, such as agricultural waste. Expensive raw materials are used in landscaping, such as metal seating, when local, low-cost materials such as wood and natural stone could be used and focused on. There is also a lack of cooperation between investors and the university in developing the university campus by adding commercial, recreational, and sports services near the residential areas within the campus. The campus lacks many essential services that encourage its use and presence for the longest possible time, such as medical, commercial, sports, recreational, and cultural services. If they exist, they are very few and do not achieve the desired purpose. Some campus buildings and natural scenes do not reflect the cultural and historical identity of the city and the community within it. The campus also lacks the utilization of natural resources in its natural landscape, despite the richness the city enjoys in terms of the availability of heritage crafts and human skills. There is weak communication between decision-makers and campus users, and a lack of awareness about the importance of sustainability and the necessity of activating it due to its great importance in providing for present needs and ensuring the rights of future generations.

Economic Aspect:

The university campus lacks many important basic services that encourage its use and presence for the longest possible period of time, such as medical, commercial, sports, entertainment, and cultural services. If available, there are very few, and they do not achieve their intended purpose. Some of the buildings and landscapes of the university campus do not reflect the cultural and historical identity of the city and the community within it. The university campus, the study

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site, also lacks the exploitation of natural resources within its natural landscape, despite the city's richness in terms of the availability of traditional crafts and human skills. There is weak communication between decision-makers and campus users and a lack of awareness of the importance of sustainability and the need to activate it, given its great importance in meeting the requirements of the present and guaranteeing the rights of future generations.

Design Aspect (Landscape Design):

A field survey of the university campus revealed that the percentage of gardens and green spaces is 205,000 m². This percentage represents 8.576% of the total site area of 2,390,351 m². This means that the percentage of space allocated per person is 8.832 m², while the space allocated per person should not be less than 28 m², as approved by UNESCO. The University of Kufa includes a number of gardens spread across its site Figure (3), but a large number of them are suffering from deterioration. This is attributed to the following reasons:

1. The failure to properly employ basic planning and design standards in garden design, in addition to the clear shortcomings and neglect in applying the principles and rules of garden design.
2. The scarcity of irrigation water and the insufficient quantities of water for garden irrigation, especially in the summer. Furthermore, the use of saline well water for irrigation is often used to fill the water shortage.
3. Lack of skilled labor and inexperience.
4. Random planting of plants has led to the loss of many functional and aesthetic features of the gardens.
5. The gardens lack artificial lighting, drinking water points, and seating areas.
6. The lack of water in various forms, including fountains, ponds, water basins, and other elements, in some gardens, which plays an important role in improving the environmental and aesthetic functions of gardens.
7. The lack of drains to dispose of accumulated salts in the soil, which is one of the main reasons for the failure of many plants to grow in the site's gardens.

A-Lack of irrigation water and dryness of the green area

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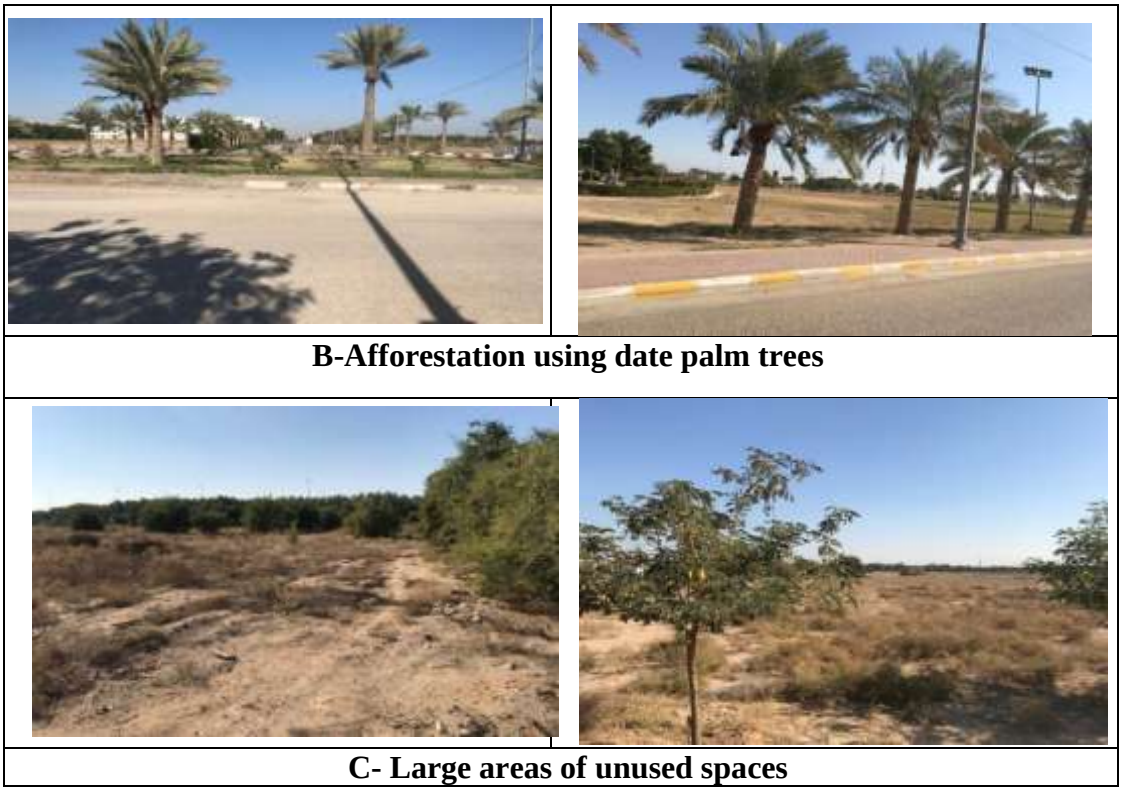

B-Afforestation using date palm trees

C- Large areas of unused spaces

Figure 3. Gardens on the campus of the University of Kufa

A proposal for the design of selected landscapes was presented to address the problems affecting the sustainability of the university campus landscape by employing afforestation in the landscape, as it can provide sustainability by achieving many functions including shading, privacy, and climate improvement, among others, and not focusing solely on the aesthetic aspect. Sustainability can also be achieved by focusing on planting local plants that can adapt to climatic conditions, as well as focusing on species that do not require large quantities of irrigation water, with the possibility of using recycled water for plant irrigation. Additionally, vegetation cover can be employed to reduce the impact of undesirable, dust-laden winds by using green belts of trees and shrubs, as well as planting plants with rough, light-colored leaves to reduce the sensation of glare resulting from intense solar brightness [13]. As shown in Figure (4-a and 4-b), Figure (5-a and 5-b), and Figure (6-a and 6-b), which illustrate the design of selected landscapes for Zone 3, Zone 4, and Zone 6 gardens in 2D and 3D formats.

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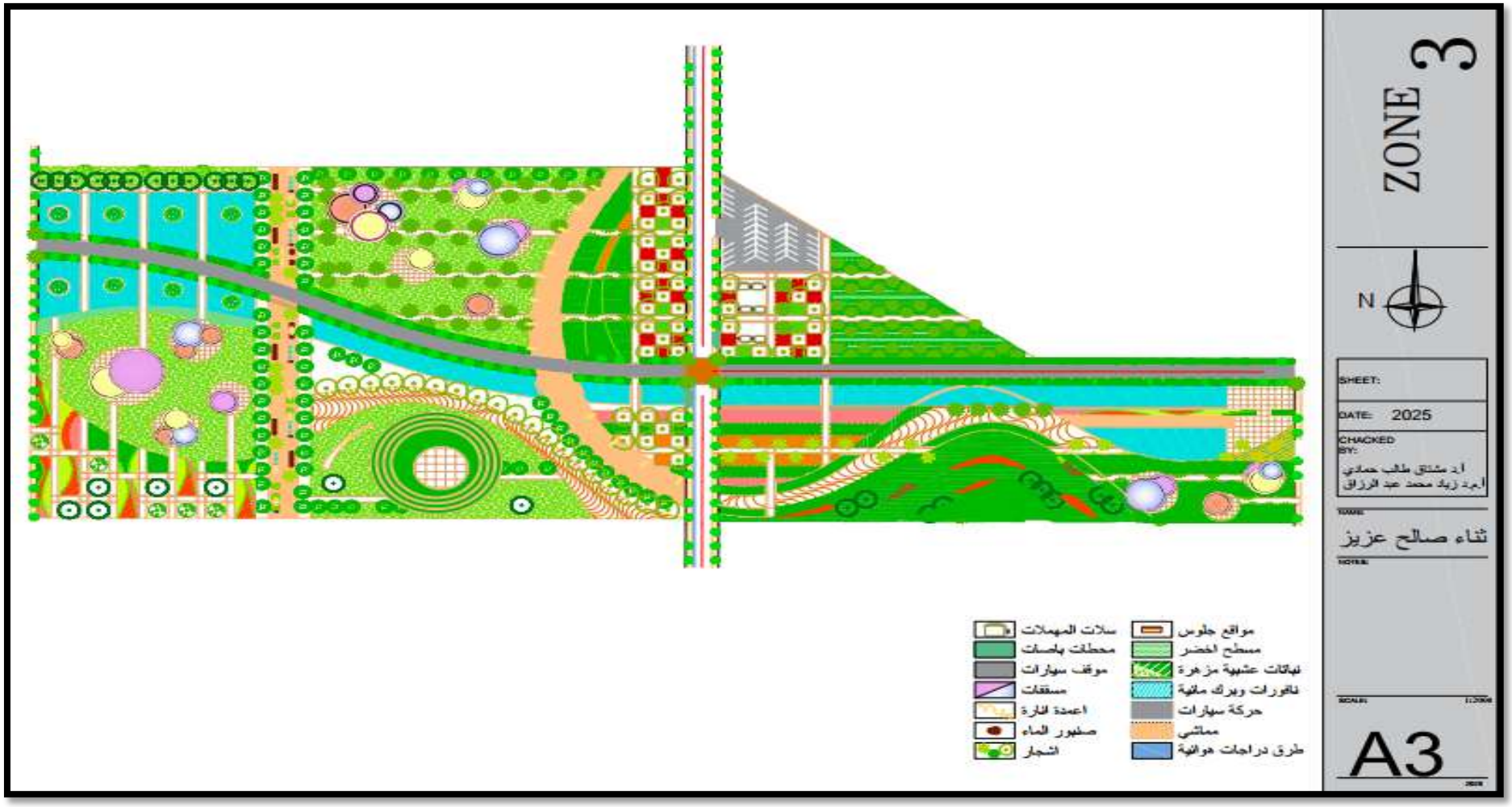

Figure 4-a. Proposed 2D design for Zone 3 site

Figure 4-b. Proposed 3D design for Zone 3 website

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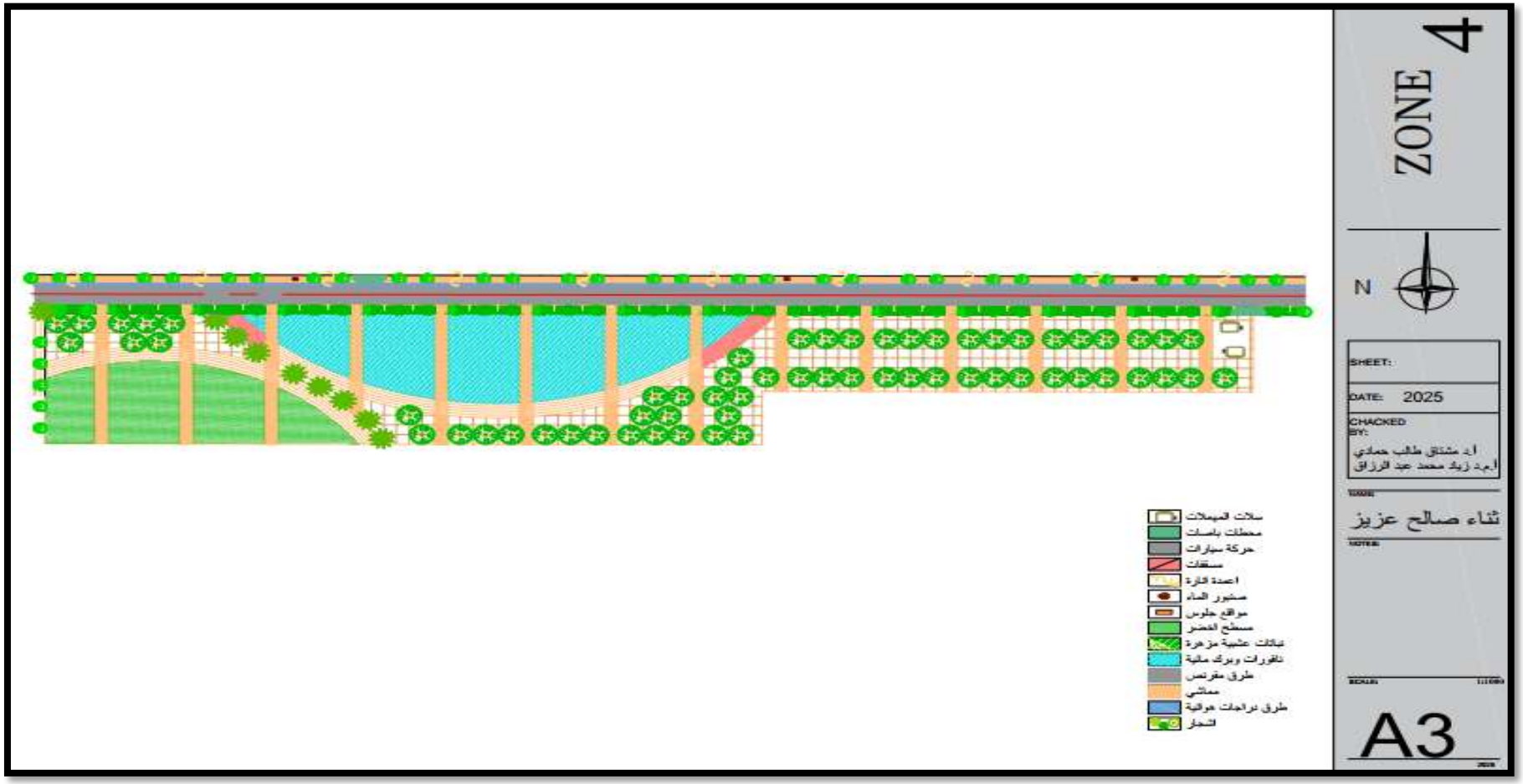

Figure 5-a. Proposed 2D design for Zone 4 site

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Figure 5-b. Proposed 3D design for Zone 4 site

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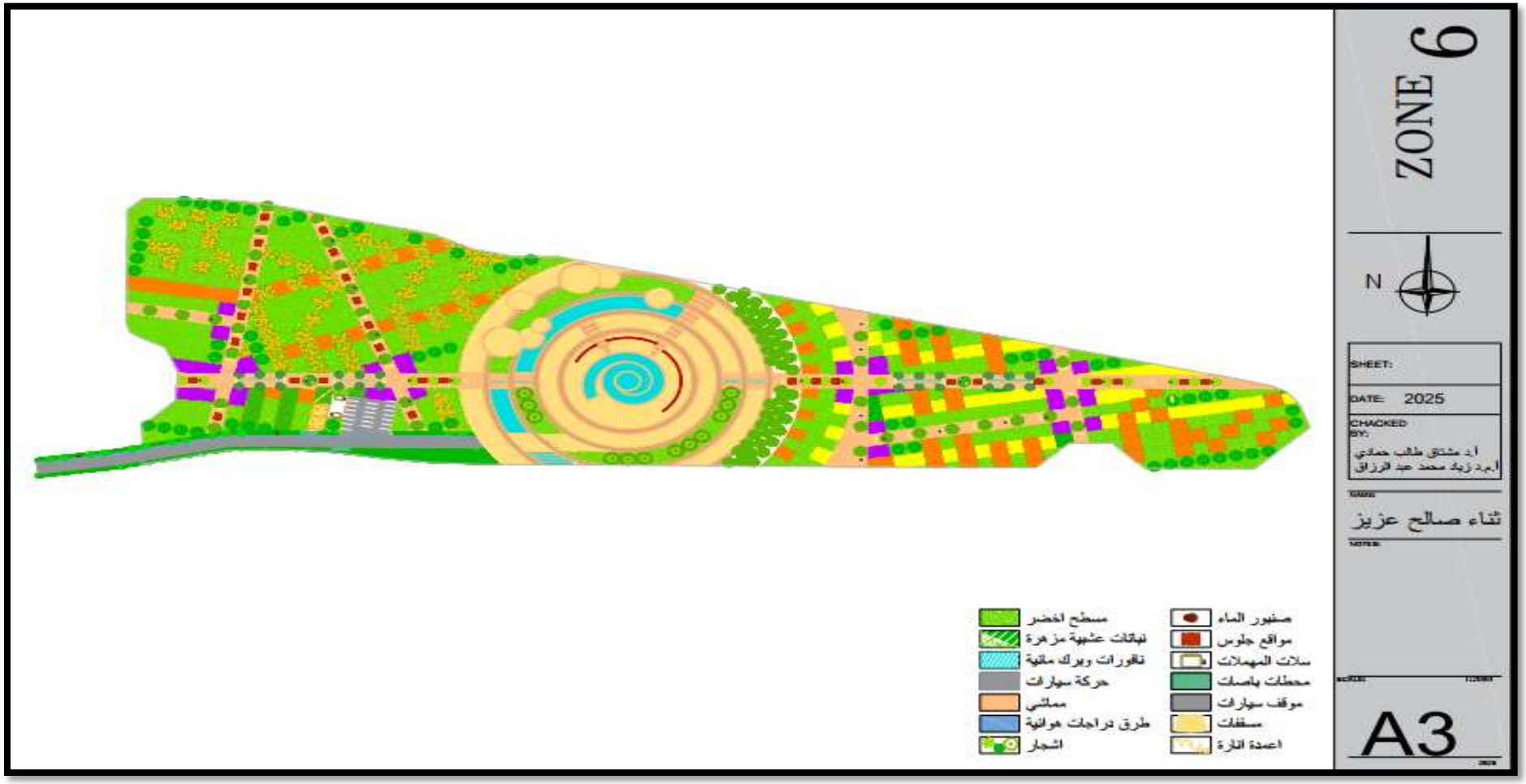

Figure 6-a. Proposed 2D design for Zone site

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Figure 6-b. Proposed 3D design for Zone 6 site

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Discussion:

Natural and artificial components were incorporated into the design of the selected natural campus scenes. Natural components include plants in their various forms, as they play an important role in mitigating the harmful effects of direct solar radiation. In addition, the vegetative cover of plants works to maintain temperature and prevent it from radiating outwards as it is consumed in the processes of photosynthesis and transpiration. The leaves and branches of plants absorb a quantity of sunlight and store it during the day, releasing it at night [14]. Furthermore, they play an important role in lowering temperatures by absorbing, reflecting, and scattering most of the incoming solar radiation, which results in shadows that vary with the hours of the day and seasons of the year. Temperatures in the upper part of the tree canopy are higher than below it during the day, while at night the opposite occurs, as thermal radiation radiates from the ground and remains confined between the tree canopies and the ground surface, thus the air temperature under the trees is higher than in open areas [15]. Moreover, they supply the air with water vapor through transpiration, which increases the relative humidity in the atmosphere. Therefore, we observe that the relative humidity among plants and under tree cover is higher than the relative humidity above the dry soil surface, with the maximum difference occurring in summer and almost disappearing in winter [16]. Plants contribute to social sustainability in addition to their role in environmental and economic sustainability by reviving and refreshing the psychological state of connecting with nature and the green environment by linking different sectors of the campus with the natural environment. This interconnectedness is considered a strategic experience in achieving a sustainable natural landscape that, in turn, provides multiple social functions in addition to environmental, economic, and aesthetic functions [17]. They also work to reduce unwanted visual effects and increase natural colors that bring comfort to the human eye, especially green, and reduce solar glare, among others [18]. In addition, the leaves, branches, and twigs of trees absorb sound wave vibrations, and the most effective plants in absorbing sounds or noise are those with dense, thick leaves and fine-stemmed hairs [19] .

The water element in its various forms, such as fountains, ponds, and lakes, was incorporated, as it is one of the natural components widely used in the natural landscape and an essential element in its design due to its positive effects on improving environmental conditions by increasing relative humidity and achieving thermal environmental balance based on wind movement and evaporation rate, in addition to its aesthetic role and its effect on the senses of sight and hearing, as well as its symbolic status that has enriched heritage as it represents life for these spaces, and it is an important focal point. Water itself does not have design features that allow us to deal with it independently without what contains it. Therefore, water in its designs depends on the environmental context that contains it. The visual characteristics of water are flexibility, movement, reflectivity, and

dynamism, and these characteristics are affected by the size, shape, and texture of the content, the surrounding air temperature and its movement, and also the existing lighting, whether natural or artificial [4,7].

As for the artificial elements, solar-powered lighting poles were placed on both sides of the street and pedestrian paths and inside the gardens to create a distinctive atmosphere day and night. The pedestrian paths were designed from locally available natural stones that can be recycled, while the seating benches were made of wood and iron, which are environmentally friendly and reduce the reflection of sunlight. Additionally, wooden canopies were placed over the pedestrian paths to reduce the penetration of sunlight, which helps in the free movement of site users. Waste containers were regularly distributed along the pedestrian paths and next to the seating benches to ensure the cleanliness of the site. The optimal utilization of these elements in the natural landscape provides a social climate that encourages various activities and events, while considering cost reduction and achieving economic sustainability by considering durability and using locally available and recycled materials and raw materials that do not require expensive maintenance, in addition to employing local crafts in the manufacture of artificial elements for the natural landscape to reduce costs and reduce the negative impact of the manufacturing process on the environment [20].

Conclusions

The study revealed a clear deficiency in the extent to which university landscapes achieve their design objectives due to the scarcity or absence of natural and artificial design elements in these spaces, which led to a decrease in their effectiveness and limited use. The study area was also characterized, based on climate data, by extreme temperatures between summer and winter, which affected design decisions. Furthermore, the capacity and materials of pavements and walkways did not comply with approved planning standards, in addition to the lack of protection for users from harsh conditions through natural or artificial shading. Moreover, environmental and social factors (needs and requirements) were not considered when planning landscapes, which affected their use. The study showed that sprinkler irrigation is the most efficient method for watering plants, especially in the harsh climate of the site. The study proved the necessity of providing an environment that meets the needs and desires of landscape users at the educational site. These requirements determine the type of natural environment needed for development to meet user needs.

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