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Research Article

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Change Detection of Burnaz Dunes and Prediction of Environmental Effects in Iskenderun Bay

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Abstract Iskenderun Bay is in Eastern Mediterranean Region of Turkey where an important area for the biodiversity. Iskenderun Bay coastal zone of Turkey especially Burnaz coastal dunes host to very rich biotopes. Unfortunately, these dunes are threatened by several land uses. The aim of the study is monitoring the coastal dunes between 1995 and 2015 and prediction of potential environmental effects because of land use changes. There are several methods for monitoring which was preferred the biotope mapping in the study. Biotope maps were created for the two periods and then the two maps compared to determine changes in these dunes. As a result of this study, some decisions were suggested on the ecological approach to maintain sustainability.

Keywords Iskenderun Bay, biotope mapping, dunes, sustainability, change detection

Introduction

"Land-change science has been emerged as a fundamental element of global environmental change and sustainability science" [1]. With increased availability and improved quality of multi-spatial and multi-temporal remote sensing data as well as new analytical techniques, it is now possible to monitor land cover/ land-use changes and urban sprawl in a timely and cost-effective way [2,3]. 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 [4,5]. The conceptual basis is the classification of biotopes mainly based on land use and habitat type, as most habitats in urban areas have important social and economic functions, e.g. parks and school grounds [6,7,8]. It is a fundamental variable that impact on and links many parts of human and physical environments [4,3]. Biotope mapping should be based on a well-structured, fundamental concept that responds to different demands, especially maintenance and development of biodiversity and nature-like experiences for urban dwellers [9].

The study employed in Burnaz dunes where is located in Iskenderun Bay. Iskenderun Bay is located on the Eastern Mediterranean Region of Turkey. These dunes host very rich biotopes. "On the other hand, it is considered to be one of the most polluted shores of Turkey due to being a petroleum transfer harbor and constant exposure to wastes of fertilizer factory, steel-iron factory, LPG factory, and other industrial factories and agricultural chemicals" [10,11]. These are showed that, these dunes under pressure because of industrialization. Hence, the aim of this contribution is to monitor changes in coastal landscape pattern of Burnaz dunes 20 years' time period between 1995 and 2015. The coastal zone changes were detected by rectified topographic maps of 1995 and 2015. The study which performed with the help of remote sensing and GIS mainly consists of three objectives: (1) to biotope map for two periods (from 1995 to 2015) (2) to quantify

land use changes (3) to predict environmental problems that may arise because of land use changes in Iskenderun Bay.

Materials and Methods

Study Area

Iskenderun Bay is located on Eastern Mediterranean region of Turkey. Border of the study area started from the Sarımazı beach on the northwest, and Burnaz stream on the west (Figure 1). The study area occupies approximately 882 Ha. Climate regime is Mediterranean climate characterized by a mild winter during the annual precipitation of 783.3 mm falls, and a hot dry summer. Average mean annual temperature is 19.6°C, average maximum temperature is 23.8°C, average minimum temperature is 15.6 °C in İskenderun [12]. Parent material consists mostly of conglomerate, calcaire and alluvial. Mediterranean vegetation consists of evergreen forest of *Pinusbrutia* Ten., and shrub lands composed of maquis, and garrigue [3].

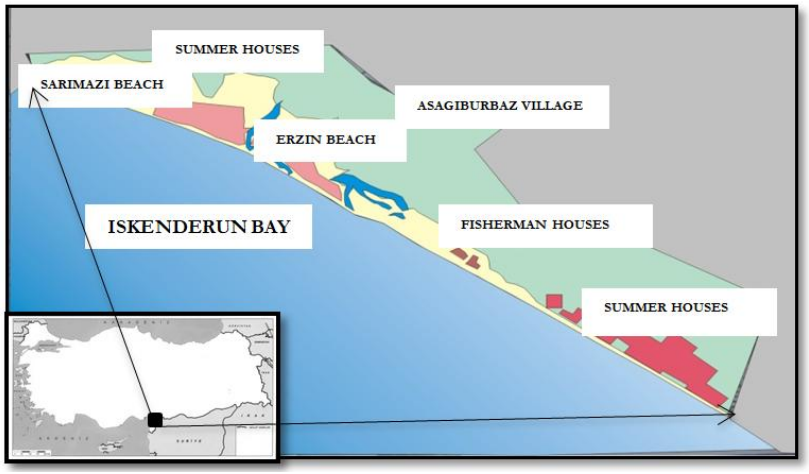

Figure 1: Location of study area

Methodology

The study comprises 3 stages: (1) obtaining data and image pre-processing, (2) biotope mapping (3) landscape change analysis and prediction of environmental effects.

First stage consists of literature survey about the subject and obtaining spatial and non-spatial data. After that topographic maps are digitized and geocoded to the UTM-WGS 84 zone 36 coordinate system. A minimum of 15 regularly distributed control point selected from the images. Second stage consists of biotope mapping of the two maps. Comprehensive biotope mapping was used in the study. It based on investigating of all biotopes, including natural area and built-up areas. It requires knowledge of vegetation [13,14]. So, the study which performed by Guzelmansur and Altan, 2000 is used to identify plant species [15]. Additionally, field work done in april and september 2015 for plant species analysis.Last stage is landscape change analysis, which was based on image classification.

Biotope mapping methods applied for using ArcGIS 10.1 for classification. Classified images were overlaid to extract landscape change information. Quantitative areal data of the overall land cover changes as well as gains and losses in each category between 1995 and 2015 can be compared. In order to analyze the rate, and location of land cover changes, a set of 'gains' and 'losses' images for each category was also produced. These 'change' images were converted into a raster format with the resolution of 0.5m. This GIS overlay intended to find landscape change information within the dunes.

Results and Discussion

This section consists of two unit; "Biotope mapping" and "Quantifying from to changes".

Biotope Mapping

Images of 1995 and 2015 were preprocessed and classified to create biotopes maps. As a result of biotope mapping, eight types of biotopes are determined; wetland, settlement, agriculture, horticulture, forest (plantation area of *Eucalyptus camaldulensis* Dehnh.), sand hills, phrygana, and industry (Figure 2, Figure 3).

Settlement: Lower Burnaz is the one village of the area. Burnaz beach and some summer houses take place in the research area as settlement. Some cultural plants like *Morus alba* L., *Ficus carica* L., *Eucalyptus camaldulensis* Dehnh., *Platanus orientalis* L., *Nerium oleander* L., *Punica granatum* L.*var. nana*, *Washingtonia filifera* (J. Linden ex Andre) H. Wendl, *Salix babylonica* L. and *Acacia cyanophylla* Lindl. are shown in these areas [15].

Agriculture

Soils where have I and II land ability classes uses as agricultural purposes. Peanut is the most common species. The other agricultural species are watermelon, tomato, pepper, eggplant, cotton, etc.

Horticulture

Citrus sp. species grown in the horticulture area.

Forest

Eucalyptus camaldulensis Dehnh. is planted to reduce groundwater level in wetland area. *Juncus acutus* L. is the natural plant in these forests.

Sand Hills

This biotope includes coastal dune vegetation. It takes place on the valve zone in the Mediterranean Sea and it the zone always interacted with the sea. Dominant species is *Cakile maritime* Scop. The other species are following; *Euphorbia paralias* L., *Calamagrostis pseudo phragmites* (Haller F.) Koehler, *Cakile maritime* Scop., *Myrtus communis* L., *Pistacia leutiscus* L., *Vitis vinifera* L., *Olea europaea* L. var. *sylvestris* (Miller) Lehr., *Laurus nobilis* L., *Jasminum fruticans* L., *Amigdalis* sp., *Paliurus spina-christi* Miller, *Pista ciaterebinthus* L., *Spartium junceum* L. Most common species area on the top of hills are; *Helianthemum salicifolium* (L.) Miller, *Malva neglecta* Wallr, *Euphorbia terracina* L., *Senecio vernalis* Waldst. et Kit., *Echium plantagineum* L., *Osyris alba* L., *Paronychia argenta* Lam. var. *argenta*, *Gastridium phleoides* (Nees et Meyen) C. E. Hubbard, *Plantago lagopus* L., *Clematis vitalba* L., *Cutandia memohitica* K. Richter, *Lotus corniculatus* L., *Salvia* sp., *Parentucellia viscosa* (L.) Caruel, *Bromus diandrus* Roth, *Polygonum equisetiforme* Sibth. Et Sm, *Trigonella velutina* Boiss., *Trifolium campestre* Schreb., *Lolium temulentum* L., *Crepis setosa* Hall. Fil.,*Ononis natrix* L., *Orobanche cernua* Loefl., *Scabiosa columbaria* (L.), *Lonicera etrusca* Santivar. *Hispidula* Boiss, *Medicago truncatula* Gaertn [15].

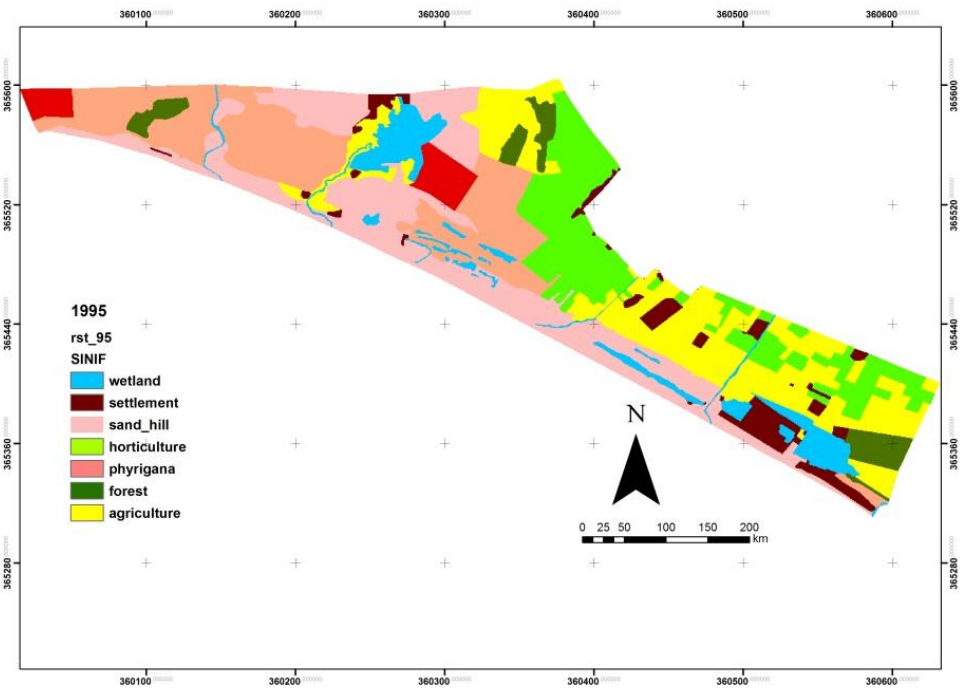

Figure 2: Biotope map of 1995

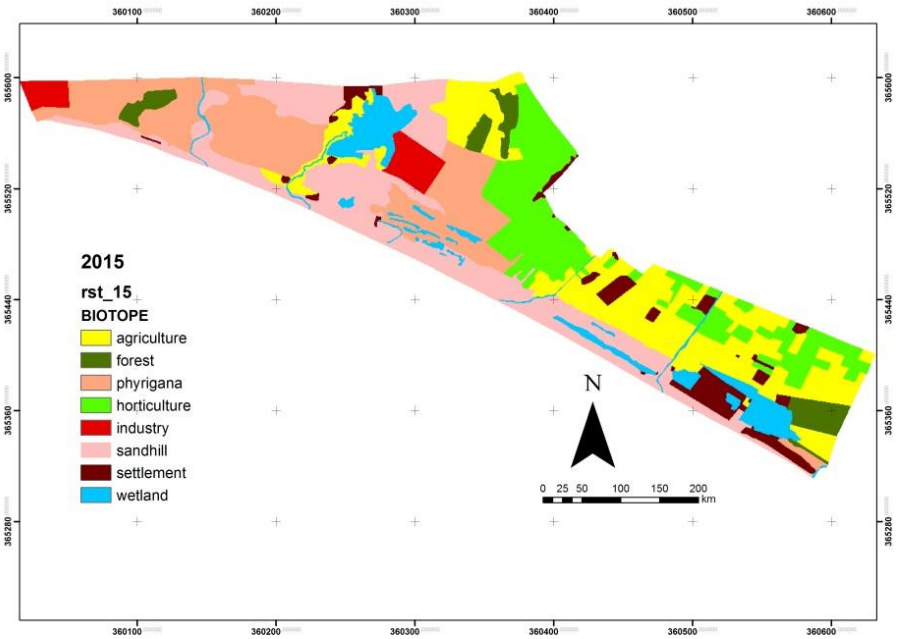

Figure 3: Biotope map of 2015

Phrygana: Phryganaconsist of wetland area in the coastal zone. It is formed because of degraded coastal and wetland area. The following plant species are represent the biotopes; *Silene colorata* Poiret, *Vulpia fasciculate* (Forsskal) Fritsch, *Anagallis arvensis* L., *Heliotropium europaeum* L., *Vaccaria hispanica* (Mill.) Rauschert, *Gastridium phleoides* (Neeset Meyen) C. E. Hubbard, *Trifolium physodes* Stev. Ex Bieb., *Avena clauda* Durieu, *Plantago lanceolate* L., *Hordeum bulbosum* L., *Certaurea solstitialis* L., *Juncus acutus* L., *Typha domingensis* Pers., *Eucalyptus camaldulensis* Dehnh., *Crepis setosa* Hall. Fil., *Trachomitum venetum* (L.) Woodson, *Juncus acutus* L., *Erica manipuliflora* Salisb., *Anagallis arvensis, Inula viscosa* (L.) Aiton, *Trifolium campestre* Schreb, *Trachomitum venetum* (L.) Woodson, *Cyperus capitatus* Vandelli, *Vulpia fasciculate* (Forsskal) Fritsch.

Industry

Industrial biotope formed after transformed from site area to free trade area in the coastal zone. Power generation plant and natural gas exploration and filling area constructed after the transformation to free trade zone.

Quantifying from to changes

In this study, landscape change analyses technique was applied. It is the most obvious method of change detection, which requires the comparison of independently produced classified images.

Figure 2 and Figure3show the result maps of land cover of 1995 and 2015. These maps show land differences between two periods of times. The most prominent land use changes determined for horticulture and wetland areas. Horticultural land use increased from 2.69% to 15.73% in 20 years (Table 1). Agricultural area transformed to horticulture which is not give negative effect to agricultural area. On the contrary, wetland areas decreased from 20.01% to 7.42%. It is natural process of succession. Some wetland areas accured as a result of excavation of sand areas. So, these areas replaced to phrygana. Sand hill decreased from 32.80% to 22.82% which cause negative effects to environment (Figure 4).Some of these areas transformed for industrial purposes. Industrial activities were forbidden use because of protection of the coastal area in 1995, but after transformation to free trade area, some industrial plant constructed in the coastal zone. Industrial activities negatively effects to environment. It damages coastal zone by occupying the sensitive area. Additionally, it damages vegetation and fauna of coastal zone. It also damage microclimate of these dunes due to hot water from the factory and smoke. All in all, it damages the ground water because of factory wastewater.

Table 1. Land use/Land cover (LU/LC) of 1995 and 2015

LU/LC Type	1995(Ha)	1995(%)	2015(Ha)	2015(%)
Settlement	19.07	3.75	26.97	4.95
Agriculture	198.75	39.11	115.82	21.29
Horticulture	13.65	2.69	85.58	15.73
Forest	8.38	1.65	21.96	4.04
Sand hill	116.70	32.80	124.14	22.82
Wetland	101.67	20.01	40.39	7.42
Phrygana	35.93	6.60	112.405	20.66
Industry	0.00	0.00	16.84	3.10
Total	508.22	100.00	508.22	100.00

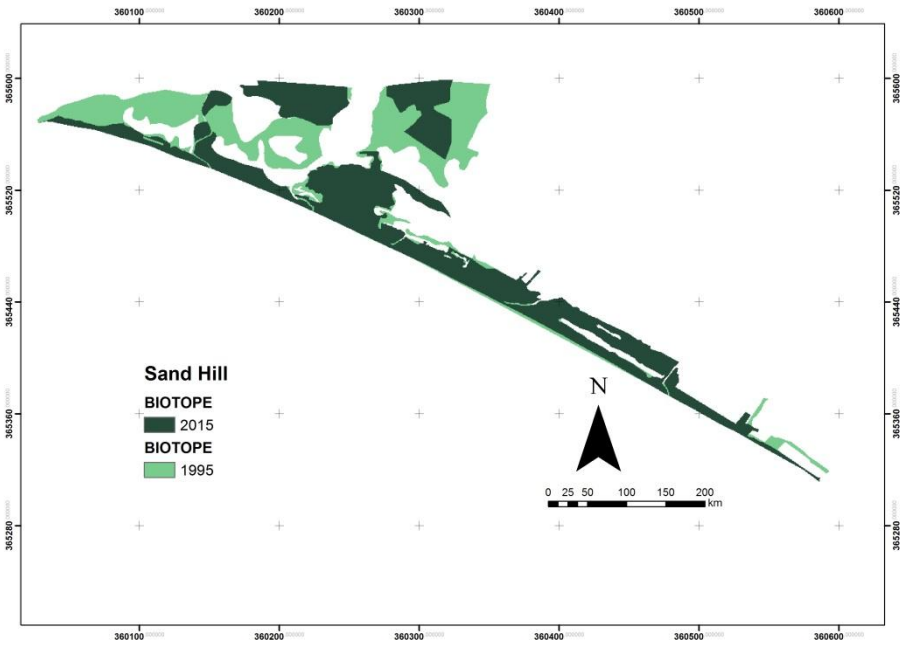

Figure 4: Land use changes for sand hill from 1995 to 2015

Conclusion

The aim of the study was monitoring the changes of coastal dunes from 1995 to 2015 and determination its environmental effects in Iskenderun Bay, Burnaz Dunes. Comprehensive biotope mapping methods preferred for monitoring these changes in the study. The method has some advantages; it based on vegetation analysis which enforce us to collect all vegetation data about study area. So, it gives us the opportunity to collect all ecologic data. The factor also necessitate to qualified labor about ecological data. On the other hand collection all ecological data give some disadvantages like, difficulties to collect all ecological data in restricted time period. The other difficulty is requirement of qualified labor about vegetation. Despite all these disadvantages, biotope mapping is one of the best methods for monitoring ecologically sensitive areas.

Monitoring changes determined with help of GIS. It gives us opportunity to comply easily with the maps if there is any new development. The coastal zone is sensitive to human disturbance. Industrial, agricultural and horticultural activities threaten the wildlife. The anthropogenic pressure is possible through the integration of ecological, social and economic system.

Additionally, over fishing create pressure on the sea fauna and wetland fauna. Summer houses give pressure on the coastal dunes. All vehicles can park in the coastal area which gives negative effect on the coastal vegetation and fauna. Plantation exotic plants in the coastal zone like *Washingtonia filifera* (J. Linden ex Andre) H. wendldisrupt natural structure.

As a conclusion, these dunes are very important and very sensitive to human disturbance. The study show that dramatically changes occur against the natural structure in the past 20 years. Anthropogenic pressure increased year by bear. Only after a comprehensive plan of action could the coastal area is protected. It is very important to reduce these environmental effects for the Bay to maintain sustainability.

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