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Zoning Coastal Marine Boujagh National Park and Sustainable Management by Geographic Information System

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Abstract

Zoning is a basic step to separate protected areas for planning and sustainable management purposes of a region. The objective of this study was to obtain potential zones in Boujagh national park within an area of 3266 ha, in Guilan province, Iran, by using grid method. For this purpose, after recognizing ecological, social and economic resources, data analysis was performed with grid method in Geographic Information System (GIS) feature in a 1/25000 scale. The gridding of studied area was conducted by using satellite image of IRS 2007 and Arc GIS 9.3 software. A number of 160 grid cells and 40 micro grids were recognized in the studied park and the data of each grid cell was imported in cell characteristics table, using GIS. According to ecological characteristics of Boujagh national park and based on the classification for the parameters, some specific ecological models were designed. Also, ecological capability evaluation of area was performed by several agent techniques for different zones. After recognizing and organizing of zones, zoning map of the studied national park was created. The results indicated that in coastal marine Boujagh national park, the strict nature, protected, extensive use, intensive use, recovery, administrative, scientific use and multiple use zones are consisted of 21.85, 56.05, 3.35, 6.09, 0.82, 0.05, 1.64 and 10.16 percents of the total studied area, respectively.

Keywords: Ecological Capability Evaluation, Geographic Information System (GIS), Grid Method, Spatial Ecological Models

1. Introduction

Studies by Day[3], Hopley[6], Hendrick[5], and Kenchington[10] were performed about ocean zoning. Theses researchers provide the basic models and principles of zoning. Also these studies show that marine uses effectively improve by ocean zoning not only for a specific purpose, but also to achieve the objectives of marine multiple uses. Making a zoning map is very important to the spatial planning of area and GIS maps are a good tool for producing these maps. Zoning maps based on activity zones, sub-regions with distinct profiles, determine the spatial structures of a study area[11].

Any use of marine protected areas requires government and private sector appropriate decisions for optimal applications[8]. Marine recourses are part of sea wide zones. Therefore, general environment alone is not enough for success in zoning protected area[14]. From management point of view, protection of coastal and marine environments is more important than national parks and caches. For this reason, this issue should be carefully taken into account in any planning[1,12]. Therefore, protection of renewable resources in marine environment is very important from the point of human interests[7,13].

Boujagh national park as first coastal-marine national park in Iran is located in the Kiyashahr seaport, Astaneh Ashrafiyyeh city, Guilan province, Iran. Boujagh wetland as international wetland is one of the basic stations for migratory birds of cold regions[2]. According to protection of biodiversity, this protected area is *in situ*

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protection pillar[15]. In this study, the emphasis is focused on biodiversity. In this regard, 21 mammal species from 12 families, five species of reptiles and two species of amphibians from five different families were identified in the park[4].

The objective of this study was to identify the potential zones in Boujagh national park with grid method and leaving aside sensitive areas to minimize the land use effects in the park. This area zoning was based on landscape approach and Geshtalt method was used for data analysis, previously and the grid method was compared with the Geshtalt method.

2. Materials and Methods

2.1 Materials

Boujagh national park which covers an area of 3266 ha is located between 49° 51' 42" and 50° 00' 03" East longitude, and 37° 24' 57" and 37° 28' 59" North latitude. This national park geologically is located within Alborz geological zone and Rasht-Gorgan sub zone. From viewpoint of altitude, this area was located below the zero level. Also, the area was flat and its slope class falls in 0–0.5% class and there is no any topography in the studied scale. The climate of the area is very humid. Sefidrood river is the most important river in this park that emanated from the heights of the Alborz and Zagros. Also there are no kariz and springs within the area. Based on some previously conducted studies, four soil types including loam, sandy loam, sandy and clay loam are the dominant soil textures in Boujagh national park. Surface, wind and fluvial erosion are the main types of soil erosions in the area. Current land use in the area is forest, grassland, common rush, lake, wetland, riverbed, arable land, fish ponds and roads. A number of 248 plant species are recorded in the area. Families of *Fabacea, Cyperaceae, Asteraceae, Poaceae, Caryophyllacee* with more than 11 taxon are the dominant species in the study area. Also, 21 species of mammals have been identified in the region that *Phoca caspica*, *Lutra lutra*, *Sus scrofa* and *Felis chaus* are typical mammal species. In addition, 234 bird species are estimated to be in the area that 55, 61 and 118 species of these are aquatic, wader and xerophyte birds, respectively. At least 8 species of these are in Red list of international union for conservation of nature. From 25 species of fish in Boujagh Wetland, 8 species of Rudd, Common carp, Tench, North caspian roach, Southern caspian roach, Caspian Shemaya, Caspian Vimba and Pike have great economic value. Social and Economical studies shown that there are 7 villages around this area and fishing with 94.5% is the most economical role in the area and agriculture with 4.2% is the next activity.

2.2 Methodology

Identification process of ecological, economic and social resources of Boujagh national park was done as first zoning step in a 1:25000 scale. In this stage, Identification was done based on available information and some field survey[4]. In next step, for data analysis, grid method was selected and grid cells were considered as unit of evaluation. Grid cells are unit size of mapping. According to ecological characteristics of the area grids of 500 m × 500 m was selected. Satellite images of IRS 2007 and Arc GIS 9.3 software were used for zoning the studied area. After that, all used ecological parameters in zoning of Boujagh national park such as soil, erosion, geology, land use, vegetation and wildlife entered in park area with GIS software. Then, by putting these layers with classified maps, information of every grid was identified and entered in attribute table of grids with GIS. Also, economic and social information such as people traffic, rubbish, animals, fishing and route traffic of fishing and tourist boats were added to attribute table of grids.

In next stage, according to ecological characteristics of Boujagh national park and based on the classified available parameters, specific ecological models were prepared. In addition, criteria of species value, conservation value and species frequency were used in this study. Then, by comparing the characteristics of the cells with specific ecological models, the evaluation of capability and zoning was performed.

2.3 Results

Figure 1 demonstrates the outcome of the zoning for the studied area.

The obtained results of zoning Boujagh national park indicated that 160 grids of 25 ha and 40 micro grids of 6.25 ha are separated in studied area. Also, 10 parameters were evaluated to design specific ecological models of Boujagh national park. Table 1 shows the used symbols for each parameter. The used parameters were then classified as follows:

The results of coding of used parameters in specific ecological models of Boujagh National Park are given in Table 2. Final zoning map of the area is presented in Figure 2.

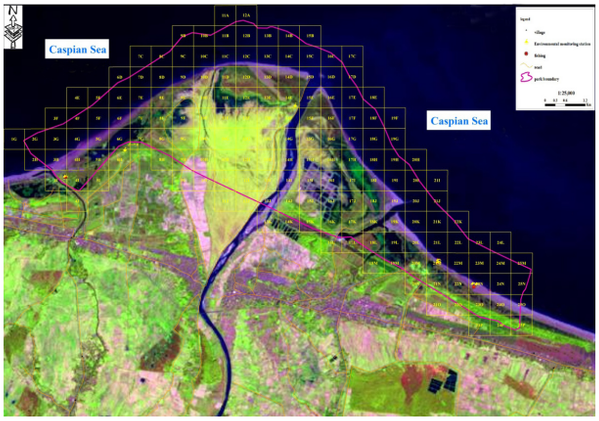

Figure 1. The performed zoning of Boujagh National Park.

Table 1. Symbols used to designate the parameters.

Symbol	Parameter
Bs	wildlife species value
Cvt	Plant species Conservation value
Ba	wildlife species Richness
Pte	Soil texture
Es	Erosion
Ha	Habitats
Si	Sensitive habitats
In	Conflicts & Threats
D	Damaged ecosystems
Z	Infrastructure Facilities & Conditions

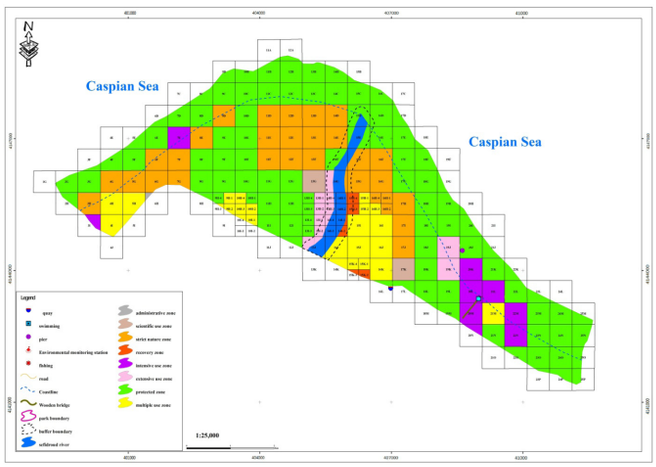

Figure 2. The performed final zoning map of Boujagh national park.

The obtained results indicated that due to presence of valuable plant and animal species in different habitats of the region, about 56 percent of the park is dedicated to the protected zone. Also 21.85 percent of the park is eligible for strict nature zone. Finally, 78 percent of the park has the priority for conservation. The identified Zones in Boujagh national park are presented in Table 3 and Figure 3.

3. Discussion

This study analyses and investigates the current uses of this coastal marine national park using grid method. The grid method and grid cell were selected as the unit of evaluation and the area have coastal marine without coral islands and tide. The whole study area is flat without deep and rocky canyons. Similar studies have been performed to apply grid method for zoning coastal marine Nayband national park by using grid method[9]. Similar to wildlife refuge of Kharkou, there are several estuaries, mangrove forests, sandy coasts, coral islands and deep and rocky canyons in Nayband national park.

Another difference between this study compared to previous studies is the dimensions of grids. According to area of the Boujagh national park and concerning the fact that there is not any specific phenomenon in the area, grids dimensions of 500 m * 500 m (0.7% of the park area) was selected. But, in zoning Nayband national park and wildlife refuge of Kharkou dimension of grids has been considered to be 1 km * 1 km (0.2% of the park area) and 100 m * 100 m (0.02% of the park area), respectively. Consequently, the dimension of grids in this study was assigned to be larger than those areas.

The zones of strict nature, scientific use, buffer, protected and intensive use in Boujagh national park conform with zones of extreme protection, scientific research, buffer, habitat protection and public uses in Great Barrier

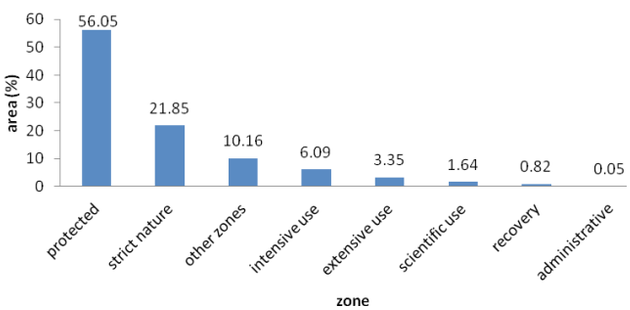

Figure 3. Area of zones in the Boujagh national park.

Table 2. Coding of used parameters in specific ecological models of Boujagh National Park.

Parameter / Code	Bs*	Cvt	Ba	Pte	Es	Ha	Si	In	D	Z
1	Sociable Lapwing(CR)	Centellaasiatica (VU)	High	loam	Non erosion	Grassland	Delta	Road	arable land	Drinking water
2	White-headed duck(EN)	Schoenoplectuslacustris (L.) Palla (Endemic)	Average	sandy loam	Wind erosion	River	River	Military sites	The Old waste disposal site	power
3	Dalmation pelican (VU)	Schoenoplectuslitoralis (Schrad.) Palla (Endemic)	Low	sandy	Surface erosion	Delta	western part of the wetland	Fishing stations	wetland	access to road
4	Lesser With-fronted *Goose* (VU)	Schoenoplectustriqueter (L.) Palla (Endemic)		clay loam	fluvial erosion	Beach		fish ponds	grassland	hiding
5	Caspian seal (VU)	Phragmitesaustralis (Cav.) Trin (Endemic)				Sea		New waste disposal site	sefidrud	Recreational amenities
6	Little Bustard (NT)	GaliumelongatumC.Presl (Endemic)				Wetland		The animals		Accommodation for Tourists
7	Great Snipe (NT)	Solanumdulcamara L. (Endemic)				Forest		Fishing activities		
8	Ferruginous *Duck* (NT)	NelumbiumnuciferumGaertn (Endemic)				Other habitats		Tourism		
9	European Otter (NT)	Cladiummariscus (Endemic)						Fishing in the sea		
10	*Red*-footed Falcon (NT)	Berulaangustifolia (Endemic)						sefidrood Pollution		
11	Other species such as Bean *Goose*, Pygmy Cormorant, White Stork, Ruddy Shelduck ، Teal ، Common Crane, Collared Pratincole	Iris pseudocurus L. (Endemic)								
12		Hydrocotyleranunculoides (Endemic)								
13		Typhalatifolia L. (Endemic)								
14		Other species								

* The threat categories are based on the last category Red List of IUCN, 2012.

Table 3. Area of zones in the Boujagh national park.

Zone / Area	strict nature	protected	extensive use	intensive use	recovery	administrative	buffer*	scientific use	other zones	Total
Hectare	713.77	1830.80	109.22	198.85	26.71	1.48	333.03	53.47	331.70	3266
%	21.85	56.05	3.35	6.09	0.82	0.05	10.19	1.64	10.16	100

*Overlap with other zones.

Table 4. Area of zones based on two methods of landscape approach and grid method.

Zones									Method
Scientific use	Multiple use	Buffer	Administrative	Recovery	Intensive use	Extensive use	Protected	Strict nature	
–	31.3	99.6	2.2	10.7	90	53.2	2368.4	611.4	landscape approach
331.70	53.47	333.03	1.48	26.71	198.85	109.22	1830.80	713.77	grid method

Reef national park in Australia[6]. Also, three identified zones of Boujagh national park conform with three zones of coastal marine Bunaken national park in Indonesia[15]. This conformation is as follows: zones of strict nature, extensive use and intensive use in Boujagh national park with zones of strict nature, traditional uses and public uses in Bunaken national park.

In study of Nayband national park, zoning of some grids did not follow the principles of grid method[9]. Also, there was not designed micro grid in wildlife refuge of Kharkou Jozaee[9]. But in this study, to avoid such problem in certain cases, micro grid was designed. Thus, each grid was divided again into four smaller grids and potential evaluation process was done based on micro grids, which can be considered as an advantage of this study.

Zoning Boujagh national park based on landscape approach was performed previously and the results indicated eight zones of strict nature, protected, extensive use, intensive use, recovery, special use, buffer and multiple use. But the results of this study indicated nine zones and in addition to above zones, scientific use zone was also recognized. Finally, area of recognized zones was different. Thus, the area of zones based on landscape approach and grid method are given in Table 4.

In zoning procedure which is based on landscape approach, the Geshtalt method was used to data analysis whereas in this study grid method was used. In Geshtalt method models are characters and in fact, models are qualitative and not quantitative, but in this study the designed models were mathematical. Therefore, GIS software can be used to accelerate the process which is an advantage of this study. But, because the boundaries of grid method are arbitrary and do not follow the shape of the landforms, the obtained evaluation of this method might consists of more inaccuracy compared to landscape approach. Finally, coastal marine Boujagh national park zoning influences on sustainable coastal marine development in studied area, including the development, conservation, and management of coastal marine resources, spatial uses, and coastal marine environmental protection.

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