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Zoning and Mapping Recreational Activities in Coastal Marine Protected Areas (Case Study: Mangrove Forests of Hara PA)

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ABSTRACT

Selecting appropriate activities and their distribution in natural areas is one of the most important issues in tourism management and planning in natural ecosystems. Accordingly, in the present study, while identifying suitable areas for recreational activities development that are demanded and can be developed in the mangrove forests of Hara Protected Area (PA), these activities were prioritized according to the capabilities of the natural areas and the effective criteria for their development. The criteria were selected based on previous documents and studies, as well as experts' viewpoints. These criteria were standardized in the numerical range of 0 to 1 in a linear path and then weighted using the ANP model. Then, for each criterion, a spatial map was prepared in Arc GIS software, and the Topsis method was used in Topsis Solver software to prioritize recreational activities. As the results revealed, the zoning of recreational activities in this area includes 4 options of how to combine the recreational activities demanded in the mangrove forests of Hara PA. Based on the ranking of activities, the highest priority is related to option 2, and the next priorities include options 3, 1, and 4, respectively. In general, measuring the proportionality of recreational activities in tourism destinations, especially in PAs that have legal prohibitions and potential biological and protective restrictions for human activities development, is essential and can lead to proper planning and management. Considering that the mangrove forests of Hara PA are among the valuable protected reserves of the southern coasts of the country, prioritizing recreational activities in suitable areas and outside the protection zones of the region can help to sustainably use the capacity of natural resources and the appropriate distribution of recreational activities in the area while protecting these natural habitats.

1. Introduction

Recreational and nature tourism activities are one of the tourism sectors that has grown significantly in recent years due to the expansion of environmental requirements in all human activities, so it accounts for 30-40% of the global tourism volume [15, 31]. Recreational activities can be an important economic activity, but in case of improper development and not properly managed, they can also lead to harmful impacts on the environment and economy of natural ecosystems [21, 40]. Therefore, according to the increasing importance of nature tourism in the world, it is necessary to provide fields for the development of recreational activities that are appropriate to the nature

of each activity, along with the ecological and socio-economic requirements of the region.

Nature tourism oversees sustainable recreational activities in connection with environmental considerations in natural environments and Protected Areas (PAs), which can help control the negative impacts of tourists on these valuable biological reserves [38]. In this regard, one of the most important topics discussed in the management and planning of tourism in natural areas is how to choose recreational activities that can be developed and demanded by tourists in these areas [32]. Experts in the field of nature tourism believe that any development in the nature tourism industry can only be achieved through proper management and planning of destination recreational activities, as well as people's cooperation in the field of sustainable nature tourism protection and development in these susceptible areas [37]. Therefore, the zones and areas that can develop nature tourism are selected [27]. In the following, recreational activities that are suitable and can be established in the selected areas are placed and designed, and finally, a sustainable management program is presented considering training, participation and monitoring of recreational activities [8]. In general, the zoning and prioritization of selected recreational activities that are appropriate to nature is one of the most important goals of management and planning for the development of sustainable nature tourism in natural ecosystems and pristine PAs.

The increasing demand for the development of recreational activities requires management measures to adapt these activities to nature and protect biodiversity while reducing the negative impacts of tourism on natural areas [4, 34]. Considering the importance of this issue in preserving and exploiting natural areas, some studies conducted in this direction were investigated. Franceschinis et al. (2022), studied the factors that determine the choice of recreational activities in PAs. The findings showed that each recreational activity has different impacts and capabilities on natural heritage to generate income, protect nature, and increase the quality of local communities' life, so the selection of activities should be made according to the location characteristics of the park. DaRugna et al. (2022), studied the heterogeneity of recreational activities in a park and protected area. Their results showed that the lack of coordination of recreational activities in PAs can have significant negative consequences for natural areas. Xi & Ma (2021), assessed tourism resources and countermeasures based on network connections and the TOPSIS model. The results demonstrate that the relative importance of proportionality measurement of tourism resources and its evaluation is very important, and evaluation and countermeasures of these resources based on network communication and TOPSIS model can be effective. In another study, Mahmoudi et al. (2018) planned the development of nature tourism in the "Anshan" tourist area in Khuzestan province. The obtained results showed that this area has a moderate capacity for recreational planning and placement of recreational activities in nature and rural tourism.

According to the studies, most of the studies have focused on the evaluation of the ecological potential and the location of recreational areas in natural ecosystems, and less attention has been paid to the zoning and prioritization of recreational activities in accordance with natural areas, especially in PAs and coastal ecosystems that have sensitivity and highly fragile against environmental changes. Accordingly, in the present study, recreational activities were zoned and prioritized in Hara PA with the aim of sustainable nature development tourism in this area.

Mangrove forests of Hara PA, as a land-sea ecosystem on the coasts of the country, have many attractions and landscapes for the development of nature tourism. Since this area is known as one of the areas under the protection of the environmental organization, it has biological sensitivities and high protection prohibitions for the development of tourism and recreational activities. Therefore, the development of nature tourism in these natural habitats should be done within the framework of the principles of sustainability and considering the biological capacities of the area. Based on this, in the present study, by identifying suitable zones for the development of recreational activities in Hara PA, each of these activities is prioritized according to the capabilities of the natural areas and effective criteria for their development. In this regard, the main research questions are: 1) What are the suitable zones for the implementation of recreational activities that are demanded and can be developed in the mangrove forests of Hara PA? 2) Which recreational activities have a higher priority for the development of nature tourism in this area?

2. Study Area

Hara PA with an area equal to 86258 ha in Hormozgan province and in the position of north latitude 26° 43' 47" to 27° 01' 02" and east longitude 55° 23' 46" to 55° 54' 01" (Figure. 1). Mangrove forests in this area, based on the habitat, include 3 delta types (Kal and Mehran river deltas), coastal (Qeshm island coast) and island types [34]. The predominant plant species in the tree area is Avicennia marina, and in terms of its animal species, we can mention 6 families and 16 species of terrestrial and aquatic mammals, as well as 111 species of birds from 33 families [17]. This area is known as one of the most demanding places for coastal nature tourism due to its many tourist attractions and high potential for the development of recreational activities.

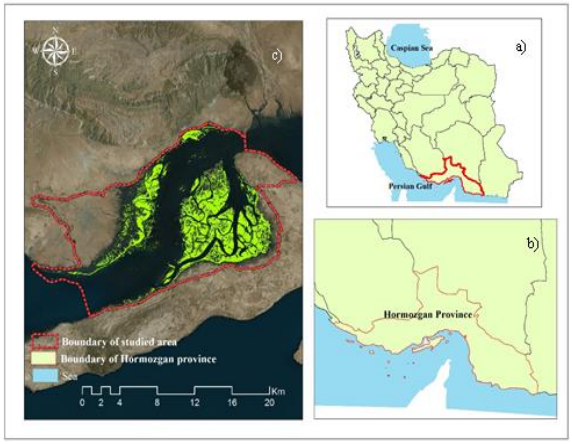

Figure. 1. Location of the studied area; a) Iran, b) Hormozgan province, c) Hara PA

3. Materials and methods

3.1. Methodology

To identify recreational activities that can be developed in Hara PA based on the expert's viewpoints and available documents [9, 25, 30], a list of recreational activities was prepared (Table 1). Then, 43 recreational activities were identified and given to tourists in the form of a questionnaire to determine their chosen activities and prioritize them in the numerical range of 1 to 10. According to Cochran's relationship, the sample size with the unknown population and with a confidence factor of 90%, according to Eq. 1 (Krebs, 1999), was determined to be equal to 96, and in this regard, by randomly distributing 100 questionnaires among the tourists, a survey was conducted and their demand was identified about the recreational activities available in this area.

$$n = \frac{z^2 pq}{d^2} \quad (1)$$

In the above equation, n: the number of required questionnaires, d: error rate (0.1), Z-statistic: 1.96, and p, q = 0.5. In the next step, the required activities were screened and selected according to Eq. 2. In this regard, Zi: weighted score of the activity, yi: the priority coefficient, xi: priority score, n_i: frequency of selecting the priority, and N: frequency of the requested activities. The basic selection of activities in this study is based on more than 10% of the total priorities, which have the most demand among recreational activities with an average of more than 100 (priorities 1 to 3). It should be mentioned that the final score of the activities is also standardized and reviewed according to the highest sum of the priority coefficients.

$$Z_i = \sum y_i n_i \times N \quad (2)$$

$$y_i = \frac{x_i}{\sum x_i}$$

Table 1. List of recreational activities suitable for development in the studied area

Recreational activities		
1) Pedal Boat (PEB)	16) Stand-Up Paddleboard (SUP)	30) Jet Boating (JEB)
2) Fan Boat (FBT)	17) Hovercraft (HOC)	31) Sailing Ships (SSH)
3) Flyfish Rides (FFR)	18) Banana Boat Rides (BBR)	32) Water Tricycle (WTR)
4) Rafting (RAF)	19) Body Glove Sea Shuttle) (BGS)	33) Kayak Ride (KYR)
5) Wind Surfing (WSU)	20) Jet Skis (JSK)	34) Kart Ride (KAR)
6) Skim Boarding (SKB)	21) Foil Surfing (FSU)	35) Kite Surfing (Kite Boarding) (KIS)
7) Zorbing (ZOR)	22) Parasailing (PAS)	36) Motor Kite (MOK)
8) Zipline (ZIP)	23) Visiting the Forest with a Balloon (VFB)	37) Glider Ride (GLR)
9) Atv's on the Beach (ATB)	24) Segway (SEG)	38) Bike Riding (BKR)
10) Beach Football (BFB)	25) Beach Volleyball (BVB)	39) Camel Riding on the Beach (CRB)
11) Watching Marine Wildlife (WMW)	26) Beach Paintball (BPT)	40) Bungee Jumping (BJU)
12) Walking in the Forest (WAF)	27) Watching Muddy Islands and Forest (WMF)	41) Watching Sports Competitions (WSC)
13) Visiting Villages near the Forest (VVF)	28) Picnic in Mangrove Fore st (PMF)	42) Camping in Mangrove Forest (CMF)
14) Traditional Fishing (TFI)	29) Photography in Mangrove Forest (PHM)	43) Sunbathing on the Beach (SUB)
15) Floating Gazebo (FGA)		

After examining the results of questioning to examine recreational activities, a series of spatial indicators were presented according to the land and coastal-sea nature of these activities. Therefore, according to relevant study records (Jahani et al. (2011); Akhondi (2014); Masnavi et al. (2013); Babazadeh (2014); Golchin et al. (2013); Mirkarimi et al. (2014); Shamshiri (2015); Sobhani (2022); Lotfikhah et al. (2017); Sharifian (2018); Mirzaei (2021); Markova et al. (2013); Danehkar et al. (2016); Asur et al. (2020); Misthos et al. (2019); Jahani (2019)), 13 indicators were used to estimate the spatial proportionality of recreational activities, including coastal slope, maximum elevation above sea level, beach material, wind intensity, precipitation intensity, speed of the water flow, maximum wave height, maximum water depth, best time for recreational activities (Tourism Climate Index), viewing angle, direction of view, maximum viewing distance, and landscape composition. Likewise, in the present study, the zoning of recreational activity demanded and developable in Hara PA was examined. Moreover, the spatial compatibility map of each of these activities was prepared based on the linear relationship of the combined spatial indicators. The codes related to the keywords of spatial indicators are also presented in Table 2.

Table 2. Spatial indicators codes (keywords) examined in recreational activities

Row	Spatial index	Code
1	Beach Material	BM
2	Coastal Slope	CS
3	Direction of View	DV
4	Elevation (above sea level)	EL
5	Landscape Composition	LC
6	Precipitation Intensity	PI
7	Viewing Angle	VA
8	View Distance	VD
9	Water Depth	WD
10	Speed of the Water Flow	WF
11	Wave Height	WH

12	Wind strength	WS

3.1.1. Prioritizing recreational activities

After zoning recreational activities, weighting and prioritization of these activities were conducted according to the series of selected criteria based on the viewpoints of 35 experts (Table 3) and similar studies and documents (Danehkar et al., 2019; Mirzaei, 2021, Lotfikhah et al., 2018). Likewise, in the process of identifying criteria, the environmental conditions of the studied area and other factors that can affect recreational activities development in this area were considered (Table 4).

Table 3. Characteristics of experts

Expertise	Number
Management and planning of coastal areas (coastal and wetland environment)	10
Environmental management and planning	7
Evaluation and land use planning	6
Environmental science and engineering	4
Management and planning of forest ecosystems (environmental assessment and planning)	8

Table 4. Criteria examined in the zoning of recreational activities

Criteria	Classes	Criteria	Classes
Existing sea	0-1000	Road access	0-100
infrastructure and	1000-2000	network (m)	100-200
ports (m)	<2000		<200
Distance from	0-1000	Distance from	0-1000
protective patches (m)	1000-2000	the city (m)	1000-2000
	<2000		<2000
Resident population	>1000	Location of	0-1000
(people)	1000-4000	settlements (m)	1000-2000
	<4000		<2000

In the following, the investigated criteria for prioritizing recreation areas in the numerical range of 0 to 1 were standardized according to the linear method according to Eq. 3 and 4. Then weight was assigned to each of the criteria using the ANP model. Finally, a spatial map was prepared for each criterion in ArcGIS software. In Eq. 3 and 4; $x_j^{Max} - x_j^{Min}$: the maximum and minimum value range of the desired indicators, x_j^{Max} : the maximum value assigned for the jth attribute, x_j^{Min} : the minimum value assigned for the jth attribute and Xij: the assigned value for the jth attribute and option i.

$$x_{ij} = \frac{x_{ij} - x_j^{Min}}{x_j^{Max} - x_j^{Min}} \quad (3)$$

$$x_{ij} = \frac{x_j^{Max} - x_{ij}}{x_j^{Max} - x_j^{Min}} \quad (4)$$

In addition, in the present study, the Topsis method was used in the Topsis Solver software to prioritize recreational activities, and the steps of this method are as follows (Chakraborty, 2022).

Step 1

Create an evaluation matrix consisting of "*m*" alternatives and "*n*" criteria, with the intersection of each alternative and criteria given as x_{ij}, hens, a matrix $\left(x_{ij}\right)_{m\times n}$.

Step 2

The matrix $\left(x_{ij}\right)_{m\times n}$ is then normalized to form the matrix

$R = \left(r_{ij}\right)_{m\times n}$, using the normalisation method

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{k=1}^{m} x_{kj}^2}}, i = 1,2,...,m,\ j = 1,2,...,n$$

Step 3

Calculate the weighted normalized decision matrix

$t_{ij=} r_{ij}.w_j,\ i = 1,2,...,m,\ j = 1,2,...,n$

Where $w_j = \dfrac{W_j}{\sum_{k=1}^{n} W_K}, \ j = 1,2,...,n$ so that $\sum_{i=1}^{n} w_i = 1$, and w_j is the original weight given to the indicator v_j, . $j = 1,2,...,n$

Step 4

Determine the worst alternative $\left(A_w\right)$ and the best alternative $\left(A_b\right)$:

$$A_w = \left\{ \left\langle \max(t_{ij} \mid i=1,2,...,m) j \in J- \right\rangle, \left\langle \min(t_{ij} \mid i=1,2,...,m) j \in J+ \right\rangle \right\} \equiv \left\{ t_{wj}, j=1,2,...,n \right\}$$

$$A_b = \left\{ \left\langle \max(t_{ij} \mid i=1,2,...,m) j \in J- \right\rangle, \left\langle \min(t_{ij} \mid i=1,2,...,m) j \in J+ \right\rangle \right\} \equiv \left\{ t_{bj}, j=1,2,...,n \right\}$$

Where,

$J+ = \{ j = 1,2,...,n, j \}$ associated with the criteria having a positive impact, and

$J- = \{ j = 1,2,...,n, j \}$ associated with the criteria having a negative impact.

Step 5

Calculate the L^2 - distance between the target alternative i and the worst condition A_w

$$d_{iw} = \sqrt{\sum_{j=1}^{n} \left(t_{ij} - t_{wj} \right)^2}, i = 1,2,...,m$$

and the distance between the alternative i and the best condition A_b

$$d_{ib} = \sqrt{\sum_{j=1}^{n} \left(t_{ij} - t_{wj} \right)^2}, i = 1,2,...,m$$

Where d_{iw} and d_{ib} are L^2-norm distances from the target alternative i to the worst and best conditions, respectively.

Step 6

Calculate the similarity to the worst condition:

$$s_{iw} = d_{iw} \Big/ \left(d_{iw} + d_{ib} \right), \quad 0 \le s_{iw} \le 1, \; i = 1,2,...,m$$

$s_{iw} = 1$ if and only if the alternative solution has the best condition; and

$s_{iw} = 0$ if and only if the alternative solution has the worst condition.

Step 7

Rank the alternatives according to $s_{iw} \; (i = 1,2,...,m)$

4. Results and Discussion

4.1. Identify recreational activities suitable for development in the area

The results showed that from 43 recreational activities in this area, 27 activities were selected (Table 5). In the next step, the screening and selection of demanded activities was done according to Eq 2. As the results demonstrate, 12 recreational activities with an average of more than 100 and based on the frequency of the first 3 selections (priority 1 to 3) had the most demand among tourists. In addition, the results show that among these activities, the highest standardized score is related to "visiting the forest with a balloon" (with a score of 69.55) and the lowest score is related to the activity "sunbathing on the beach" (with a score of 7.90). Likewise, the highest frequency in the first priority is allocated "walking in the forest" and "visiting villages near the forest" (n=16), in the second priority "visiting the forest with a balloon" (n=28), and finally, in the third priority, the highest frequency was assigned to "watching marine wildlife" (n=17). In this regard, the studies of Mirzaei (2021) and Sharifian (2018) showed that development of the tourism industry in any destination with different geographical and climatic conditions, requires the identification and selection of the most appropriate recreational activities that can be developed in the area.

Table 5. List of recreational activities identified in the area

Row	Recreational activities	xi	3	2	1	∑	Standardization	Weighted score	Standardized score
		yi	0.5	0.33	0.17				
1	Visiting the Forest with a Balloon	n	2	28	9	39	0.90	906.29	69.55
		xi.n	6	56	9	71			
		zi	1	9.24	1.53	11.77			
2	Watching Marine Wildlife	n	15	8	17	40	1	729.68	56
		xi.n	45	16	17	78			
		zi	57	2.64	2.89	13.03			
3	Walking in the Forest	n	16	7	0	23	0.79	597.98	45.89
		xi.n	48	14	0	62			
		zi	8	2.31	0	10.31			
4	Visiting Villages near the	n	16	3	0	19	0.69	431.52	33.12

	Forest	xi.n	48	6	0	54			
		zi	8	0.99	0	8.99			
		n	12	1	4	17	0.54	294.42	22.60
5	Jet Boating	xi.n	36	2	4	42			
		zi	6	0.33	0.68	1.01			
		n	4	10	2	19	0.43	276.36	21.21
6	Traditional Fishing	xi.n	12	20	2	34			
		zi	2	3.30	0.34	5.64			
7	Watching Muddy Islands and Forest	n	3	6	5	14	0.33	242.48	18.61
		xi.n	9	12	5	26			
		zi	1.50	1.98	0.85	4.33			
8	Camping in Mangrove Forest	n	4	6	5	15	0.37	241.5	18.53
		xi.n	12	12	5	29			
		zi	2	1.98	0.85	4.83			
9	Atv's on the Beach	n	0	8	7	15	0.29	187.67	14.40
		xi.n	0	16	7	23			
		zi	0	0.12	0	0.12			
10	Bike Riding	n	2	3	8	13	0.26	140.7	10.80
		xi.n	6	6	8	20			
		zi	1	0.99	1.36	3.35			
11	Photography in Mangrove Forest	n	5	0	7	12	0.28	125.46	9.63
		xi.n	15	0	7	22			
		zi	2.50	0	1.19	3.69			
12	Sunbathing on the Beach	n	1	7	3	11	0.25	102.92	7.90
		xi.n	3	14	3	20			
		zi	0.50	2.31	0.51	3.32			
13	Body Glove Sea Shuttle	n	0	8	1	9	0.22	95.54	7.33
		xi.n	0	16	1	17			
		zi	0	2.64	0.17	2.81			
14	Motor Kite	n	9	0	0	9	0.35	81	6.22
		xi.n	27	0	0	27			
		zi	4.50	0	0	4.50			
15	Sailing Ships	n	0	4	0	4	0.10	63.36	4.86
		xi.n	0	8	0	8			
		zi	0	1.32	0	1.32			
16	Zorbing	n	5	0	0	5	0.19	42.5	3.26
		xi.n	15	0	0	15			
		zi	2.50	0	0	2.50			
17	Zipline	n	3	0	1	4	0.13	26.72	2.05
		xi.n	9	0	1	10			
		zi	1.50	0	0.17	1.67			
18	Glider Ride	n	0	0	9	9	0.12	26.1	2

		xi.n	0	0	9	9			
		zi	0	0	1.53	1.53			
19	Water Tricycle	n	0	0	5	5	0.07	24.65	1.89
		xi.n	0	0	5	5			
		zi	0	0	0.85	0.85			
20	Camel Riding on the Beach	n	0	1	5	6	0.09	14.16	1.09
		xi.n	0	2	5	7			
		zi	0	0.33	0.85	1.18			
21	Rafting	n	3	0	0	3	0.12	12	0.92
		xi.n	9	0	0	9			
		zi	1.50	0	0	1.50			
22	Bungee Jumping	n	1	0	0	1	0.04	9.5	0.73
		xi.n	3	0	0	3			
		zi	0.50	0	0	0.50			
23	Segway	n	0	0	5	5	0.07	9.35	0.72
		xi.n	0	0	5	5			
		zi	0	0	0.85	0.85			
24	Fan Boat	n	0	4	0	4	0.10	7.92	0.61
		xi.n	0	8	0	8			
		zi	0	1.32	0	1.32			
25	Kart Ride	n	0	0	3	3	0.04	5.61	0.43
		xi.n	0	0	3	3			
		zi	0	0	0.51	0.51			
26	Pedal Boat	n	0	0	3	3	0.04	2.04	0.16
		xi.n	0	0	3	3			
		zi	0	0	0.51	0.51			
27	Beach Paintball	n	0	0	2	2	0.03	1.7	0.13
		xi.n	0	0	2	2			
		zi	0	0	0.34	0.34			

4.2. Investigating recreational activities according to location indicators

After identifying and determining the recreational activities demanded in the area, these activities were investigated according to the spatial indicators in Table 6. In this way, every recreational activity was examined and analyzed in a range of defined index values.

Table 6. Spatial indicators of proportionality of recreational activities demanded

Indicator / Activity	Landscape Composition	Maximum viewing distance (m)	Viewing Angle & Direction of View	Best time for recreational activities (TCI)	Maximum Water Depth (m)	Maximum Wave Height (m)	Speed of the Water Flow (m/s)	Precipitation Intensity (mm)	Wind intensity (Km/h)	Beach Material	Maximum Elevation above sea level (m)	Coastal Slope (%)

Visiting the Forest with a Balloon (VFB)	Various	<300[1]	–		Very good to excellent	–	–	–	No heavy rain	16<	–	–	5<
Watching Marine Wildlife (WMW)	Various	1500<	[3]East to South	110-180	[2]January-February	–	–	–	No heavy rain	–	–	–	–
Walking in the Forest (WAF)	Uniform	–	–		Very good to excellent	–	–	–	No heavy rain	30<	–	–	5<
Visiting Villages near the Forest (VVF)	Uniform	500<	[4]Northeast to South	45-180	Very good to excellent	–	–	–	No heavy rain	–	–	20<	–
Jet Boating (JEB)	–	–	East to South	110-180	Very good to excellent	5	1	1<	No heavy rain	30<	Sandy	–	5<
Traditional Fishing (TFI)	–	–	–		Very good to excellent	5	1	1<	No heavy rain	–	–	–	
Watching Muddy Islands and Forest (WMF)	Various	500<	East to South	110-180	Very good to excellent	–	1	–	No heavy rain	–	–	–	–
Camping in Mangrove Forest (CMF)	–	–	–		Very good to excellent	–	–	–	No heavy rain	–	Non-muddy	–	–
Atv's on the Beach (ATB)	–	–	–		Very good to excellent	–	–	–	No heavy rain	30<	Sandy	–	5<
Bike Riding (BKR)	–	–	–		Very good to excellent	–	–	–	No heavy rain	30<	Sandy	–	5<
Photography in Mangrove Forest (PHM)	Various	500<	[5]Northeast to West	45-270	Very good to excellent	–	–	–	No heavy rain	–	–	–	–
Sunbathing on the Beach (SUB)	–	–	–		Very good to excellent	–	–	–	No heavy rain	–	Sandy	–	–

[1] Vertical view based on the height above the sea level in the area

[2] As the weather cools down and birds migrate to this area

[3] Based on the existing birdwatching site in the area

[4] Based on the high concentration of historical and traditional villages in the northeastern and southern regions of the area

[5] Based on the distribution of mangrove habitats in the area

4.3. Recreational activities zoning

4.3.1. Suitable zones for visiting the forest with a balloon

Visiting the forest with a balloon is an activity that can be done in conditions with a beach slope of less than 5%, wind less than 16 km/h, no heavy rain, tourist climate (during the months of December, January, February, March and April) in very good and excellent conditions, vertical viewing distance less than 300 m and various landscape combinations are applicable. The linear model of this activity zoning is as follows and in Figure. 2, suitable zones for the implementation of this activity can be seen.

VFB=CS1+WS2+LC1

4.3.2. Suitable zones for watching marine wildlife

Watching sea animals and birds in this area, in the condition of no heavy rain, in the winter season and during the months of January and February (coinciding with the migration of birds to the area), the viewing angle 45 to 180 degrees, in the east to south direction, in the maximum visibility distance up to 1500 m, and with various landscape combinations for this activity is significant (Figure. 3).

WMW= (VA1, VA2, VA3, VA4) + (VD1, VD2, VD3) + LC1

4.3.3 Suitable zones for walking in the forest

Suitable conditions for the implementation of this activity include beach slope less than 5%, wind intensity less than 30 km/h, no heavy rain, tourism climate in very good to excellent conditions and various landscape combinations. Suitable areas for this activity are according to Figure. 4.

WAF=CS1 + (WS1, WS2) + LC2

4.3.4. Suitable zones for visiting villages near the forest

Visiting villages near the mangrove forests at a maximum height of less than 20 meters, no heavy rain, tourism climate in very good to excellent conditions, viewing angle 45 to 180 degrees (northeast to south viewing direction), distance visibility less than 500 m, and this activity is possible with the combination of a uniform landscape. Figure. 5 also shows the zoning map for the implementation of this recreational activity.

VVF= (EL1, EL2, EL3) + (VA1, VA2, VA3, VA4) +VD1, LC2

4.3.5. Suitable zones for traveling by Jet boating

To perform this recreational activity (Figure. 6), the slope of the beach must be less than 5% and sandy. Likewise, other requirements for using this activity include wind speed less than 30 km/h, no heavy rain, water flow speed less than 1 m/s, maximum wave height of 1 m, and maximum water depth of 5 m. The appropriate time for this activity is in the conditions of very good to excellent tourism climate and in the viewing angle of 110 to 180 degrees (east to south view direction).

JEB= CS1+BM1+(WS1, WS2) +WF1+(WH1, WH2) +(WD1, WD2, WD3) +(VA3, VA4)

4.3.6. Suitable zones for traditional fishing (hook fishing)

It is possible to perform this recreational activity in the condition of no heavy rain, the water flow speed is less than 1 m/s, the maximum wave height is 1 m, and the maximum water depth is 5 m. Furthermore, the favorable indicator of tourism climate for traditional fishing is very good to excellent. Figure. 7 also shows the zoning map for the implementation of this recreational activity.

TFI= WF1+(WH1, WH2) +(WD1, WD2, WD3)

4.3.7. Suitable zones for watching muddy islands and forest

Viewing muddy islands and mangrove forests should be done in conditions such as no heavy rain, maximum wave height of 1 m, tourism climate in very good to excellent conditions, viewing angle 110 to

180 degrees (east to south viewing direction), maximum viewing distance less than 500 m, and various landscape combinations for this activity is significant (Figure. 8).

WMF= (WH1, WH2) + (VA3, VA4) + VD1 + LC1

4.3.8. Suitable zones for camping in the mangrove forest

In terms of weather, camping in the mangrove forest is possible in the no heavy rain. Likewise, the beach material should be non-muddy type and the tourism climate should be in very good to excellent condition. It should be noted that due to the proximity to habitats, water areas, and the effects of tourists, as well as any possible danger, suitable zones for camping are considered at a distance of 100 m from the mentioned items (Figure. 9).

CMF= BM3

4.3.9. Suitable zones for traveling with an Atv's on the beach

It is possible to travel with an Atv's on the beach with a maximum slope of less than 5% and sandy material. Other requirements for doing this activity include wind intensity of less than 30 km/h, no heavy rain, and very good to excellent tourism climate (Figure. 10).

ATB= CS1 + BM1 + (WS1 + WS2)

4.3.10. Suitable zones for bike riding on the beach

Bike riding on the beach is applicable with a maximum slope of less than 5%, sandy beach material, wind intensity less than 30 km/h, no heavy rain, and very good to excellent tourism climate (Figure. 11).

BKR= CS1 +BM1 + (WS1+WS2)

4.3.11. Suitable zones for photography in the mangrove forest

The necessary conditions for photography in the mangrove forest include no heavy rain, a very good to excellent tourism climate, a viewing angle of 45 to 270 degrees (northwest to west viewing direction), a viewing distance of less than 500 m, and various landscape combinations (Figure. 12).

PHM= (VA2, VA3, VA4, VA5, VA6) + VD1 + LC1

4.3.12. Suitable zones for sunbathing on the beach

The conditions for the implementation of this activity include the sandy beach, no heavy rain, and the tourism climate is very good to excellent. Figure. 13 also shows the map of suitable and feasible zones for this recreational activity.

SUB=BM1

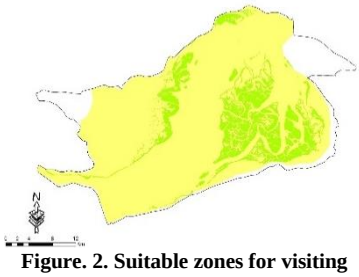

Figure. 2. Suitable zones for visiting the forest with a balloon

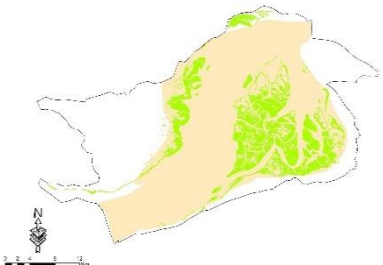

Figure. 3. Suitable zones for watching marine wildlife

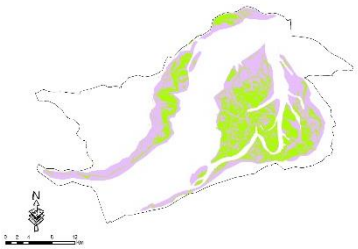

Figure. 4. Suitable zones for walking in the forest

Figure. 5. Suitable zones for visiting villages near the forest

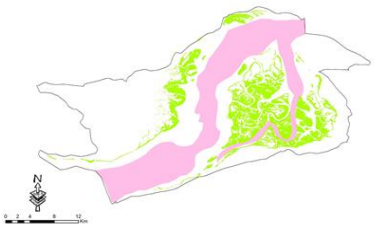

Figure. 6. Suitable zones for touring by jet boating

Figure. 7. Suitable zones for traditional fishing

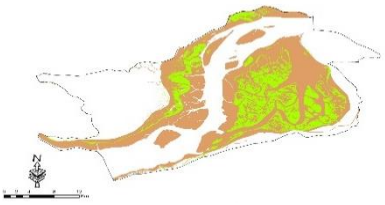

Figure. 8. Suitable zones for watching muddy islands and forest

Figure. 9. Suitable zones for camping in mangrove forest

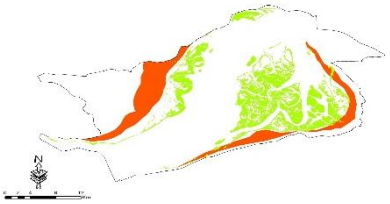

Figure. 10. Suitable zones for Atv's on the beach

Figure. 11. Suitable zones for bike riding

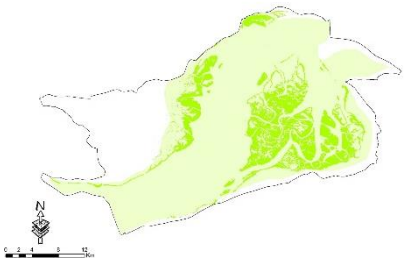

Figure. 12. Suitable zones for photography in mangrove forest

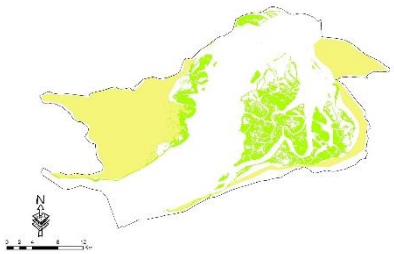

Figure. 13. Suitable zones for sunbathing on the beach

4.4. Zoning of recreational activities

After identifying the suitable zones for recreational activities development demanded in the area, the final map of the suitable recreational zones was compiled and prepared. Since the studied area is also known as a PA, the final map of the integration of recreational activities in this area was prepared by considering the position of the protection zones (1 and 2), and as a result, recreational activities corresponding to the protection spots were removed from the map (Figure. 14). This map includes 4 options for the state of dispersion of integrated recreational activities, which include the following according to Table 7:

• Option 1 includes zones with three recreational activities,

• Option 2 includes zones with four recreational activities,

• Option 3 includes zones with five recreational activities,

• Option 4 includes zones with seven recreational activities.

In this regard, the results of other studies such as Latfikhah (2018), Mirzaei (2021), and Danehkar (2019), which focused on the zoning of tourism activities in the southern regions of the country, indicate the similarity of geographical conditions and location, as well as the most effective spatial indicators in measuring the proportionality of recreational activities in this area.

Table 7. Combined recreational activities in the studied area

Option	Recreational activities
1	Walking in the forest, watching marine wildlife, visiting the forest with a balloon
2	Visiting villages near the forest, walking in the forest, watching marine wildlife, visiting the forest with a balloon
3	Photography in mangrove forest, traditional fishing, Jet boating, watching marine wildlife, visiting the forest with a balloon

4	Sunbathing on the beach, Atv's on the beach, camping in mangrove forest, watching muddy islands and forest, walking in the forest, watching marine wildlife, visiting the forest with a balloon

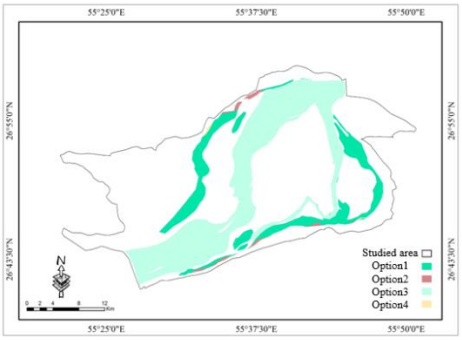

Figure. 14. Map of the combination of recreational activities in the studied area (including protection zones 1 and 2)

4.5 Weighing and prioritizing recreational activities

To prioritize demanded recreational activities in Hara PA, these activities were weighted and prioritized based on the suggested and selected criteria as follows. For this purpose, firstly, the standardization of the criteria was conducted (Table 8). As the results revealed, among the criteria, the access road network, distance from the city, the location of settlements, marine infrastructure and existing ports have a decreasing linear relationship, which means that by reducing these criteria, the distribution value and prioritization of recreational zones in the area increase. On the other hand, distance measures from protective patches and resident population have an increasing linear relationship. Thus, increasing the distance from protective patches (protection and safe zones of the area), as well as increasing the number of people living in the region, leads to an increase in the importance of recreational activities in these areas. Yaqubzadeh et al. (2020), also investigated the role of docks around mangrove habitats in Khamir port and Khor Azini. Their results showed that the existing docks and structures in these areas have increased widely in recent years, which have a great role and effects on the mangrove habitats in this area.

Table 8. Standardization classes of the studied criteria

Criteria	Classes	Function type	Standardized value of criteria	Criteria	Classes	Function type	Standardized value of criteria
Road access network (m)	0-100	Linear reduction	1	Existing sea infrastructure and ports (m)	0-1000	Linear reduction	1
	100-200		0.5		1000-2000		0.5
	<200		0		<2000		0
Distance from the city (m)	0-1000	Linear reduction	1	Distance from protective patches (m)	0-1000	Linear increase	0
	1000-2000		0.5		1000-2000		0.5
	<2000		0		<2000		1
Location of settlements	0-1000	Linear reduction	1	Resident population	>1000	Linear increase	0
	1000-2000		0.5		1000-4000		0.5

(m)	<2000	0	(people)	<4000	1

Following, the criteria were weighted using the ANP model and based on experts' viewpoints (Table 9). According to the obtained results, the highest weight is assigned to the criterion of marine infrastructure and existing ports (0.215), and the lowest weight is related to the criterion of distance from the city (0.104). Figure. 15 to 20 also show the spatial maps of studied criteria.

Table 9. The weighting coefficient of the studied criteria

Criteria	Criterion weight
Road access network	0.168
Distance from the city	0.104
Location of settlements	0.115
Existing sea infrastructure and ports	0.215
Distance from protective patches	0.187
Resident population	0.152

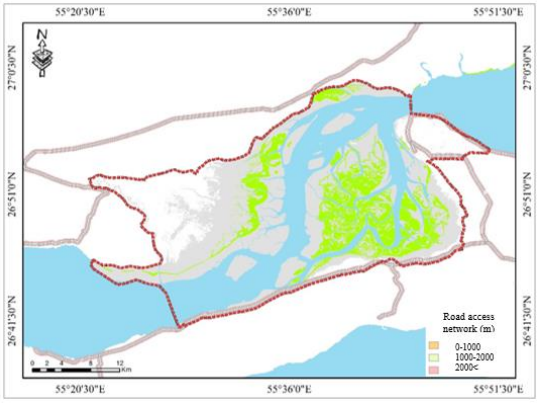

Figure. 15. Map of the road access network

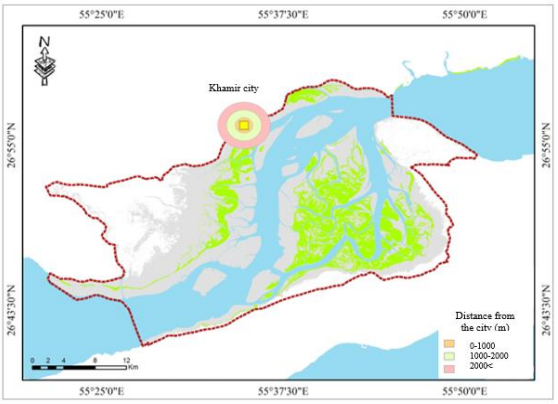

Figure. 16. Map of the distance from the city

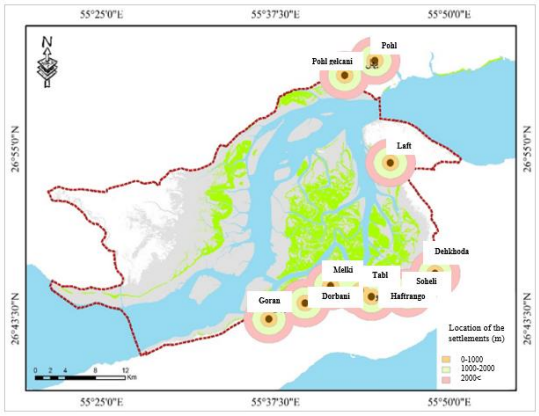

Figure. 17. Location map of the settlements

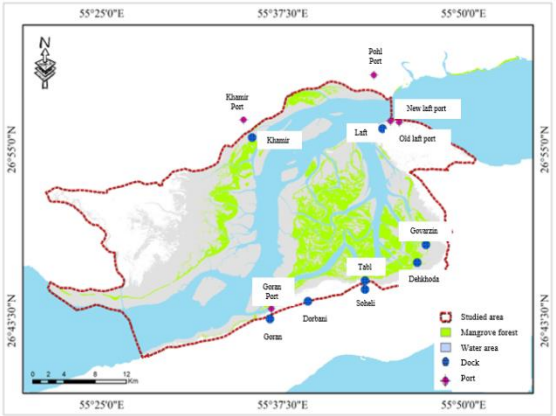

Figure. 18. Distribution map of existing sea infrastructure and ports

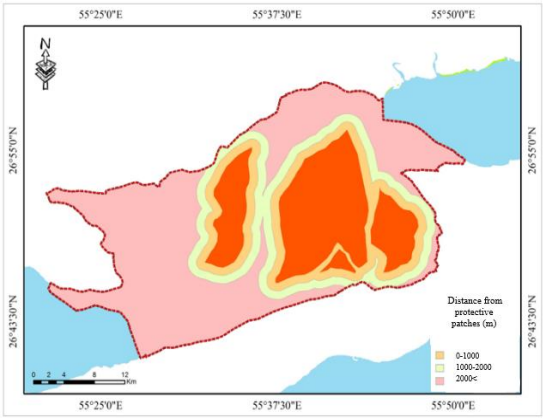

Figure.19. Map of the distance from protective patches

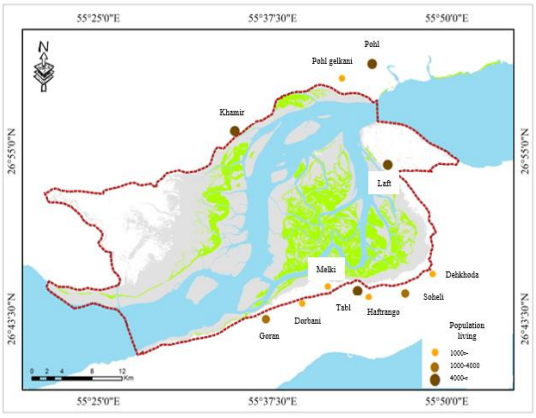

Figure. 20. Map of the population living in the area

In this study, the Topsis method was used in the Topsis Solver software to prioritize recreational activities (Tables 10 to 15). Based on the results obtained from the ranking of recreational activities, the highest priority is related to option 2, and the next priorities include options 3, 1, and 4, respectively (Table 16). In this regard, Mirzaei (2021), discussed the zoning and integration of tourism activities in the coastal cities of Hormozgan province. The results showed that Bandar Abbas city has the highest priority (in terms of favorable zones) for the development of recreational activities in this area. In another study, Sorkhaei et al. (2022), investigated the effective criteria in the development of sports and tourism activities in the coastal areas of Hormozgan. They stated that prioritizing the development of sports activities in this area requires the examination of economic-marketing criteria, infrastructure facilities, public relations and advertising, social-cultural, political-security, and management factors.

Table 10. Creating a decision matrix

Option	Road access network	Distance from the city	Location of settlements	Existing sea infrastructure and ports	Distance from protective patches	Resident population
1	1	2	3	5	4	2
2	2	1	4	5	5	3
3	1	2	3	4	5	4
4	4	1	3	5	2	4
Criterion type	–	–	–	–	+	+
Criterion weight	0.168	0.104	0.115	0.215	0.187	0.152

Table 11. Matrix normalization

Option	Road access network	Distance from the city	Location of settlements	Existing sea infrastructure and ports	Distance from protective patches	Resident population
1	0.21	0.63	0.45	0.52	0.47	0.29
2	0.42	0.31	0.61	0.52	0.59	0.44
3	0.21	0.63	0.45	0.41	0.59	0.59
4	0.85	0.31	0.45	0.52	0.23	0.59

Table 12. Determination of positive and negative ideal solution

Option	Road access network	Distance from the city	Location of settlements	Existing sea infrastructure and ports	Distance from protective patches	Resident population

+	0.035	0.032	0.051	0.088	0.110	0.089
–	0.14	0.065	0.07	0.111	0.043	0.044

Table 13. Determining the distance from the positive and negative ideal solution

Distance size	+	–
1	0.070	0.11
2	0.031	0.10
3	0.044	0.13
4	0.09	0.05

Table 14. Proximity to the positive and negative ideal solution and the ranking of the options

Option	Proximity factor	Rank
1	1.68	3
2	3.32	1
3	3.08	2
4	0.60	4

Table 15. Prioritization of recreational activities in the studied area

Priority	Options (combined recreational activities)
1	Visiting villages near the forest, walking in the forest, watching marine wildlife, visiting the forest with a balloon
2	Photography in mangrove forest, traditional fishing, Jet boating, watching marine wildlife, visiting the forest with a balloon
3	Walking in the forest, watching marine wildlife, visiting the forest with a balloon
4	Sunbathing on the beach, Atv's on the beach, camping in mangrove forest, watching muddy islands and forest, walking in the forest, watching marine wildlife, visiting the forest with a balloon

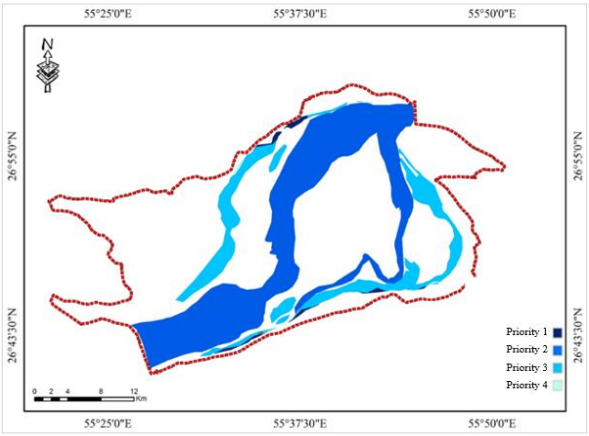

Figure. 21. Map of prioritizing recreational activities in the area

5. Conclusion

Selecting appropriate activities and their distribution in natural areas is one of the most important issues in tourism management and planning in natural ecosystems. Accordingly, the present study identified suitable zones for the development of recreational activities in Hara PA, each of these activities was prioritized according to the capabilities of the natural areas and effective criteria for their development.

As the results revealed, the zoning of recreational activities in this area includes 4 options of how to combine the recreational activities demanded in the mangrove forests of Hara PA. Based on the ranking of activities, the highest priority is related to option 2,

and the next priorities include options 3, 1, and 4, respectively. In general, measuring the proportionality of recreational activities in tourism destinations, especially in PAs that have legal prohibitions and potential biological and protective restrictions for human activities development (both physical and economic activities), is essential and can lead to proper planning and management. In fact, the successful development of a tourist destination can be based on effective planning and in compliance with the principles of sustainable development, and this goal is achieved when the development of suitable and developable recreational activities in the region is addressed. According to the results obtained, one of the most important factors in the development of sustainable nature tourism, as well as the possibility of using the power and tourist attractions in natural ecosystems, is the zoning and prioritization of recreational activities according to the environmental conditions of the region. Considering that the mangrove forests of Hara PA are among the valuable protected reserves of the southern coasts of the country, prioritizing recreational activities in suitable areas and outside the protection zones of the region can help to sustainably use the capacity of natural resources and the appropriate distribution of recreational activities in the area while protecting these natural habitats. In addition, for a more detailed investigation, it is suggested that the zoning of recreational activities in other mangrove habitats in southern Iran be investigated and analyzed with other methodologies in future research.

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