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The Importance of Biotope Mapping from the Viewpoint of Protection of Urban Environment and Sustainable Urban Development: The Case of the City of Kahramanmaraş

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Abstract

This study aims at the analyzing and mapping of biotopes in the city of Kahramanmaras, Turkey. Three main and 25 sub biotope types were identified which characterize general structure of the study area. High resolution satellite image was used for obtaining ground information on urban biotopes. The biotopes were analyzed from the viewpoint of areal coverage, number of parcels, and vegetation cover. According to results, agricultural areas are the main biotope group that covers the largest area (4270.96 ha) among all biotopes, what follow this biotope group are non-built-up areas (3181.66 ha) and built-up areas (2694.42 ha). From the viewpoint of total number of parcels, it was seen that the built-up areas biotope group has the highest number with 18,170. Our results revealed that rapid encroachment of urban areas and agricultural activities have caused a decrease in the areal coverage of the some biotope types, and in the distribution areas and samples of the some natural plant species. It is concluded that biotope maps should be used as a basic tool in planning and management of land uses to protect the living habitats for continuity of natural ecosystems.

Keywords: Land use change, urbanization, remote sensing, Bornova, İzmir

INTRODUCTION

Biotopes are generally described as a part or element of the environment which create suitable conditions for living organisms to be nourished, to shelter, to protect one another, and to contact with each other, and can be limited according to their functional point of view [1]. The biotopes which also symbolizes the species and habitat diversity are in great importance for the cities creating habitats for wildlife, establishing a link between rural and urban environment, generating recreation areas, ameliorating climate in cities, and contributing to the aesthetics of urban areas [2, 3, 4]. Although biotopes play an important role for having healthy living conditions in the cities, negative effects of the environmental interactions originated from urbanization displayed the need for the studies directed to protection of the urban biotopes. The studies realized with this point of view emphasize the importance and the roles of biotope mapping in planning practices in determination of thresholds regarding to use and the protection balance [5], in providing persistence of ecosystem functions as well as flora and fauna characteristics [6], and in helping to take the most suitable decisions about sustainable land use (LU) structure [7]. The use of biotope maps in urban and regional planning studies as the base, which is started in Europe in 1970s, is an approach performed and recommended worldwide [2, 6, 8, 9].

Intricate LU structure of the cities is the most important factor which makes difficult the classification and analysis of the urban areas. In this sense, mapping of urban biotopes reliably necessitates to make a detailed classification. Therefore, remote sensing (RS) and geographical information systems (GIS) are used widely to create the maps with high accuracy and to integrate them to the nature conservation and urban planning studies easily [9, 10, 11], and the benefits provided by these tools are emphasized in technical reports [12].

This study aims at the mapping and analyzing of biotopes in Kahramanmaras (K.Maras) urban area where an impressive LU change occurred against the natural landscape potential, as a result of rapid population increase and urbanization. The study which performed with the help of RS and GIS mainly consists of four steps: (1) To identify the biotope types which display the structural characteristics of the study area, (2) to analyze vegetation cover for describing the biotopes from the viewpoint of their natural features, (3) to map the biotopes to analyze their areal amounts and positions, and (4) to determine some guidelines for providing sustainable environment conditions from the viewpoint of biodiversity and urban LU management.

MATERIALS AND METHODS

The study area

The study area with 10,333.5 ha of land, the city of K.Maras, is situated in the Eastern Mediterranean region of Turkey, and surrounded by forest cover in outskirts of Ahir mountain with 800 m altitude in the north, alluvial K.Maras plain with 500 m altitude in the south and the east, and Sir Dam Lake in the west (Figure 1).

The average annual temperature is 17.2 oC while the sum of annual precipitation is 737.6 mm, and the annual relative humidity is 60% [13]. Outskirts of the Ahir mountain consist of metamorphic and sedimentary rocks including schist, serpentine, limestone, sandstone, marl, conglomerate while alluvial deposits with I, II and III. land capability classes are dominant in the plain. K.Maras urban area has relatively inclined land type due to situating on outskirts of the mountain, and areas with a slope of more than 6% constitute 50% of the total area [14, 15].

There are three vegetation zones in the region: shrub, forest and alpine formations [16]. Shrub formation is situated between the altitudes of 500 and 1200 m, and mainly consists of Quercus coccifera, Q. infectoria, Styrax officinalis, Rhus coriaria, Phillyrea latifolia and Paliurus spina-christii. Forest formation begins in 800-900 m and mainly consists of

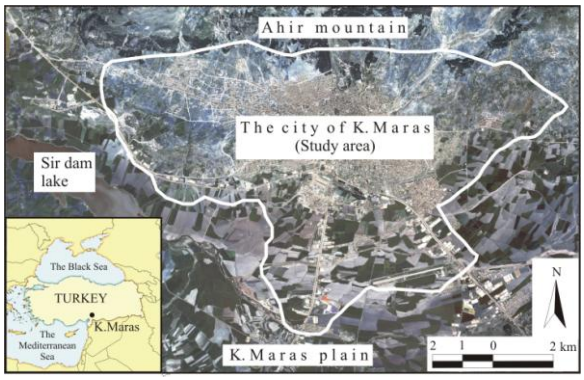

Figure 1. Location of the Study Area.

coniferous species dominated by Pinus brutia, besides, there are also some other species such as Pinus nigra, Pinus pinea, Cedrus libani, Abies cilicica and Juniperus excelsa. Alpin formation takes place above the upper limits of forest, 2000-2100 m. Astragalus sp., Acantholimon sp., Trifolium sp., Gallium sp., Festuca sp., Campanula sp. and Viola sp. are the common species of this formation.

In K.Maras, the urban population increased by 11-fold from 34,641 in 1950 to 420,000 in 2011. LU types have been also changed dramatically in the city and its surrounding region. According to a study [17], urban build-up areas have increased more than two times from 1571.78 ha in 1989 to 3526.38 ha in 2004. Besides, another study put forward that urban area increased by 708.22 ha between 1985 and 2006, while olive groves decreased by 116.09 ha [18].

Methods

Identifying biotope types

To identify the biotope types, it was benefited from island biogeography and landscape patch definitions which enable to describe and to limit the biotopes as detached habitats [18]. Within this context, 25 sub biotope types were identified which characterize general LU structure of the study area. Afterward, biotope types were grouped into three main headings from the viewpoints of their structuring levels and features: i) "Built-up areas" which directly formed by the people, has structures on it and, has been used with high or low density, ii) "Non-built-up areas" which formed by the people or natural processes, abandoned or it is not possible to use due to natural or legal reasons, and iii) "Agricultural areas" which formed by the people, however, differentiate from other biotopes with their functions and features. Built-up areas main heading was also divided into three sub headings to combine some similar sub biotope types: Settlements, Transportation, and Green Areas.

Vegetation cover analysis

Vegetation cover analysis were performed on a transect which contains sample areas for each sub biotope types. The analysis were realized in April-July period. A survey form has been used for compiling the data regularly belong to sample areas and vegetation cover. The species identified in-situ were recorded into forms, and the other unidentified species were taken into herbarium and then, they were described with the help of "Flora of Turkey and the East Aegean Islands" [20, 21]. Finally, the results of the analysis performed in the sample areas for each sub biotope type were associated with other similar biotopes, thus generalizing vegetation cover feautures on the basis of map for whole area [22, 23].

Mapping biotopes

The 2006 Quickbird image with 0.6 m resolution was used for obtaining ground information. Object-based analysis method was preferred in the classification process, which gives more succesful results in high resolution images with respect to classical pixel-based classification.

Biotope mapping studies mostly contain manual operations which consist of correcting vector data obtained by object-based classification method. For example, to avoid the potential confusions, transportation lines were excluded from classification procedure, and they were digitized manually. However, although field surveys were performed for each sub biotope types, some biotopes could not be distinguished in image classification procedure, and statistical information that belongs to these sub biotope types was evaluated as a whole (e,g., Transportation and buildings with garden).

RESULTS AND DISCUSSION

According to results obtained, agricultural areas have 4270.96 ha and cover the largest area among all biotopes, non-built-up areas have 3181.66 ha, and built-up areas have 2694.42 ha. This situation, puts forward that the rate of urbanization in the study area is about 1/3 (Table 1) (Figure 2). On the other hand, built-up areas biotope group has the highest parcels number with 18,170. In other words, this biotope group is the most fragmented constituting 70% of the total number of parcels. Parcel numbers of the agricultural and non-built-up areas biotope groups are 4800 and 4356, respectively.

Table 1. Areal Coverages and no of Parcels of the Main Biotope Groups.

Main biotope groups	Area		No of parcel	
	ha	%	no	%
Built-up areas	2694.42	26.55	18170	66.49
Non-built-up areas	3181.66	31.36	4356	15.94
Agricultural areas	4270.96	42.09	4800	17.57
Total	10147.04	100	27326	100

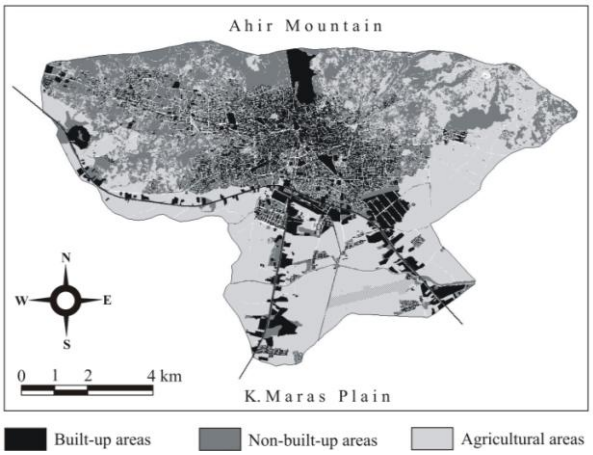

Figure 2. Main Biotope Groups.

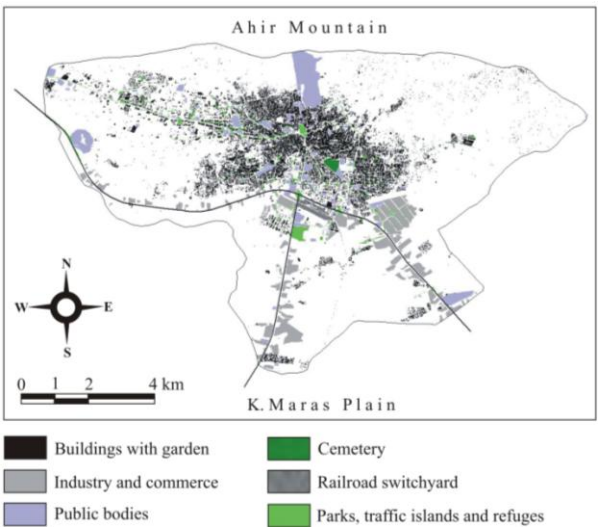

Figure 3. Built-up Areas Sub Biotope Types.

Table 2. Built-up Areas Sub Biotope Types.

Biotope type		Area		No of parcel	Mean parcel width (ha)
		ha	%		
Settlements	Multi storey buildings with garden	92853	8.99	15979	0.06
	1-4 storey buildings with garden				
	Old houses with garden				
	Industry and commerce	442.97	4.29	219	2.02
	Public bodies	351.49	3.40	254	1.38
Transportation	Asphalt roads	803.35	7.77	-	-
	Bad - soil roads				
	Railway				
Green areas	Parks	47.17	0.46	107	0.44
	Traffic islands and refuges	97.74	0.95	1602	0.06
	Cemetery	13.04	0.13	1	13.04
	Railroad switchyard	10.13	0.10	8	1.27

Built-up areas

Sub biotope types grouped under settlements, cover the largest area in built-up areas main biotope group with 1722.99 ha of land, and have the greatest parcels number among all types, with 16,542. Transportation sub biotope types are 1200 km long and have 803.35 ha of land. Constituting %0.46 of the study area, there are 107 parks in the city with total 47.17 ha of land. Besides, plantings in refuges and pedestrian ways also generate a strong green texture in the urban area. In addition to this, the cemetery and railroad switchyard sub biotope types are the largest one-piece green areas in the city core. Their surface areas are 13.04 and 10.13 ha, respectively (Figure 3) (Table 2).

Settlements and green areas sub biotope types are substantially endowed by exotic ornamental plants. Some of the most commonly seen tree and shrub species in these areas are Platanus orientalis, Acer negundo, Cupressus sempervirens, Pinus brutia, Cedrus libani, Melia azedarach, Viburnum tinus, Rosmarinus officinalis and Ligustrum vulgare. The greatest amount of biennial or perennial herb species were determined in the military training zone, which is sub biotope type of public bodies, located upper parts of the mountain foothills. Depending on the protected structure of this area from destructive effects of urban expansion, some natural species belong to Ahir mountain formations were found such as Rhus coriaria, Dianthus floribundus, *Arctium minus* subsp. *pubescens*, *Crupina crupinastrum* and *Centaurea urvillei* subsp. *nimrodis*. On the other hand, although some herb species are also exist in industry and commerce, cemetery, and railroad switchyard sub biotope types, these are mostly cosmopolitan and ruderal species such as *Senecio vulgaris*, *Xanthium spinosum*, *Convolvulus arvensis*, *Ecballium elaterium*, *Cardaria draba* subsp. *draba*, *Vaccaria pyramidata* and *Papaver rhoeas*.

In the transportation routes, cosmopolitan and ruderal herb species are considerably pervasive depending on the land destructions occured as a result of road construction activities. However, around the asphalt roads situated in newly urbanized northern and western sides of the city, it is possible to see some species belong to natural vegetation of the region, such as *Vicia peregrina*, *Lathyrus sativus*, *Eryngium falcatum*, *Echinophora orientalis*, *Crambe orientalis* var. *orientalis*, *Inula graveolens* and *Centaurea tomentella*, which is endemic for K.Maras region and its surroundings. This situation shows that new road constructions can narrow dispersion areas of these species by increasing fragmentation of the landscapes and habitats.

Non-built-up areas

"Non-built-up spaces in settled areas" (NSSAs) sub biotope type covers the largest area (1279.05 ha). This biotope type is probably old olive grove parcels, which are abandoned without re-planting them due to their potential for using new building constructions. NSSAs create relatively suitable environments for natural life in urban areas. Therefore, it is possible to see the species belong to natural flora of the region, such as *Helleborus vesicarius*, *Nigella orientalis*, *Delphinium peregrinum*, *Geranium molle* subsp. *molle*, *Erodium malacoides*, *Salvia multicaulis*, and an endangered species *Ankyropetalum reuteri*. "Uncultivated spaces in olive groves" (USOGs) sub biotope type has the second largest area which consists of vacant lots surrounded by olive plantations

which lost their property value due to their fragmentation into too small pieces. Hence, *Geranium molle* subsp. *molle*, *Salvia multicaulis* and endemic *Centaurea tomentella* natural species can be seen in USOGs as well as cosmopolitan species, such as *Senecio vernalis* and *Papaver rhoeas* (Figure 4) (Table 3).
With 324.81 ha of land, forest sub biotope type consist of afforested areas in mountain foothills. The dominant tree species is *Pinus brutia*, and also it is possible to see the natural species, such as *Coronilla scorpioides*, *Hymenocarpus circinnatus*, *Anarrhinum orientale*, *Crupina crupinastrum* and *Centaurea urvillei* subsp. *nimrodis*. On the other hand, in the afforested areas there are some spaces where forest cover is not formed properly. In this sub biotope type, named forest gaps, some natural species of the region can be seen, such as *Rhus coriaria*, *Fibigia clypeata*, *Isatis aucheri*, *Cephalaria kotschyi* and *Teucrium polium*. It is estimated that species diversity in these areas will decrease and after will be lost over time in case of the gaps are covered and shaded by tree species.

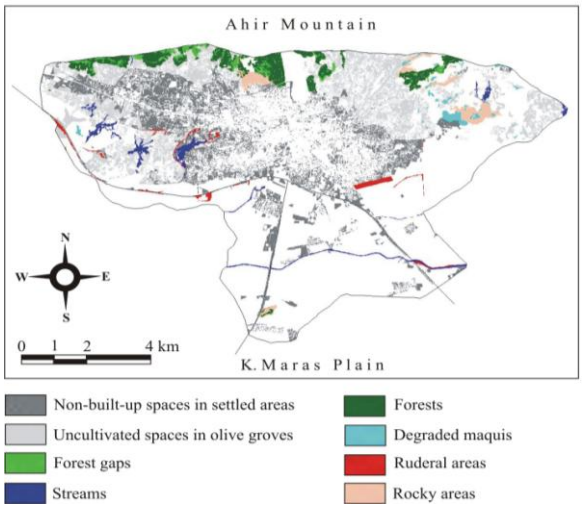

Figure 4. Non-built-up Areas Sub Biotope Types**.**

The sub biotope types of running waters and intermittent streams are relatively protected from adverse effects of built-up areas owing to their being away from urban tissue but under the pressure of agricultural activities. In this streams it is possible to see *Populus* sp., *Juglans regia*, *Salix alba*, *Olea europea*, *Jasminum fruticans*, *Rubus canescens* and *Rhus coriaria* species. There are also *Hymenocarpus circinnatus*, *Salvia multicaulis*, *Teucrium polium* and *Sanguisorba minor* as natural species, *Ranunculus arvensis*, *Crepis sancta* and *Senecio vernalis* as cosmopolitan species, and partly *Xanthium spinosum* as ruderal species.

Ruderal areas sub biotope type which cover 66.20 ha of land, consist of cut and fill areas around newly established roads, construction rubbles etc. The species with high ecological tolerance can be seen abundantly in the ruderal areas, such as *Inula graveolens*, *Senecio vernalis*, *S. vulgaris*, *Notobasis syriaca*, *Urtica dioica*, *Papaver rhoeas* and *Convolvulus arvensis*. With 144.53 ha of land, rocky areas sub biotope type is relatively protected from the effects of agricultural and constructional activities. *Quercus coccifera*, *Onosma ovalifolium*, *Veronica bozakmanii*, *Ajuga chamaepitys* subsp. *rechingeri* and *Teucrium polium* were observed as typical samples belong to this type of sub biotope types. With 47.65 ha of total surface area, degraded maquis sub biotope type gives the impression of decreased due to agricultural and constructional activities. In vegetation cover of these areas *Quercus coccifera* is dominant, and natural species of the region also can be seen abundantly, such as *Colchicum falcifolium*, *Iris persica*, *Gynandriris sisyrinchium*, *Salvia multicaulis* and *Sherardia arvensis*.

Table 3. Non-built-up Areas Sub Biotope Types.

Biotope type	Area		No of parcel	Mean parcel width (ha)
	ha	%		
Non-built-up spaces in settled areas	1279.05	12.19	3444	0.37
Uncultivated spaces in olive groves	1131.11	10.95	518	2.18
Forest gaps	73.73	0.71	107	0.69
Intermittent streams	114.58	1.08	34	3.37
Running waters				
Forests	324.81	3.14	146	2.22
Degraded maquis	47.65	0.46	61	0.78
Ruderal areas	66.20	0.64	36	1.84
Rocky areas	144.53	1.40	10	14.45

Agricultural areas

Agricultural areas main biotope group (4270.96 ha) dominates in the study area. Extensive cultivation sub biotope type cover the largest area within this main biotope group with 3333.81 ha of land. This sub biotope type displays a non-fragmented structure with 10.48 ha of mean parcel width. The plants observed in these areas mostly consist of weed species, such as *Ranunculus arvensis*, *Sisymbrium marianum*, *Sinapis arvensis*, *Lepidum perfoliatum* and *Lathyrus sativus*. Furthermore, there are also ruderal species, such as *Xanthium spinosum*, *Inula graveolens*, *Ecballium elaterium* and *Solanum nigrum* (Figure 5) (Table 4). Olive groves sub biotope is among the leading biotopes destroyed due to urbanization. This biotope type which concentrated throughout the foothills of the Ahir mountain displays considerably fragmented structure with 3811 parcels. This type of areas generally covered by the cosmopolitan plant species, such as *Senecio vulgaris*, *Capsella bursa-pastoris*, *Cardaria draba* subsp. *draba* and *Silene colorata*.

On the other hand, some samples of the endemic and endangered *Ankyropetalum reuteri*, and low risk *Centaurea cataonica* species were also seen in the borders of the olive groves. This situation points out that weed control by pesticides and soil working activities restrict the dispersion area of natural species.

High stem orchards sub biotope type covers relatively small area among other agricultural areas with 86.85 ha of land. *Morus alba*, *Ficus carica*, *Amygdalus communis*, *Persica vulgaris*, *Juglans regia*, *Populus* sp. and some small olive groves parcels represent general characteristics of this type of areas. It is also possible to see some cosmopolitan species abundantly, such as *Senecio vernalis*, *Capsella bursa-pastoris*, *Papaver rhoeas* and *Portulaca oleracea*. Vegetative border elements which surround or disconnect the farmlands, olive groves and houses were handled as hedgerows sub

biotope types. *Elaeagnus angustifolia*, *Olea europea*, *Pinus brutia*, *Amygdalus communis* and *Salix alba* are the dominant trees in this type of border elements. Additionally, *Phragmites australis* and *Sorghum halepense* with subterranean stems and capable to compete, and some contributory species such as *Erysimum smyrnaeum*, *Xanthium spinosum* and *Datura stramonium* were also observed.

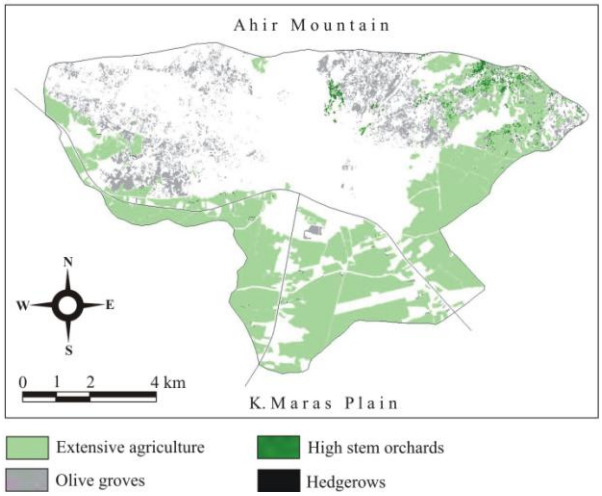

Figure 5. Agricultural Areas Sub Biotope Types.

Table 4. Agricultural Areas Sub Biotope Types.

Biotope type	Area		No of parcel	Mean parcel width (ha)
	ha	%		
Extensive cultivation	3333.81	32.26	315	10.58
Olive groves	832.72	8.06	3811	0.22
High stem orchards	86.85	0.87	421	0.21
Hedgerows	17.58	0.17	253	0.07

CONCLUSIONS

The protection of the biotopes which are in danger of being degraded or lost due to multi-directional pressures of urbanization, has a great importance from the viewpoint of providing healthy urban environmental conditions in favor of the people and natural life. Within this framework, vegetation analysis was conducted with the purpose of posing features and importance of biotopes in the city of K.Maras with respect to natural life and problems that the biotopes identified come across. Biotope mapping was also conducted to provide an ecological basis for urban planning activities. Thus, the aim of the biotope maps can be specified to allow lands to be used under consideration of their environmental states.

The results put forward that the agricultural areas main biotope group is dominant in the study area from the areal coverage point of view, and due to this, has a great pressure on the natural species diversity. On the other hand, although cover the smallest land in the study area, built-up areas biotope group which has a sprawled form creates a powerful impact in large areas with its high number of parcels in occurrence and increase of the fragmentation of habitats and LU.

Vegetation cover analysis displayed that the species which are the elements of natural vegetation of the region were observed in the urban area, but the number of the samples is in the tendency of decreasing. For example, some samples of the endemic *Ankyropetalum reuteri* and *Centaurea tomentella*, and low risk *Centaurea cataonica* species, which mostly seen in the intact lands, were found in and around the asphalt roads, olive groves and NSSAs sub biotope types. This situation shows that urbanization and agricultural activities can cause reduction of dispersion areas of these natural species and even can cause lost. On the other hand, cosmopolitan herbal species which have high dispersion and competitive capacity were also observed throughout the study area. Natural species which are non-tolerant from the viewpoint of habitat choice leave the area, while the cosmopolitan ones which can disperse easily in degraded areas are become dominant. In this context, the most remarkable situation observed during the vegetation analysis was the natural species can have the possibility to live and disperse in urban areas on condition that their habitats are to be protected.

Some arrangements should be made for providing sustainability of the contributions of the biotopes, which under multi-directional pressures of human activities in the study area, to natural and urban life. Firstly, sub biotope types which harbor natural species, rare from the viewpoint of number of parcels and/or areal coverage, and in the tendency of to be fragmented or lost need to be protected and than improved. For example, the military training zone which is not used with high density has the greatest number of natural herbal species among built-up areas sub biotope types. This sample should be assessed as an alternative approach from nature conservation and urban LU management points of view. In this context, degraded maquis, rocky areas and streams sub biotope types, which are surrounded by various LU types, and vulnerable against the external influences, can be assign to universities or to another research institutions as natural experiment areas.

Finally, urbanization and agricultural activities were determined as the main factors in destruction of the biotopes and the reduction of the biodiversity in the study area. These developments, which show the biotopes and land potential are faced with the un-sustainable utilization forms, display the necessity of the use of biotope maps as a basic tool in LU planning and management studies for protecting and providing continuity of the benefits of the biotopes to the urban environment.

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REFERENCES

[1] Koseoglu, M. 1981. Peyzaj ekolojisi calismalari ve Ege bolgesinde ekolojik yonden onemli biyotoplarin haritalanmasi uzerine bir arastirma. Ege Üniversitesi Yayınları. İzmir.

[2] Maurer, U., Peschel, T., Schmitz, S. 2000. The flora of selected urban land-use types in Berlin and Potsdam with regard to nature conservation in cities. Landscape Urban Plan 46:209-215.

[3] Yucel, M. 2001 Çevresel Etki Degerlendirmesi Baki Yayınları. Adana.

[4] Mansuroglu, S., Ortacesme, V., Karaguzel, O. 2006. Biotope mapping in an urban environment and its implications

for urban management in Turkey. Journal of Environmental Management 81:175-187.

[5] Altan, T. 1997. Imar planlarina ekolojik panlamanin katilimi ve biyotop haritalamanin onemi. Kiyi Ege Belediyeler Birligi Kiyi Sorunlari ve Cevre Sempozyumu, Kusadasi.

[6] Lofvenhaft, K., Bjorn, C., Ihse, M. 2002. Biotope patterns in urban areas: a conceptual model integrating biodiversity issues in spatial planning. Landscape and Urban Planning 58:223-240.

[7] Deak, J. A. 2005. Landscape ecological researches in the western Marosszog (Hungary). Acta Climatologica et Chorologica 38-39:33-46.

[8] Sukopp, H., Weiler, S. 1988. Biotope mapping and nature conservation strategies in urban areas of the Federal republic of Germany. Landscape and Urban Planning 15:39-58.

[9] Kim, H.O., Lakes, T., Kenneweg, H., Kleinschmit, B. 2005. Different approaches for urban habitat type mapping - the case study of Berlin and Seoul. In: Moeller M, Wentz E (eds) Proceedings of the 5th international symposium remote sensing of urban areas, Arizona.

[10] Angold, P.G., Sadler, J.P., Hill, M.O., Pullin, A., Rushton, S., Austin, K., Small, E., Wood, B., Wadsworth, R., Sanderson, R., Thompson, K. 2006. Biodiversity in urban habitat patches. Science of the Total Environment 360:196-204.

[11] Svoray, T., Bar, P., Bannet, T. 2005. Urban land-use allocation in a Mediterranean ecotone: habitat heterogeneity model incorporated in a GIS using a multi-criteria mechanism. Landscape and Urban Planning 72:337-351.

[12] Jarvis, P.J., Young, C.H. 2005. The mapping of urban habitat and its evaluation. Man and the Biosphere Programme, UNESCO.

[13] MGM (Meteoroloji Genel Müdürlüğü). 2007. Kahramanmaras iklim verileri, Ankara.

[14] KHGM (Köy Hizmetleri Genel Müdürlüğü) (1978) Ceyhan havzasi topraklari, Ankara.

[15] MTA (Maden Tetkik ve Arama Genel Müdürlüğü). 2006. 1:25.000 Ölçekli K.Maraş ve Çevresi Jeoloji Haritası. Ankara.

[16] Korkmaz, H. 2001. Kahramanmaras havzasi jeomorfolojisi. Kahramanmaras Valiliği, Turkey.

[17] Doygun, H., Alphan, H., Kusat, G.D. 2007 Kahramanmaras kenti ve yakin cevresinde arazi ortusu - alan kullanim degisimlerinin belirlenmesi ve surdurulebilir alan kullanim onerileri gelistirilmesi. TUBITAK 104O161, Ankara.

[18] Doygun, H. 2009 Effects of urban sprawl on agricultural land: a case study of Kahramanmaras, Turkey. Environmental Monitoring and Assessment 158:471-478.

[19] Forman, RTT. 1995 Land mosaics: the ecology of landscapes and regions. Cambridge Press, Cambridge.

[20] Davis, P.H. 1965-1985 Flora of Turkey and the East Aegean Islands. University Press, Edinburgh.

[21] Davis, P.H., Mill, R.R., Tan, K. 1988. Flora of Turkey and the East Aegean Islands, University Press, Edinburgh (Supplement) (Davis 1965-85 and 1988).

[22] Atik, M. 1997. Adana kentinde biyotoplarin haritalanmasi. Yüksek Lisans Tezi, Çukurova Üniversitesi.

[23] Yilmaz, H. 2001. Bartin kenti ve yakin cevresinde biyotoplarin haritalanmasi. Doktora Tezi, İstanbul Üniversitesi.