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The Relationship between Shadow Analysis and Sustainability in University Campuses The Example of Selcuk University Alaeddin Keykubat Campus[#]

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ABSTRACT

Today's cities show an unplanned and rapid development in direct proportion to the development of technology. As a result of rapid and unplanned development, the natural silhouette of the cities has deteriorated and the proportion of reinforced concrete structures has increased day by day. For these reasons, putting green areas in the second plan causes some ecological problems for the city. The existence and sustainability of green areas are among the most important approaches that can reduce these problems. If we look at the concept of sustainability and its derivatives, the university campuses in the city give the appearance of a small city model and the green campus, sustainable campus, eco-campus, etc. that have emerged in recent years. Due to these concepts, in this study, "Selçuk University Alaeddin Keykubat Campus", located within the provincial borders of Konya, was chosen as the study area. The aim of the study was to determine the shadow lengths created by the buildings in the "Selçuk University Alaeddin Keykubat Campus" on the green areas and the new building or open green areas, and according to the light, shade and water requirements of the plants in the open green areas in line with the obtained data. Its contribution to ecological sustainability and green campus studies has been evaluated by revealing whether it is placed in areas with 2D (2D)-3D (3D) software and with different analysis techniques. In the light of the data obtained; It is seen that the shadow periods created by the buildings in Selcuk University Alaeddin Keykubat Campus are higher in December and February, and the shadow durations are less in other months. The shadow periods of the building's immediate surroundings are longer than the open areas. It has been determined that the species in the vicinity of the building are adversely affected by this situation. Plants are exposed to the sun, especially in the summer months, so the water demand and consumption of plants increases.

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Introduction

Today, cities develop in an unplanned manner depending on population growth, development of technology and urbanization movements. With the unplanned urbanization movements, the rate of concretization in cities is constantly increasing, and in parallel, green areas (road trees, pocket parks, agricultural areas, urban parks, campuses, green buildings, green roofs, etc.) are destroyed and their amount decreases. This situation negatively affects living life and human health, causing ecological problems such as air-water and noise pollution. Urban green spaces have many contributions to the solution of the city's ecological problems and climate control, to protect biological diversity, to create green area networks, to provide recreation opportunities to urban people, and to create livable and sustainable cities. In the new urbanization concept; In order to ensure the sustainable development of cities, it is very important to use renewable energy sources, reduce waste consumption, construct smart buildings, and ensure ecological sustainability, apart from the use of non-motorized transportation system.

The word sustainability means to ensure the continuity of diversity and productivity and to preserve the ability of people to be permanent (Holmberg and Sandbrook, 1992). The concept of sustainability was adopted in 1972 at the Stockholm Conference, the first global assessment of the environment. The concept was officially used for the first time in the report Our Common Future (Brundtland Report) prepared by the United Nations World Commission on Environment and Development (WCED) in 1987. The concept of sustainability is defined in this report as "the development process in which the needs of

the present generation can be met without compromising the ability of future generations to meet their needs" (WCED, 1987). Ecological sustainability is; It is defined as the conservation and sustainable use of ecological processes, biological diversity and natural resources that support life on earth (Costanza, 1999). Sustainable campus; it is also called as green campus, green campus, green university, environmentally friendly campus, eco-campus (Güler 2001).

Campuses evaluated on a small scale as an urban model; It fulfills basic functions such as education, accommodation, rest and transportation (Dober, 2000). Campuses are small laboratories that can develop rapidly and adapt easily to globalization and technological developments (Kurdoğlu & Çelik, 2016; Bayramoğlu & Kurdoğlu, 2018; Gömeli, 2018; Kurdoğlu et al., 2018/a; Kurdoğlu et al., 2018/b). ; Kurdoğlu et al., 2018/c; Kurdoğlu et al., 2018/d). Studies on sustainability have started since 1972, and higher education institutions have been involved in studies in this direction since 1990 (Alshuwaikhat & Abubakar, 2008; Lozano et al., 2013).

In this study, "Selçuk University Alaeddin Keykubat Campus" located within the provincial borders of Konya was chosen as the study area. The aim of the study was to determine the shadow lengths created by the buildings in the "Selçuk University Alaeddin Keykubat Campus" on the green areas and the new building or open green areas, and according to the light, shade and water requirements of the plants in the open green areas in line with the obtained data. Its contribution to ecological sustainability and green campus studies has been evaluated by revealing whether it is placed in areas with 2D-3D software and with different analysis techniques.

Material and Method

Material

Working area

Selcuk University Alaeddin Keykubat Campus, located in the north of Konya province border, was chosen as the study area by considering the campuses evaluated on a small scale as an urban model (Figure 1).

Established in 1975, Selcuk University Alaeddin Keykubat Campus is approximately 2,000,000 square meters. There are 23 faculties, 5 colleges, 7 institutes, 23 vocational schools and 53 application research centers in the campus. Transportation by motor vehicles is approximately 10 minutes to the International Konya Airport, 20 minutes to the Konya Intercity Bus Terminal, 30 minutes to the city center and approximately 25 minutes to the TCDD High Speed Train Station. It is also possible to reach by tram. Selcuk University, which plays an important role in the demographic, economic and physical development of the city, has been and continues to be effective in shaping the city form (Güneroğlu et al., 2018; Kurt Konakoğlu and Kurdoğlu, 2019).

Konya province is located in the Central Anatolia Region, in a location where the continental climate is dominant. Endemic plant species of the Central Anatolia Region and exotic species that do not belong to this region are located together in the campus green areas.

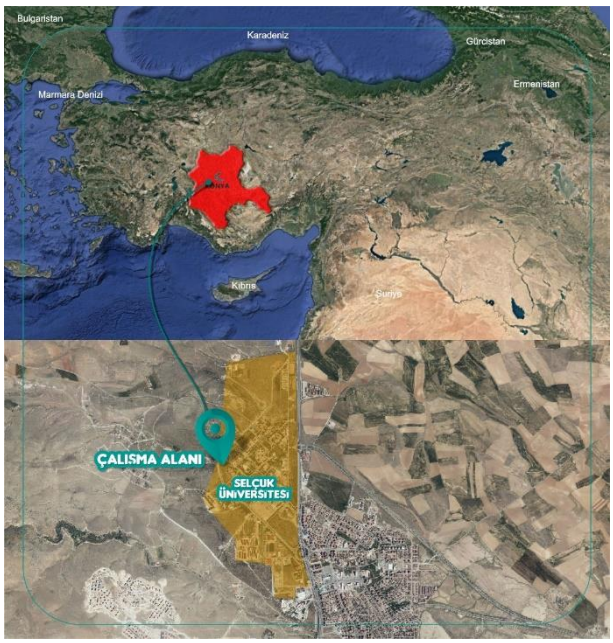

Figure 1. Satellite Image of Study Area

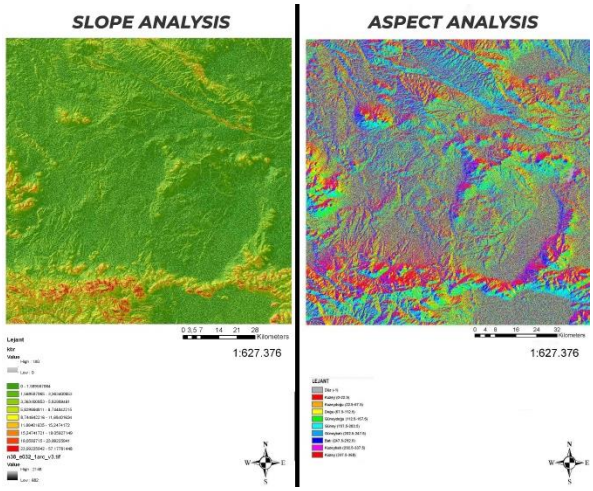

Figure 2. Slope and Aspect of Selcuk University Alaeddin Keykubat Campus

In addition to being rich in plant species diversity, the campus is also rich in bird, small mammal and rodent species. The fact that the campus is rich in both plant and animal diversity is an important detail in terms of ecological sustainability.

Slope and aspect analyzes were made in the GIS environment of Selcuk University Alaeddin Keykubat Campus. Since the city sits on a flat ground in general, there are no high slopes and elevation differences, but the trees around the buildings sit on almost the same elevations (Figure 2).

Method

In this study, it is aimed to reveal the contribution of the current plant status of the campus to ecological sustainability by determining whether the plants used in the green areas of the campus are positioned correctly in accordance with the shadow lengths they create on the green areas of the education buildings located in Selçuk University Alaeddin Keykubat Campus. In the first step of the study, the plant species in the campus were determined and photographs were taken from

different angles. In the second step, the buildings in Selcuk University Alaeddin Keykubat Campus were modeled in 3D (3D) with SketchUp and Lumion software. In the third step, the model created by the 3D structures was transferred to the Sketchup Pro 2021 program and 3D shadow analysis was performed according to different months of the year. Thus, by determining the shadow lengths of the buildings at different time intervals throughout the year, it has been determined how many hours of sunlight the plant species in the green areas receive on average per year. While performing 3D shadow analysis with the "Shadow Analysis" add-on in Sketchup Pro 2021 program, the time when the sun's rays are perpendicular for 6 months is taken as a basis.

Findings and Discussion

Findings

In the first stage of the study, the plant compositions in the campus were shown and the list of plants growing on the campus was determined (Figure 3).

In the second step, the plant species in the campus were determined and photographs were taken from different angles. In the second step, the buildings in Selcuk University Alaeddin Keykubat Campus were modeled in 3D (3D) with SketchUp and Lumion software. In the third step, the model created by the 3D structures was transferred to the Sketchup Pro 2021 program and 3D shadow analysis was performed according to different months of the year. Thus, by determining the shadow lengths of the buildings at different time intervals throughout the year, it has been determined how many hours of sunlight the plant species in the green areas receive on average per year (Figure 4).

Conclusions and Recommendations

In the light of the data obtained; It is seen that the shadow periods created by the buildings in Selcuk University Alaeddin Keykubat Campus are higher in December and February, and the shadow durations are less in other months. The shadow periods of the building's immediate surroundings are longer than the open areas. It has been determined that the species in the vicinity of the building are adversely affected by this situation. Plants are exposed to the sun, especially in the summer months, so the water demand and consumption of plants increases.

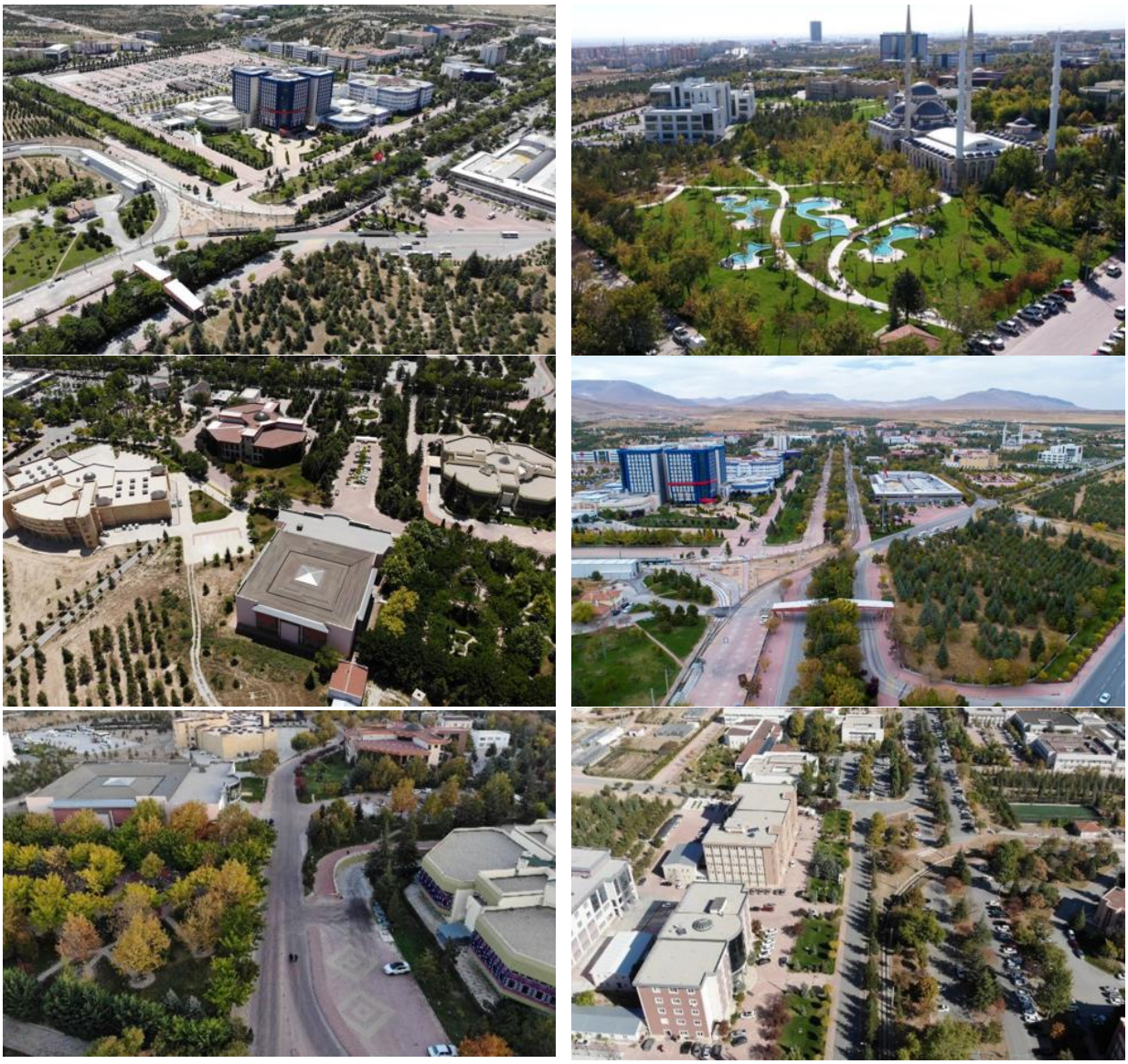

Figure 3. Views and Plant Compositions from Selcuk University Campus

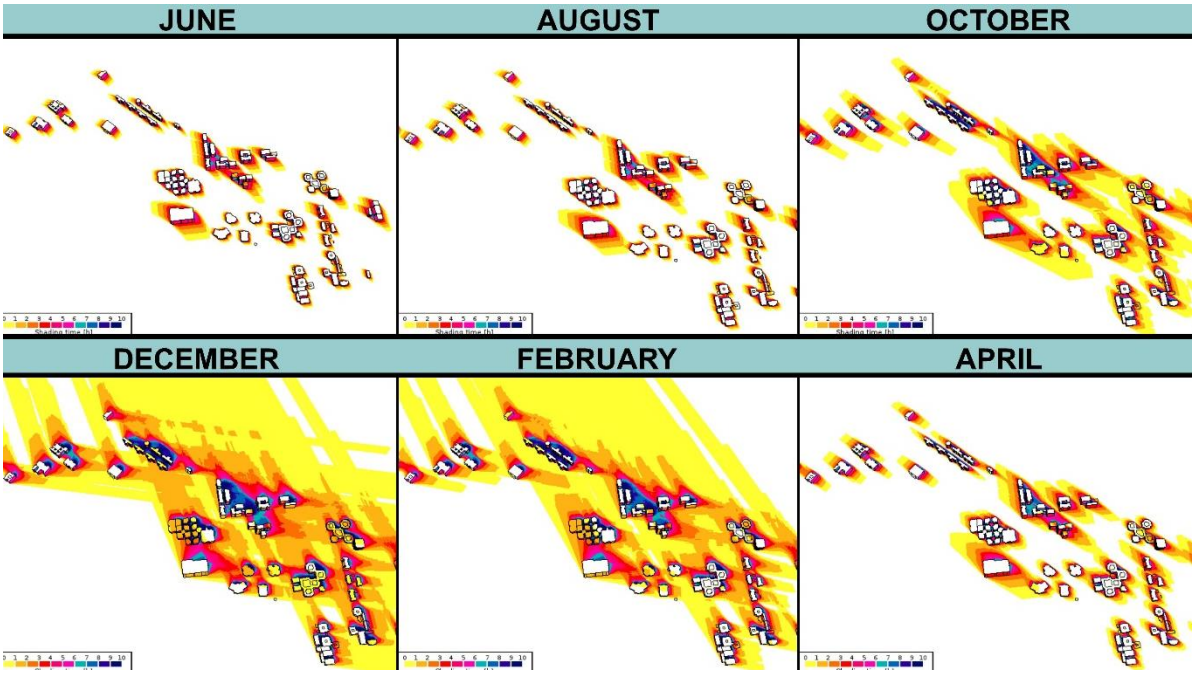

Table 1. Types of Trees Growing in the Campus

Broadleaf Trees	Coniferous Trees
Acer negundo	*Abies bornmülleriana*
Acer negundo 'Flamingo'	*Abies nordmanniana*
Acer platanoides	*Cedrus atlantica "Glauca"*
Acer pseudoplatanus 'Crimson King'	*Cedrus deodora*
Aesculus hippocastanum	*Cedrus libani*
Aesculus carnea Briotii	*Cupressocyparis leylandii*
Ailanthus altissima	*Cupressocyparis leylandii 'One ball'*
Albizzia julibrissin	*Cupressocyparis leylandii 'Spiralle'*
Betula alba	*Cupressus arizonica*
Catalpa bignonioides	*Cupressus arizonica 'Glauca One ball'*
Cercis siliquastrum	*Cupressus arizonica 'Glauca Spiralle'*
Cotinus coggygria 'Royal Purple'	*Picea abies*
Fraxinus americana	*Picea glauca*
Fraxinus excelsior	*Picea pungens*
Ginkgo biloba	*Picea pungens 'Glauca globose nana'*
Gleditschia triacanthos	*Picea pungens 'Hoopsii'*
Hibiscus syriacus	*Pinu Mugo*
Lagerstroemia indica	*Pinus nigra*
Liriodendron tulipfera	*Pinus nigra var.* 'Pyramidata'
Malus floribunda	*Taxus baccata*
Magnolia x soulangeana	*Thuja occidentalis 'Smaragd'*
Platanus occidentalis	*Thuja orientalis 'Pyramidalis aurea'*
Platanus orientalis	
Prunus cerasifera	
Prunus serrulata 'Kanzan'	
Robinia pseudoacacia	
Robinia pseudoacacia 'Umbraculifera'	
Salix babylonica	
Sophora japonica	
Tilia argentea	
Tilia tomentosa	
Quercus robur	

This situation increases the water consumption of the campus and causes the ecological balance to deteriorate as it consumes more water than it needs. In order to solve the need for water on campus within the framework of ecological sustainability approach, rain water should be collected and used for irrigation, plant species suitable for the Central Anatolian climate, shade and water consumption should be preferred.

In the selection of plant species to be used in cities or campuses, shade analysis of buildings and planting plants in this direction is an important approach in landscape architecture studies. With this study, the importance of 3D shadow analysis in the design of green areas has been revealed. Connecting green spaces on campuses will make campuses more readable, more educational and ecologically sustainable.

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