JOURNAL OF SOCIAL AND HUMANITIES SCIENCES RESEARCH
Uluslararası Sosyal ve Beşeri Bilimler Araştırma Dergisi

ISSN:2459-1149

Article Type	Received / Makale Geliş	Published / Yayınlanma
Research Article	30.11.2019	20.02.2020

http://dx.doi.org/10.26450/jshsr.1767

Citation: Atasoy, M. (2020). Geophytoscape: a new insight into the landscape design process and implementation model for case study. *Journal of Social and Humanities Sciences Research, 7*(50), 214-223.

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GEOPHYTOSCAPE: A NEW INSIGHT INTO THE LANDSCAPE DESIGN PROCESS AND IMPLEMENTATION MODEL FOR CASE STUDY

ABSTRACT

The improvements in physically sufficient and high-standard outdoor arrangements play an important role in visual landscape quality and design. In order to create a landscape design comprising of interpretative plant-geography, researchers often establish an outdoor geoscience laboratory to teach rock identification, mapping activities, interpretations of landscape features and subsurface geophysical structures in the field. However, there is a lack of an interpretative term to determine and manage the relationship between the characteristics of applied plant species composition and history and characteristics of the rocks. The main purpose of this study is to propose a new term called *"Geophytoscape"* to the landscape design field and apply an example of landscape design project in Osmaniye, Turkey that can increase the understanding of knowledge associated with the proposed term. The methods of Geophytoscape garden project implementation consist of three phases: 1) Site selection and preparation, 2) Selection of plant species and native rocks, and 3) Application process of Geophytoscape design. Within the scope of the designated project, it was demonstrated that a Geophytoscape garden can be a valuable landscape feature that includes a historical and regional relationship between rock characteristics and plant species being applied to the landscapes. Also, designing a naturalistic Geophytoscape garden is more than solely arranging the metamorphic rocks and plants in a random design. In order to create a satisfying naturalistic garden, basic design principles are very important in reducing the artificial effects of the designated garden.
Keywords: Geophytoscape; Interpretative geography; Landscape design; Spatial arrangement; Visual quality

1. INTRODUCTION

For centuries, investigating the species senescence and terms used to identify transoceanic dispersal of plant species have been argued by scientists. Methods applied to derive these definitions have strived for identifying "interpretative plant-geography". Also, a branch of botany, "Phytogeography" revealed which is defined as *"a term used to observe and analyze the behavior of plants in motion over the maps of the past and the present alike"* (Croizat, 1952, p.528). Additionally, GeoScape, which is a landscape design approach comprising of colored gravels applied to an area with boulders and flagstones, gained momentum in the landscape design field (Calderone et al, 2003). More importantly, since the metamorphism of the rocks, archaeologists have reconstructed ancient artefacts on the purposes of chromatic variations, landscape compositions, and derived objects (Gungor and Polat, 2018; Lee, Ishii, Duun, Su & Ren, 2011).

GeoScape term has commonly been used to improve the geological knowledge of undergraduate and graduate students. In many cases, the instructors establish an outdoor geoscience laboratory to teach rock identification, mapping activities, interpretations of landscape features and subsurface geophysical structures in the field (Smith, 2014; Wenning, 1998). Also, the improvements in physically sufficient and high-standard outdoor arrangements play an important role in visual landscape quality (Atasoy, 2018; Atasoy, Anderson & Atasoy, 2018; Gungor and Polat, 2017). One of the examples of these outdoor design concepts are rock gardens, and they can be defined as gardens which consist of various sizes of rocks with plants growing accordantly (Hitching, 2012). The rock gardens are designed in the concept of definiteness of scheme which must have a plan (Farrer, 2008). Furthermore, Japanese rock gardens are other examples of the outdoor design of GeoScape models that have an arrangement of the rocks applied with integrity and reflectance of the architecture of buildings nearby (Van Tonder, Lyons & Ejima, 2002).

Considering the definitions provided in the literature so far, there is a lack of an explanatory term in the landscape design field to identify and manage the relationship between applied plant species composition with history and characteristics of the rocks. Therefore, the main purpose of this study is to propose a new term to the landscape design field and apply an example of landscape design project in Osmaniye, Turkey that can increase the understanding of knowledge associated with the proposed term.

2. MATERIAL AND METHODS

2.1. The Geophytoscape Term and Etymology

I, therefore, propose the designation "Geophtyoscape" which can be defined as landscaping designed specifically to create a relationship between metamorphic rocks and plant species composition within the scope of regional belonging and conformity. The name is derived from the Greek *geō-*, the earth; and the *phyton*, the plant. The principles of Geophytoscape design can be classified as follows: 1) the metamorphic rocks should belong to the region of landscape design application, 2) the plant species need to be selected among the native plants of the region, and 3) the relationship between landscape design materials should follow the fundamental principles of design which are balance, proximity, alignment, repetition, contrast, and space. The proposed principles and criteria are the distinguishing factors of Geophytoscape term from the other terms such as "GeoScape" and "rock garden" in the literature.

2.2. The Case Study

2.2.1. Study Area

This study was conducted at Osmaniye Korkut Ata University campus in the city of Osmaniye, Turkey (Figure 1). The city of Osmaniye is located on the eastern edge of the Çukurova plain in the Mediterranean region of Turkey. The city is surrounded by Gaziantep to the east, Kahramanmaras to the north, Hatay to the south, and Adana to the west. The city is lowland and flat and the altitude of the study area is 121 m. The vegetation of Osmaniye is classified in three categories: cultivated plants on plain bases, maquis on threshold zones, and conifers on high altitude landscapes (Atasoy, 2019; Osmaniye Municipality, 2019).

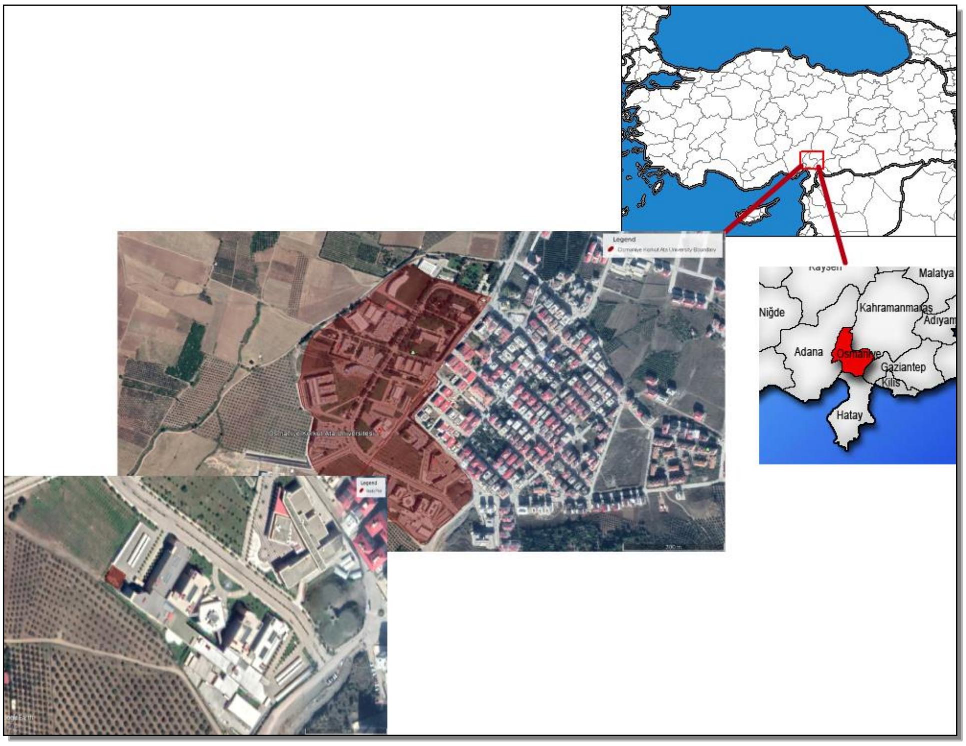

Figure 1. Location of Study Area and Study Plot Located in Osmaniye Korkut Ata University Campus, Osmaniye, Turkey.

2.2.2. Application Process of Geophytoscape Garden Project

Phase 1: Site Selection and Preparation

The first step of the application procedure was the site selection which is located at Osmaniye Korkut Ata University campus. The study plot ($10x13=130\ m^2$) was established on the landscape area nearby the Architecture, Design, and Fine Arts building along with identifying locations of the current plants and landscape structures such as arbours, benches, and paving materials in the garden. The second step was the site preparation during which the area is cleaned from the invasive plants by plant removal and herbicide application. The small patch allocated for the design of rocks and associated plant species were delineated with lime dust. Then, distance to the present walking trails was measured by using tape meter and marked with wood sticks.

Phase 2: Selection of Plant Species and Native Rocks

The rocks used in this study are native metamorphic rocks, called "Rosso Turkish Levanto" and derived from Çağşak Village of Osmaniye. The Rosso Turkish Levanto rock is a dark red metamorphic rock featuring random linear white veining textures (Figure 2). The dark red color is originated from hematite mineral in the rock and these serpentine rocks have a complex history (Erdogan and Yasar, 2001; Pivko, 2003).

Figure 2. The Rosso Turkish Levanto Rock (Margraf, 2019).

The plant species applied to the study plot were also chosen from rock garden plants and the majority of the species were Mediterranean plants (Table 1). Also, in order to apply the fundamental principles of landscape design such as balance, proximity, alignment, repetition between species diversity and rocks' features, plants were selected among the species with red flowers or leaves. During the selection of species diversity, time of bloom, flower and foliage color, and plant shape were considered. The primary focus was to coordinate colors with the Rosso Turkish Levanto rocks and apply plants by blooming periods for a uniform display of flowers throughout the year. The framework of Geophytoscape design principles was introduced by implementing metamorphic rocks and regional plants in the same study plot.

Table 1. List of Plant Species Applied to the Study Plot.

Species Name	Family	Growth Form
Agave americana	*Asparagaceae*	Shrub
Abelia grandiflora	*Caprifoliaceae*	Shrub
Acer platanoides 'Crimson King'	*Sapindaceae*	Tree
Buddleja davidii	*Scrophulariaceae*	Shrub
Berberis thunbergii 'Atropurpurea Nana'	*Berberidaceae*	Shrub
Cyperus alternifolius	*Cyperaceae*	Grass-like
Celosia argentea	*Amaranthaceae*	Annual
Cedrus atlantica 'Glauca'	*Pinaceae*	Tree
Cordyline australis 'Red Star'	*Asparagaceae*	Perennial
Cercis siliquastrum	*Fabaceae*	Tree
Cupressus sempervirens 'Stricta'	*Cupressaceae*	Tree
Dracaena marginata	*Asparagaceae*	Shrub
Erythrina crista 'Galli'	*Fabaceae*	Tree
Euonymus japonica 'Var. Aurea'	*Celastraceae*	Shrub
Hebe pinguifolia 'Sutterlandii'	*Plantaginaceae*	Shrub
Iris germenica	*Iridaceae*	Perennial
Lavandula angustifolia	*Lamiaceae*	Perennial
Magnolia grandiflora	*Magnoliaceae*	Tree
Prunus cerasifera 'Atropurpurea'	*Rosaceae*	Tree
Salvia splendens	*Lamiaceae*	Perennial
Vinca sp.	*Apocynaceae*	Perennial

The location of plant species, arrangement of rocks, and current study plot landscape features such as arbours, plants, walking trail, and benches were designated in 3D view format using Realtime Landscaping Pro version 2018 software (Figure 3). In order to illustrate the framework of design, plan, front-side, left-hand side, and right-hand side views were created and a legend of plant species was provided on the plan view of the Geophytoscape design project. These views were included to reveal more details considering the fundamental design principles suggested with the proposed Geophtyoscape term.

LEGEND	
Agave americana	3
Abelia grandiflora	3
Acer platanoides 'Crimson King'	3
Buddleja davidii	9
Berberis thunbergii 'Atropurpurea Nana'	19
Cyperus alternifolius	5
Celosia argentea	5
Cedrus atlantica 'Glauca'	2
Cordyline australis 'Red Star'	3
Cercis siliquastrum	2
Cupressus sempervirens 'Stricta'	5
Dracaena marginata	2
Erythrina crista 'Galli'	1
Euonymus japonica 'Var. Aurea'	22
Hebe pinguifolia 'Sutterlandii'	13
Iris germenica	5
Lavandula angustifolia	20
Magnolia grandiflora	5
Prunus cerasifera 'Atropurpurea'	3
Salvia splendens	11
Vinca sp.	9

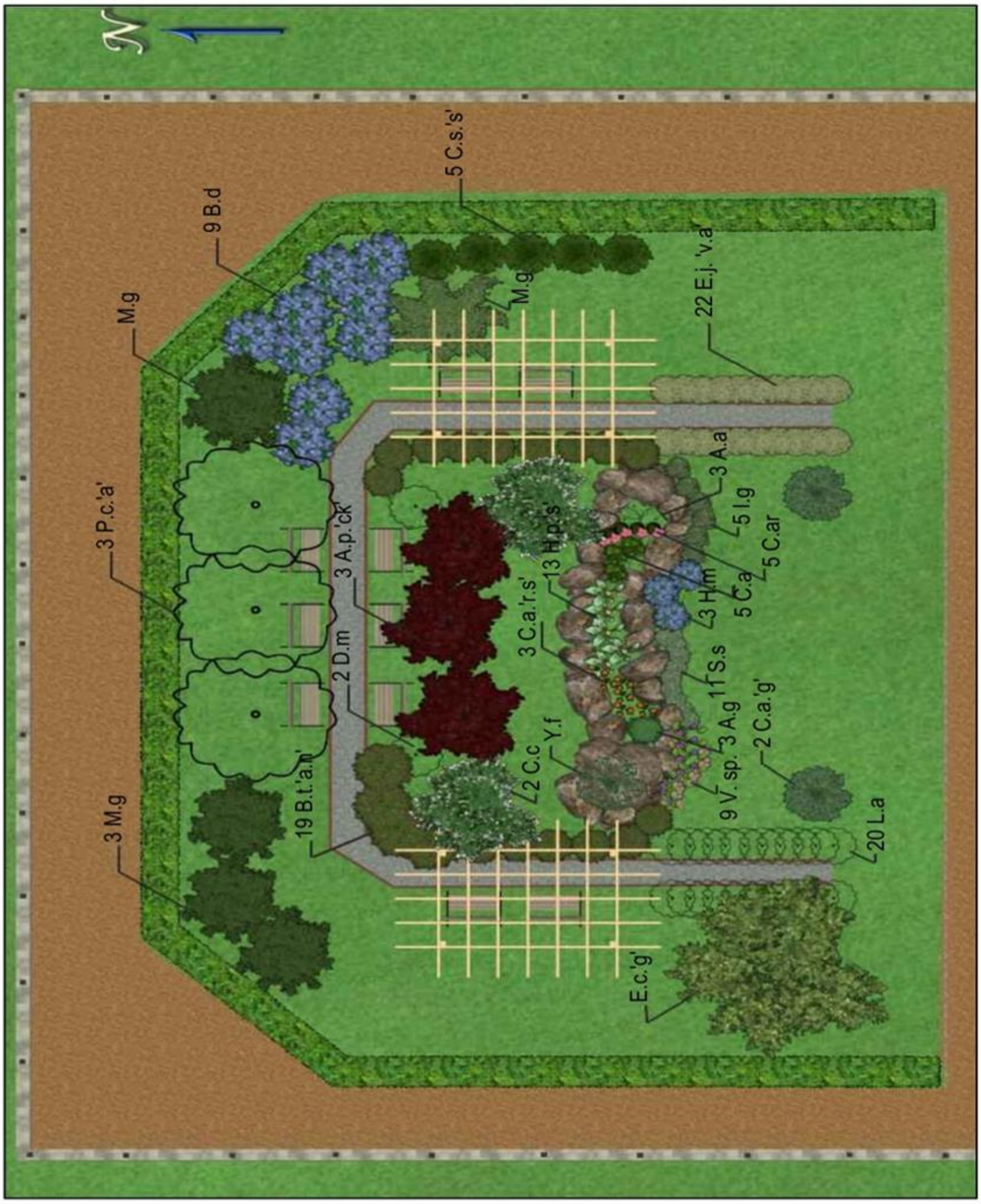

Figure 3. Plan View of the Geophytoscape Design Project and Legend of Applied Plants.

Phase 3: Application Process of Geophytoscape Design

By using the illustrations of the project designed in Phase 2, during this phase, first, the rocks having random sizes were established on along with the marked lime dust borders on the study plot. Then, the largest rocks were placed as dominant objects and aligned with the strata of small rocks as applied in Van Tonder and Lyons (2005). To create consistency for natural design, the rocks were unevenly arranged and the background plants were applied with a composition of conifers, deciduous trees and shrubs. In order to remove the invasive plants spreading in the study area, herbicide treatment was applied. Once the soil was cleaned, the appropriate and well-drained and gravelly soil was implemented by mixing equal parts of sand or fine gravel with the soil and distributed over the garden at a depth of 12 cm. This mixture was prepared to provide an efficient way of water retention and long-term water absorption by plant roots in the garden.

After preparing the plantation points adjacent to the rocks, three layers of plants were created. The first layer consists of small size annual and perennial plants whereas the second layer was planted with medium size shrubs to increase the aesthetic view of the garden. The planting spaces between species were widely distributed to minimize the competition for nutrition among the plant roots. The last layer was considered as the background plants including conifers and deciduous trees. The plant species were informally arranged in placement and species diversity to maintain the natural view of the Geophytoscape design.

3. RESULTS

The implementation results and 3D views of the Geophytoscape project were provided in Figure 4, Figure 5, and Figure 6. Based on the Geophytoscape and fundamental principles of landscape design, the homogenous garden design was created by implementing balance, proximity, alignment, and repetition between plants and Rosso Turkish Levanto rocks in the study area. Plants were selected among the species with red flowers or leaves to coordinate the Geophytoscape principles throughout the garden.

Figure 4. Front View of Geophytoscape Design Illustration

Figure 5. Front View of Geophytoscape Design Application

a) Left-side View of the Application Result

b) 3D Left-side View of Design

c) Right-side View of the Application Result **d)** 3D Right-side View of Design

Figure 6. Illustrations of Side Views (figure 6-a, figure 6-b, figure 6-c, and figure 6-d) for Designated and Applied Geophytoscape Garden Project

4. DISCUSSION AND CONCLUSIONS

In this study, a new term to the landscape design field, Geophytoscape, was proposed and an example of landscape design project associated with this term was applied to increase the understanding of knowledge of the proposed term. Within the scope of the designated project, it was demonstrated that a Geophytoscape garden can be a valuable landscape feature that includes a historical and regional relationship between types of rocks and plant species being applied to the landscapes. Also, designing a naturalistic Geophytoscape garden is more than solely arranging the metamorphic rocks and plants in a random design. In order to create a satisfying naturalistic garden, basic design principles are very important in reducing the artificial effects of the designated garden.

According to Dillon, Hicock, Secco & Tsujita, (2010), a traditional laboratory demonstration using metamorphic rocks can help extract the geological insights from the garden. Geological demonstration and natural heritage protection are also very essential to transmit geological knowledge with accessible information to the non-specialized public (Moliner and Mampel, 2019). Chylińska and Kołodziejczyk (2018: 307) concluded that *"You cannot expect people to support the conservation of something they do not understand. So raising public understanding of urban geology and geodiversity is of paramount importance if urban geoconservation is to be successful".* The findings of this study demonstrate that dissemination of both geoheritage and associated phytology knowledge can be achieved by the implementation of Geophytoscape gardens encouraging scientific research and aesthetically pleasing views to the public.

Geophytoscape garden project can gain insights about underlying landscape design processes in a natural area by playing an important role in exploring the adaptation of plants and natural rocks to the region. The aesthetically pleasing arrangement of Geophytoscape design can enhance the visual quality of contemporary landscape gardens by correlating fundamental design principles with the history of metamorphic rocks and adaptive plants. This geological design can also act as an outdoor learning classroom for rock and plant identification purposes. Therefore, the geoheritage of local or regional landscapes including metamorphic rocks and regional plants are sustainably preserved with the cooperation of education and non-specialized community.

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