

## **Qeshm Geopark and an Evaluation of its Capabilities for Various Activities**

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### **Abstract**

The registration of Qeshm Geopark as the first geopark of Iran and the Middle East region in the list of global geoparks by UNESCO along with its natural, cultural, historical, economic, commercial and military capabilities has brought Qeshm Island to a unique position. It has made it have international value in addition to national and regional value. One of the ways to achieve coordinated development with the principles of sustainability and spatial planning is to evaluate the ecological potential of areas; this article examines the potential of using Qeshm Geopark for various activities. The current research has evaluated the potential of Qeshm Geopark in relation to agricultural activities, environmental protection, tourism, urban and commercial development, and industrial development using a systemic perspective and providing an ecological model. In this research, documentary information was collected from available library sources, and in the next step, maps related to the shape of the land in Qeshm Geopark were prepared in the GIS environment, after combining and analyzing the maps and combining them with existing social information. Economic information, in the final exploitation capacity of Qeshm Geopark, based on the ecological model of exploitation and using the multi-factor evaluation method, has been investigated at the level of the whole island. The results show that Qeshm Geopark has a suitable and high capacity for tourism development and extensive and concentrated industrial development and lacks sufficient capacity for agricultural development. And the ecological potential and urban development and environmental protection has been assessed as moderate.

**Keywords:** Qeshm Geopark, Ecological Power, Power Evaluation, Spatial Planning.

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## **1. Introduction**

Geo-park is a relatively new concept and phenomenon that has been proposed in connection with earth sciences (geology, geography, geomorphology, etc.) and includes goals such as strengthening sustainable development at the local level (geo-tourism), maintaining a healthy environment, protecting the earth's heritage and learning and teaching earth sciences on a large scale; and is followed by UNESCO. Till today, 53 national geo-parks have been registered in the UNESCO Global Geo-Parks Network, of which 18 geo-parks in China have been identified and registered as a network (Ziari and Omranzadeh,2008). Geopark is a rather novel concept and phenomenon that has been developed in the field of earth science (geology, geography, and geomorphology – among others) to fulfill such goals as stimulate sustainable development on a local scale (geotourism), protect a healthy environment and the heritage of the earth, and teach and learn earth science extensively (Lukáč and et al,2021; UNESCO,2020b), and it is pursued by UNESCO (Nekoe Sadri and et al, 2022). Geopark is a land with well-defined boundaries and sufficient area to supply economic development in the future, and it should contain several interesting geological sites that offer a combination of scientific characteristics, the rarity of the beauty of the phenomena, and the illustration of the geological history of the region (Saadatifar and et al,2021: 59). Indeed, geoparks are ranges with well-defined boundaries and sufficient expanses that include several rare and distinguished geological phenomena with valuable natural, historical, and cultural attractions. They need to be supplied with plans to manage their development and operation, protective schemes, and the power to enhance local people's economic status and attract public participation (UNESCO,2020a). The Global Geoparks Network was formed in 2004 with the support of UNESCO, and the first members were 17 geoparks in Europe (Nikolova and Sinnyovsky,2019) and 8 geoparks in China (Jones,2022). By 2022, 177 geoparks from 46 countries were registered in the UNESCO Global Geoparks Network, and Qeshm Geopark is the only one in Iran and the Middle East that is on the list (Darban Astaneh and et al,2021). Investigating Qeshm Geopark and evaluating its ecological power for various applications and developments are significantly important as it is the first geopark in Iran and the Middle East recognized nationally and internationally, has a sensitive island ecosystem and special location, has been explicitly influenced by the

development schemes carried out over the past few years, is the largest island in Iran and hosts a free trade zone. Qeshm Geopark, besides some instances of insufficiency, enjoys numerous opportunities and potential powers; its historical and cultural attractions, rich underwater life, its significant area, local vegetation, its special location, the establishment of a free trade zone in it, the opportunity to host provide entertainment activities during the cold season, its economic, social, and demographic structures, and the geopark phenomena of the island (Zahmatkesh Marmi and et al, 2017; Dashti and et al,2017; Nateghi and Bayat,2020) highlight the necessity of investigations similar to the present study. The present study aimed to determine uses according to the ecological power of the island, specify a convenient zoning for each use, and offer a scientific ground and accurate basis for the development of various activities in it by identifying the ecological power of Qeshm Geopark and evaluating its power to supply various activities by considering its potential. Indeed, the study intended to answer the following question: “What are the activities that the island can sustainably supply by considering the national, regional, and international significance of Qeshm Geopark, the present non-sustainable process of development, the need to determine its ecological capabilities and select accurate and appropriate sites for various uses, and plan according to the principles of sustainable development and environment protection. In this study, the potential of Qeshm Geopark has been evaluated in relation to agricultural uses, environmental protection, extensive tourism, concentrated tourism, urban and commercial development, and industrial development, and considering that in this research, all these potentials are examined together for Qeshm Geopark. Therefore, the present research is innovative in this respect.

## **2. Theoretical Foundations**

### **2-1. The Concept of Geopark**

Despite their limited geographical areas, free zones, in the light of their existential philosophy and different management systems, can be turned into small centers with great roles in macroeconomic systems in the arena of geoeconomic equations. However the economic role of these regions in geoeconomic equations is to a great extent under the influence of geopolitical position of the region (Valigholizadeh and Allahveridizadeh, 2010). Free zones are one of the economic policies that decision makers and Macro Policy makers of countries pay attention to in order to increase the

competitiveness of the national economy. So that the attraction of investment, production and export is one of the main goals of free zones, especially in developing countries, without their fulfillment, the free zone cannot be considered successful, and with their fulfillment, other goals, such as employment and regional balance will take shape (Islamic Parliament Research Center,2021). Therefore, turning a District into a free zone requires having a series of factors that guarantee the progress of that region and the country (Rashnoudi and et al,2019). In the meantime, the geopolitical and transit location of that area plays a significant role in the location and selection of free zones. In fact, a the passageway location means a place of passage, if a passageway location is important on a regional scale, it is considered a geopolitical position, but if it is important on a global scale, it is considered a geostrategic position. From this point of view, areas that have a passageway location and geopolitical and have a strategic role in global trade and commerce have a greater chance of being Placement as free zoon (Pourahmad and et al,2016). Iran can help to improve the status of its maritime power in the regional and extra-regional arenas by enjoying the economic benefits and commercial shipping (Allahverdizadeh and Ghaderi Hajat,2024). Studies of tourists' behavioral preferences from attractive places are a part of the spatial planning process of cities. Recently, this category of studies has been the focus of behavioral-spatial geography researchers due to its spatial-behavioral nature (Ziari and et al,2019). Investigating the ecological potential of the land is a subject that doubles the importance of investigating this research, and therefore Spatial Planning can be considered as a decisive keyword. Spatial planning is a systematic evaluation of natural, social, economic, cultural factors, etc., in order to find a way to encourage and help the user community in choosing suitable options for increasing and sustaining the land capacity in order to meet the needs of the society (Makhdoum,1993). Spatial planning or land management, spatial and social justice in all fields, as well as organizing and organizing the geographical space as the habitat of Iranian citizens at the national, regional, local and physical levels, and one of the foundations of the country's evelopment It facilitates the general and political management of the country (Ghaderi Hajat and Golkarami,2020). Geopark can be considered equal to the “geological park” and should be defined as areas hosting unique geological phenomena where a portion of the history of the earth can be observed (Luká~c and et al,2021). However, the concept of

geopark is beyond an attraction or a significant geological area. That is because, in addition to their geological, cultural, historical, and ecological importance, geoparks are the heritage of long-term natural and human activities and need to be constantly protected and managed (Brilha,2018). Indeed, extensive and increasing changes in industrial societies, the unprecedented growth in the global population, and the increasing need for resources have resulted in the destruction of the surface of the earth and the extinction of environmental elements. Consequently, detecting and introducing expanses called “geoparks” that can guarantee the protection of the ancient heritage of the earth seem necessary (Henriques and Brilha, 2017). The idea of creating geo-parks is basically based on an ecological view and is expressed along with the relationship between man and nature and their mutual benefit, which includes the productivity of natural gifts and cultural and human achievements, as well as their support and protection. The type of land use, followed by environmental assessment to apply appropriate land uses, is of great importance in environmental protection and sustainable development. Accordingly, "inappropriate land use must be prevented and socio-economic goals, physical constraints and environmental sites must be met" (Ziari,2003:3). Since holding a UN conference on environment and development in Rio de Janeiro in 1992 where an agenda titled “science for development and environment in the 21<sup>st</sup> century” was approved, the protection and conscious management of the environment was extensively agreed upon as a high priority (Shayan Yeganeh and et al, 2020). The same topics were recognized and approved in the World Summit on Sustainable Development (WSSD) held in Johannesburg in 2002. The introduction of geoparks added a new dimension to the 1972 Convention, which investigated the protection of the natural and cultural legacy of the world by emphasizing the potential power of the mutual relationships between socioeconomic and cultural development and the protection of natural environments (Jones,2022). A geopark is a national protected area that contains at least one earth science site and is significant in terms of being scientific, rare, and aesthetic (Zangeneh Asadi and et al,2020). Indeed, the geopark was a program propagated by the earth science department of UNESCO that was formed to attract local communities’ participation in the sustainable management and operation of an expanse to protect and maintain the geological, natural, and cultural legacy of the earth (Fornaro and Fernandes,2018). UNESCO’s Executive Board has endorsed the

addition of 18 sites to the UNESCO Global Geoparks network. This brings the total number of geoparks to 195 in 48 countries. Two UNESCO Member States join the network: New Zealand and the Philippines (UNESCO 24 May 2023 ). UNESCO offered a clear and comprehensive definition for geopark: “an expanse with well-defined boundaries and sufficient area to contain several rare and distinguished geological phenomena where valuable natural, historical, and cultural attractions can also be found. The area should be supplied with programs for managing the expansion and operation of them and protecting them and have the power to enhance the economic level of the local community and attract public participation (Global Geoparks Networks,2022). Based on UNESCO’s definition, each geopark has to have five characteristics as follows: the area should be significant from cultural, archaeological, and ecological perspectives in addition to its geological importance, managerial plans should be implemented in a geopark according to the definitions of geotourism to assist the socioeconomic condition of the region, an area is recognized as a geopark when people’s privacy and people’s local and public social rights are safeguarded simultaneously, the ground should be laid for raising people’s awareness and enhance the conditions of the geopark and environmental issues, and it should act as a part of a global network and work in an integrated way toward the sustainable development of cultural heritage (UNESCO,2020a). In addition to UNESCO’s official definition, it can be stated that a geopark is an area whose major characteristic is the existence of significant geosites, rich nature and environment, attractive cultural characteristics, and, most importantly, the active participation and presence of the local community in carrying out development, protection, and sustainability plans (Catana and Brilha,2020). Geoparks are among the best models to fulfill the sustainable symbiosis of humans and the earth. Moreover, unlike protected areas, they do not limit the entry and presence of visitors (Nekoe Sadri and et al,2020), but they are designed for them. This is something that can result in the sustainable prosperity of local economies (Han and et al,2018). Geoparks pursue diverse goals like developing the economy of local communities via the burgeoning of geotourism, explaining the value and authenticity of the earth and nature in people’s minds, stimulating public participation in the protection and maintenance of the geological heritage, and raising people’s awareness and knowledge about earth science – to name but a few. The necessary condition for the success

of a geopark is introducing convenient and accurate plans and strategies to its management; they can include strategies to protect, operate conveniently, empower local communities, and sustainably develop geoparks (Tabas Geopark,2022). Geoparks, the development of geotourism, and the protection of the environment .A geopark refers to an expanse with sufficient area that results in economic development, particularly because of the expansion of tourism. In other words, geoparks fulfill their goals by adopting a tripartite approach, including protecting significant geological forms, extensively training the public in earth sciences, and burgeoning geotourism (Nikolova and Sinnyovsky,2019). Meanwhile, geotourism makes visits to the attractions of the earth organized and purposeful and prevents their destruction by humans through creating and defining geoparks (Rodrigues and et al,2020). Indeed, geotourism is a part of a growing global industry, which is supported by people seeking to achieve a scientific understanding of the surroundings (Henriques and et al,2019). In other words, geotourism is a phenomenon is a driving force that helps visitors to nature to raise their awareness about natural resources, the cultural characteristics of their hosts, and ways to protect them (Saadatifar and et al,2021). Geotourism is a type of tourism that gained more prominence after the introduction of the concept of geopark by UNESCO in 2000. It is indeed a form of cultural and natural tourism that is intertwined with geological phenomena (Mabvuto Ngwira,2019). Thus, it can be argued that geoparks instigate the development of tourism by implementing unique geological resources and other characteristics; particularly, geoparks are not merely mechanisms to protect geological resources but aim to increase the rate of employment and enhance the local residents' welfare standards (Frey,2021). At the moment, many countries conduct extensive research studies to detect convenient sites to be registered as geoparks (Rodrigues and et al,2020). Iran can become a significant country in terms of the number and quality of geoparks as it has an area of above 1,500,000km<sup>2</sup>, occupies a unique position in the world in terms of geographical, geological, cultural, environmental, and ecological perspectives, hosts convenient locations for geoparks, and has the potential power in that regard. Nevertheless, only Qeshm Island has so far been identified and registered as a geopark in Iran. The instances of geological heritage in Iran that have the potential to be introduced as geoparks include the Shirvan Valley and the freshwater lake on top of Mount Sabalan, the beautiful Namak Lake in

Dasht-e Kavir, marvelous salt crystals in Semnan, Takht-e Soleyman, Ali-Sadr Cave, Lake Urmia, Mount Damavand, Kish Island, Hovz-e Soltan, Alamut in Qazvin, Dasht Arjan in Fars Province, and Quri Qal'eh Cave in Kermanshah (Nateghi and Bayat,2021). As it was mentioned before, one of the goals of creating geoparks was to protect the environment and its valuable elements. In other words, protecting the environment and its landscapes, preventing changes in them, and stopping human interference to transform the surface of the earth were the main goals of the introduction of geoparks (Nekouee Sadri and et al,2022). Thus, the idea of creating geoparks was founded on an ecological perspective that highlighted the mutual relations of humans and nature and the benefits of both parties as they were considered responsible to support and protect natural gifts and cultural and human achievements in addition to benefiting from them (Shekhar and et al,2019).

### **3. Method**

The present study aimed to investigate and assess the ecological power of Qeshm Geopark in an attempt to evaluate its power to provide for various activities (e.g., agriculture, environment protection, extensive tourism, concentrated tourism, urban development, commerce, and industrial development). Thus, the study implemented a qualitative methodology in terms of its content and nature. Moreover, it was an applied study in terms of the goals and could be classified as a descriptive and analytical study in terms of its nature. As a result, as it was necessary to consider any factor that influenced the evaluation of the ecological power of Qeshm Geopark for various uses, the present study was based on a systemic analysis approach. First, documentary information was collected from the available library resources and relevant organizations. Then, maps related to the shape of the earth in Qeshm Geopark in the GIS environment were obtained and were integrated and analyzed. Finally, the maps were combined with the existing socioeconomic information, and the power of Qeshm Geopark was investigated for the whole island based on an ecological model and the multi-agent evaluation method.

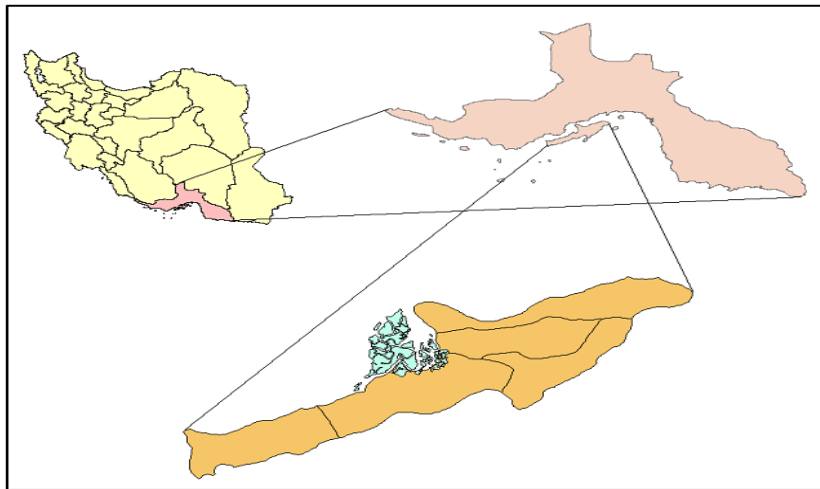
### **4. The Investigated Area**

Due to its privileged geographical location, the Persian Gulf has been a crossroads and a meeting place for many peoples and nations of the ancient world, and it has always been of interest due to its neighborhood with

relatively important countries and having resources and wealth. From this point of view, the importance of the Strait of Hormuz is also affected by the importance of the Persian Gulf; That is, the value-creating factors of the Strait of Hormuz are located in the fields of communication and economy in the Persian Gulf, and the Strait of Hormuz is the connecting level of the economy of the geopolitical unit of the Persian Gulf with the world economy. The Strait of Hormuz is one of the sensitive and strategic straits of the world, which is considered one of the geographically effective factors in the balance of power and regional and international tensions due to its communication, geo-economic, geo-strategy and geo-political values (Shamlou and Faraji Rad,2020). In the meantime, Qeshm Island has a strategic position due to its location overlooking the Strait of Hormuz and the inlet to the Persian Gulf and the Sea of Oman (Valigholizadeh and Zaki, 2011). In fact, Qeshm Island, which is the largest island in the Persian Gulf, is one of the most strategic islands of Iran and the Gulf in the Panamax category due to its proximity to the Indian Ocean, the presence of oil and gas resources, petrochemical units and refineries, and coastal equipment and port facilities for large ships. that world-renowned for its fueling services for ships passing through international waterways and energy and biotechnology parks.(Amiri and et al,2021). Also, the commercial-industrial free zone of Qeshm includes about 300 square kilometers of this island. Due to its location in a key point of the North-South transit corridor, access to the East-West international flight corridor, and its port facilities, which are somehow complementary to Shahid Rajaei Port, this area plays a prominent role in global trade .The goals and main axes of the activities of this commercial-industrial free zone include the development and expansion of the transit and transportation industry, the expansion of trade and commercial services, energy-intensive industries, biotechnological industries and marine resources, tourism industries, fisheries and industrial fishing, oil support services and parks It is energy (Lechinani and Esmaili, 2022). Qeshm is a country in Hormozgan Province, which was registered on the UNESCO list of global geoparks in March 2005 due to its unique natural, cultural, and historical phenomena and diverse landscapes (Nateghi and Bayat,2021; Darban Astaneh,2021). Qeshm Island is the largest island in Iran and has a strategic location at the mouth of the Persian Gulf near the Strait of Hormuz (Qeshm Free Area Organization,2019; Alizadeh Touli and et al,2021). In terms of morphology and geological composition, the island

is the southern trail of the Zagros Mountains that reveals the majority of its composition and forms like a mock-up (Mohammadi Ghasriyan and Zarei, 2017). The Qeshm Island is located at a longitude of  $26^{\circ}30'27''\text{N}$  and a latitude of  $55^{\circ}15'56''24'\text{E}$  (Benshams and et al, 2020:745) and has an area of almost  $1500\text{km}^2$  (Eftekharifar and et al,2019:63). Figure (1) illustrates the location of the investigated area. The city of Qeshm is the center of Qeshm Island, which is located as a semicircle on the northeast of the island 10m above sea level. The highest point in Qeshm is 397m high (Dehghan and et al,2019:38-39). The climatic characteristics of Qeshm Island include a long warm and wet season, a short mild season, little annual rainfall, high temperature, and the incomplete and slow process of soil formation (Kianinejad and et al,2017:11-112).

**Figure (1): The Location of the Investigated Area in the Country and the Province**



## **5. Discussion and Analysis**

### **5-1. The Stages and Method of Evaluation**

Evaluating the ecological power of a country is assessing its supplies and potential capabilities using clear-cut predetermined criteria (Amanollahpour and et al,2019). Indeed, it provides the necessary information on the resources of the earth and is the logic of decision-making on the selection of a particular use for an expanse of land based on analyzing the relationships between the elements to distribute and establish activities that conform to

the geographical characteristics of that expanse (Yarmohammadi and et al, 2018). Thus, the process of evaluating the ecological power of the environment for planning, zoning, and selecting nature-friendly uses is comprised of three main parts, including the detection of natural (ecological) resources, the analysis and conclusion of resources, and the evaluation of the ecological power of the environment (Tabibian and et al, 2022). Several methods can be implemented to detect the ecological resources of an expanse, and the present study mostly used the available statistical reports and information layers, topography maps, and the Geographical Information System (GIS). The natural and ecological resources of a land can be classified into two main categories, including physical resources (e.g., climate, hydrology, geomorphology, and geology – to name but a few) and biological resources (e.g., flora and fauna) (Tsesmelis and et al,2022). As the evaluation of the power of land requires a significant number of parameters related to natural resources, the results of the above investigation and detection need to be transformed into maps applicable in the ecological model of evaluation in the conclusion stage. At this stage, the maps of the resources of the land are collected and are transformed into a unified map illustrating the unit of morphology. Then, the map is combined with the vegetation map of the region (typically in GIS environment), and the map of the environmental units of the land is obtained for the final evaluation of the environment and the application of the factors concerning the intended use. Indeed, all available information layers need to be analyzed and concluded after preparing the maps. This involves the process of mapping or illustrating a simple or complicated set of the parameters of natural resources on the map of the distribution of the resources of a region or area. This set is called the Land Mapping Unit (LMU). The LMU can be a network, a polygon, or a portion of the land with shared and homogeneous characteristics (Gerçek,2017). As a particular ecological model needs to be defined for every region, the next stage involves applying determining parameters for each use according to the table of the ecological mode, which is designed to prepare classified maps, and specifying the convenient level of each use (an indication of the power of the land concerning each use). In the stage, the ratio and percentage of each use to the overall land is calculated separately, and, finally, they are processed to determine the power of the land to provide for various uses and their prioritization. Prioritizing various land uses is conducted using diverse

qualitative and quantitative methods or the socioeconomic studies of land use. The present study utilized a quantitative methodology in the form of summing up the scores obtained for each use in addition to the relevant socioeconomic information. The socioeconomic information of the region should be presented both in the form of a table and a map illustrating the land use in the existing condition.

### 5-2. Evaluating the Power of Qeshm Geopark

As was mentioned above, the first thing that should be done in evaluating the ecological power of a land is detecting the environmental resources in it. Thus, first, the ecological resources of Qeshm Geopark were collected to evaluate the power of the island. The results are presented in Table (1).

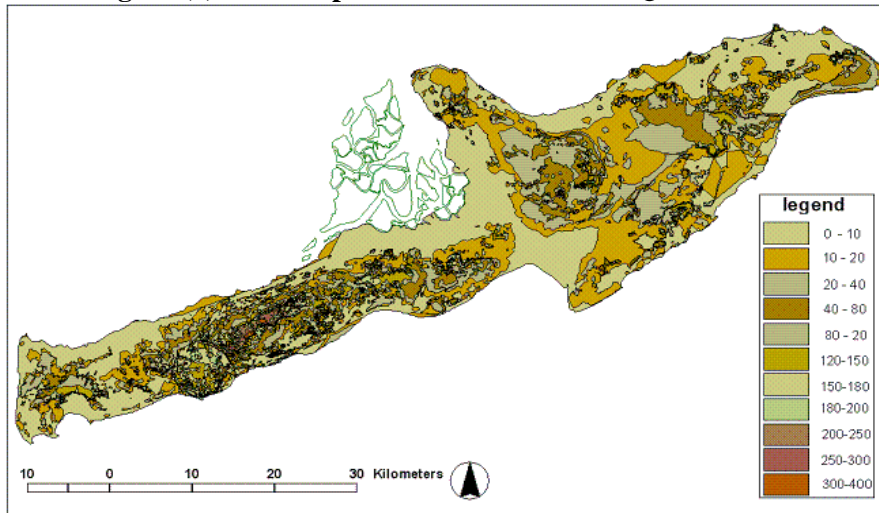
**Table (1): A Classification of the Ecological Resources of Qeshm Geopark**

<b>The ecological resources of Qeshm Geopark</b>	<b>Landform</b>	Landform maps consist of gradient maps, the direction of gradients, and the altitude of regions, which are basically considered the primary foundations of environmental units and make up the basis of evaluation. The maps were prepared using the topography maps of the region based on the UTM system. In other words, first, the Digital Elevation Model (DEM) of Qeshm Geopark was created in the GIS environment. Then, the above maps were extracted from it.
	<b>Geology</b>	Qeshm Island forms the south-southeastern fold of the Zagros Mountains. Several series of anticlines are the results of geological processes and their impacts on the deposits of the land. Namakdan Mountain is a cylindrical mountain located between the Salakh and Basaidu anticlines and has been formed as a result of various tectonic pressures. The mountain contains sedimentary formations.
	<b>Soil</b>	The soil of the island is a combination of sand, sandy loam, clay, and clay loam, which turn into claystone. The process of soil in Qeshm Island is incomplete and slow.
	<b>Vegetation</b>	<ul style="list-style-type: none"> <li>- Diverse vegetation of the island.</li> <li>- Relative paucity of the concentration of the vegetation.</li> <li>- The vegetation of the island includes the following layers: grey mangrove forests, date palm gardens, the wood-arboreal vegetation, shrubs, grass, bush, areas with no vegetation, forestlands being cultivated, and agricultural lands.</li> </ul>
	<b>Geomorphology</b>	<ul style="list-style-type: none"> <li>- The average altitude of the island is 150-190m.</li> <li>- Altitudes that range from the east to the west form 500km of the area of Qeshm Island.</li> <li>- The special shape of Namakdan Mountain is because the process of orogeny in that area is more intense than the</li> </ul>

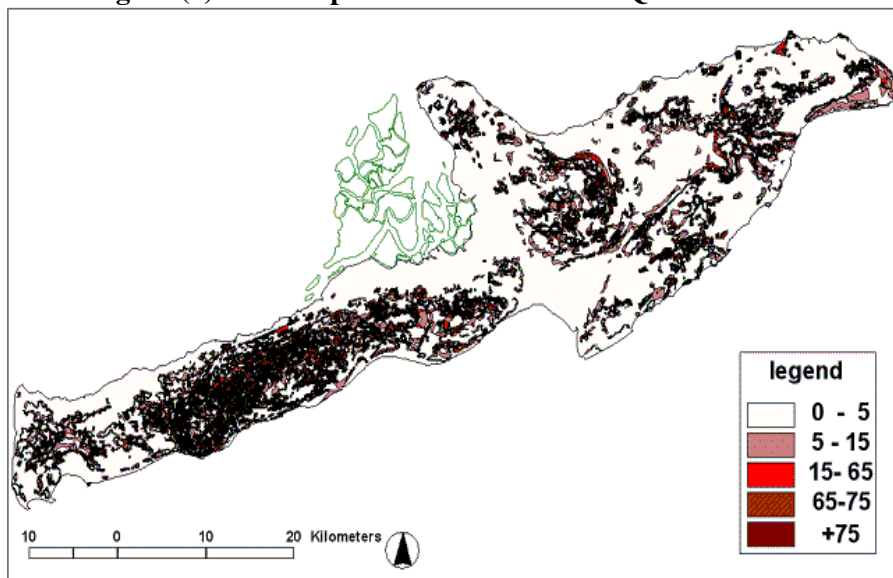
		whole Island.
	<b>Climate</b>	<ul style="list-style-type: none"> <li>- Little annual rainfall.</li> <li>- High temperature and humidity all over the year.</li> <li>- A long hot and humid season and a short mild season.</li> <li>- The low altitude of the island from the sea level, being a neighbor of the sea, and getting influenced by polar, tropical marine, and tropical air masses.</li> </ul>
	<b>Fauna</b>	<ul style="list-style-type: none"> <li>- The existence of various types of mammals (gazelle, rabbit, porcupine, and fox – to name but a few).</li> <li>- Reptiles, amphibians (snakes, lizards, scorpion, and green tortoises), and about 93 types of birds and domestic animals.</li> </ul>
	<b>Existing habitats</b>	Grey mangrove forests, birds’ habitats, the habitats of green tortoises, mammals’ habitats, the habitats of shrimps and fish, fishing spots, and the beautiful shores of the island with high potential for tourism.

To evaluate the power of Qeshm Geopark, it was necessary to identify its ecological resources, and, then, transform all such resources into classified maps to be used in the proposed model. The basis of the maps prepared for the present study was seven sheets of 1:50000 maps of Qeshm Island, which were utilized for the analyses after being geometrically modified in the GIS environment and performing the process of mapmaking. The first maps required to evaluate the power of the land were the region’s landform maps (the maps of elevation levels, gradient, geographical directions, and hydrography-waterways). The maps are illustrated in figures (2-4).

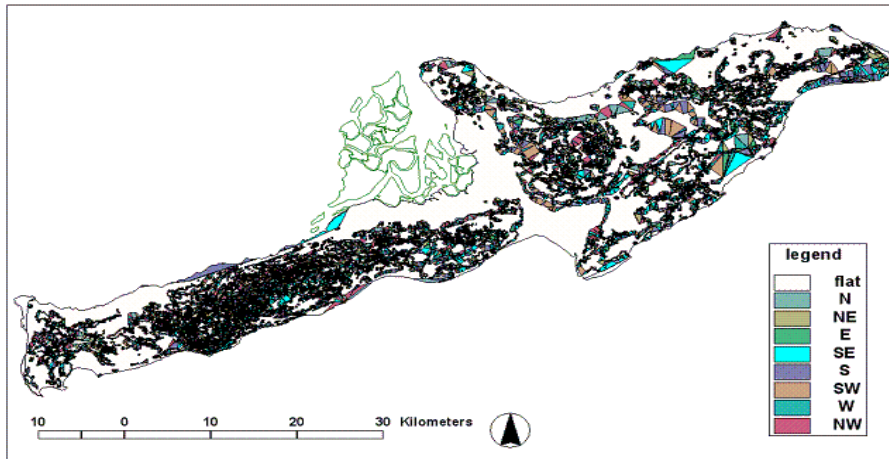
**Figure (2): The Map of Elevation Levels in Qeshm Island**



**Figure (3): The Map of Gradient Levels in Qeshm Island**

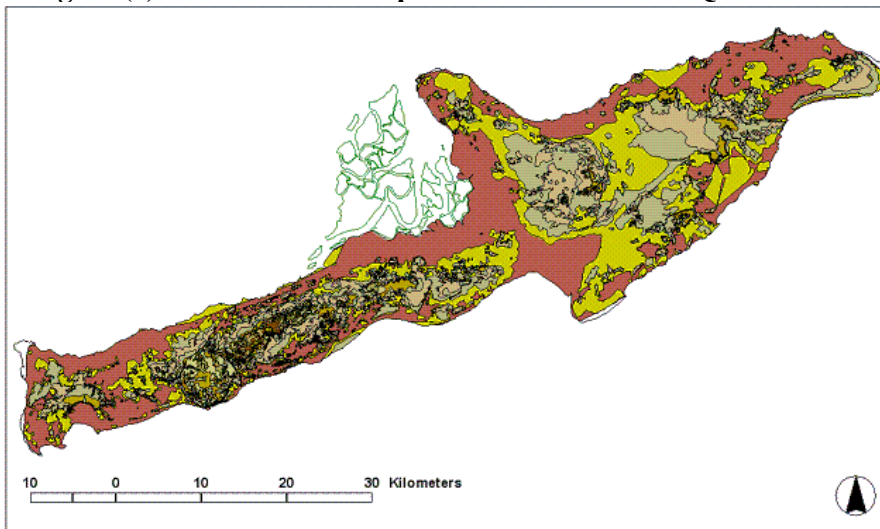


**Figure (4): The Map of Geographical Directions in Qeshm Island**



The outcome of maps (2-4) should be a map of landform units obtained by combining and adding the above maps. This needed to be conducted by reclassifying maps (2-4) and transforming them into a vector map after combining them. The outcome of the above process, which indicates the map of landform units in Qeshm island, is illustrated Figure (5).

**Figure (5): The Obtained Map of Landform Units in Qeshm Island**



In this first stage of the study, in addition to the identification of the natural (ecological) resources of Qeshm Island, identifying its socioeconomic resources was essential to prioritize the land uses in the final stage. The obtained information are presented in Table (2).

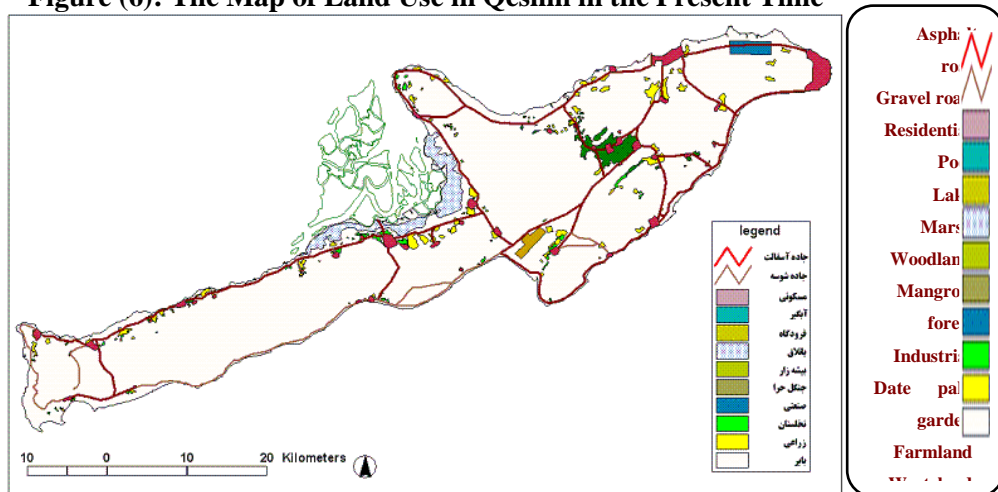
**Table (2): The Socioeconomic Resources of Qeshm Geopark**

<b>The socioeconomic resources of Qeshm Island</b>	<b>Population</b>	According to the national census in 2016, the population of Qeshm was 148,993 people. Out of the number, 44.8% lived in urban areas, while 55.2% lived in rural areas. The population of Qeshm city in the period was reported at 40,678 people.			
	<b>Employment</b>	In 2016, the employed and unemployed (seeking job opportunities) people in Qeshm made up 38.9% of the +10 population of the island. Out of the active population, 96.5% were males, and 3.5% were females.			
	<b>Literacy</b>	In 2016, out of the +6 population of Qeshm Island, 86% of the people were literate.			
	<b>Economic Activities</b>	Agriculture	Farming	Farming activities in Qeshm Island are limited and performed according to the dryland farming method due to the warm air and dry land.	
			Animal Husbandry	Animal husbandry in Qeshm Island has the same limitations and weaknesses as agriculture.	
			Catching Shrimps and Fish	Catching fish, shrimps, and oysters are some of the major economic activities and sources of income for the local residents of Qeshm Island. In other words, about 20% of the workforce are active in the field.	
		Mines and Industries	Mines in Qeshm Island include natural gas, sand, and blue salt. At the moment, the most remarkable industries in Qeshm include ice-making, salt factories, flour mills, mosaic factories, concrete block workshops, cold storage facilities for the fishery, and launch manufacturing industries (the oldest industry in the island). Out of 3816 people employed in the mine and industry sections, 3107 people work in the field of construction.		
		Services	Access and Communication Networks	The access and communication networks of Qeshm Island include three ways: aerial, land, and marine.	
			Residence for Tourists	Qeshm Island has 42 motels and 46 hotels.	
	Medical Facilities		Qeshm Island has a 40-bed hospital, three laboratories, six pharmacies, and ten medical clinics.		

			Water Resources	The water of Qeshm Island is supplied from the alluvial aquifer located outside the urban area in Hourian Valley by four semi-deep wells. However, the network cannot meet people's needs. In other words, 40.25% of the population benefit from piped water. Several water desalination plants are installed in the island. The sewage is directed toward several leaching pits.
Tourist attractions of Qeshm Geopark	Natural	Salt dome and caves, mangrove forests, sulfur springs, fantastic valleys, mineral water springs, Chahkooch Canyon, the habitat of Iranian gazelle, the valley of statues, the neighboring islands, Tang-e Aali, the Stars Valley, the habitat of dolphins, green marine tortoises, Qeshm birds, the sacred fig, and geopark highlands – to name but a few.		
	Cultural and Historical	Kharbas caves, the traditional architecture of Qeshm, wind towers in Laft, Tallaght wells, historical castles in Qeshm Laft, and Basaidu, various shrines in the island.		

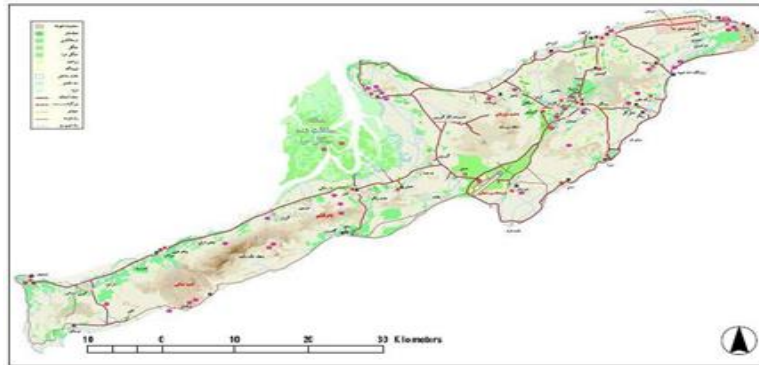
As was mentioned above, the socioeconomic information of the investigated region needed to be transformed into a map of land use in the present time so that they could be utilized in the evaluation. Thus, Figure (6) was prepared.

Figure (6): The Map of Land Use in Qeshm in the Present Time



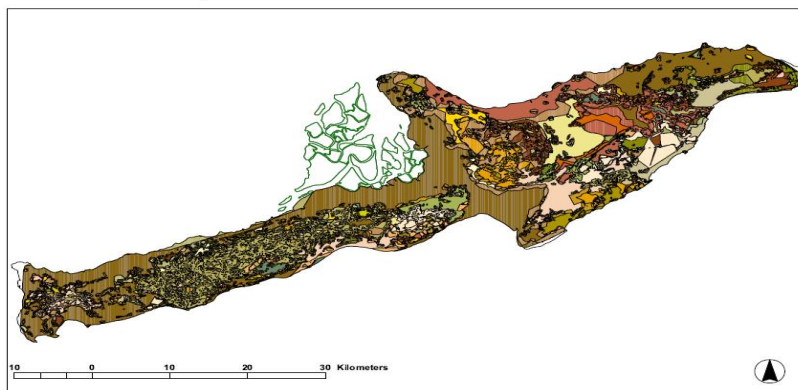
Another important map that is necessary to investigate the power of the land and is necessary for the preparation of the final map of environmental units is the map of vegetation (Figure 7).

**Figure (7): The Vegetation Map of Qeshm Geopark**



Maps and mapmaking are the most important and fundamental instruments in the evaluation of the power of a land. In this regard, the most important map needed in the present investigation was the map of the environmental units of the island, which was created by combining all of the above maps. In this process, the map of landform units and the map of the vegetation of the area were combined, and then, the units of the land with shared characteristics were extracted as environmental units. Each one of the obtained units was indeed a micro-ecosystem with particular ecological parameters and illustrated the characteristics and power of the covered regions. Figure 8 shows the map of environmental units in Qeshm Geopark.

**Figure (8): The map of Environmental Units (LMU) in Qeshm Geopark**



Evaluating the ecological power of a land is the middle stage of land-use planning or environmental planning. Indeed, evaluating a land provides fundamental information to select the best use for it (Varlamov and et al, 2020). In the present investigation, the power of Qeshm Geopark was evaluated concerning agriculture, environment protection, extended tourism, focused tourism, urban development, and industrial development. The creation of an ecological model for each one of the above uses was necessary to achieve the specified goal. The designed ecological model needed to fit the existing information layers and the conditions of the investigated area. Thus, more informative ecological models could be obtained if the information layers were extended and comprehensive. Indeed, evaluating the quality of a land for a particular use in terms of the creation of vulnerabilities and managerial requirements – which are the goals of evaluating the ecological power – is carried out by comparing the ecological characteristics of each environmental unit and the ecological models created for land uses. In this way, evaluating the capabilities of a land to perform the roles required by particular uses is performed. To achieve the goal, the ecological models of the agricultural, environment protection, extended tourism, focused tourism, urban development, and industrial development uses were created (Table 3). The classes of power indicate fitness, average fitness, and the lack of fitness, respectively.

**Table (3): The Ecological Model of the Uses Qeshm Geopark**

Use	The Class of Power	Gradient (%)	Gradient Direction	Altitude	Vegetation
<b>Agriculture</b>	1	0-5	-	5-30	Forests under cultivation, farmlands
	2	0-8	-	30-60	Date palm gardens, tree, grass, bush, farmlands
	3	8-9	-	+60	Mangrove forests – lacking any vegetation
<b>Urban and Business Development</b>	1	1-6	Southern and eastern	10-40	Lacking any vegetation, grass and wood
	2	6-10	Western-eastern and northern	5-10 and 40-50	Wood, grass, and shrub
	3	+10	Southern-western	-5 and +50	Mangrove forests, forests under cultivation, farmlands
<b>Environment</b>	1	+65	-	-	Mangrove forests

<b>Protection</b>	3	0-65	-	-	Date palm gardens, grasslands, tree, bush, lacking any vegetation, farmlands
<b>Industrial Development</b>	1	0-15	-	0-30	Lacking any vegetation
	2	0-15	-	30-50	Shrubs, grass, lacking any vegetation
	3	+15	-	+50	Mangrove forests, ate palm gardens, forests under cultivation, farmlands
<b>Extended Tourism</b>	1	0-25	-	-	-
	2	25-35	-	-	-
	3	+50	-	-	Mangrove forests and farmlands
<b>Focused Tourism</b>	1	0-5	Eastern and southern	-	Arboreal wood vegetation, shrubs, grass, lacking any vegetation, bush
	2	5-15	Northern and western	-	Date palm gardens, arboreal wood vegetation, grass, shrub, lacking any vegetation, bush
	3	+15	Northern and eastern	-	Mangrove forests, forests under cultivation, and farmlands

To evaluate the power of Qeshm Geopark concerning various important uses, the ecological characteristics of each environmental unit was compared and checked with the ecological models created for each use. Typically, urban-business development and industrial development are considered in a single class when the power of land is evaluated for various uses. However, Qeshm Island was a free trade zone, and its trade and urban development was as important as its industrial development. Thus, it was endeared to separate the models of its urban and business development from that of industrial development. Moreover, as Qeshm Island gained national, regional, and international value as a geopark, and tourism became an important consideration in it, the ecological models of extended and focused tourism were separated. In general, the investigations and evaluations of the study were carried out by studying ecological and socioeconomic resources and the intended map-making, and the ecological power of Qeshm Geopark

for the specified uses was determined. In the meantime, along with the goal of creating regional balance and equilibrium via introducing convenient levels for desirable uses, all investigations were based on the systemic viewpoint, scientific principles and foundations, and the sustainable development attitude. The results of evaluating the ecological power of Qeshm Geopark showed that the island had high and convenient power for extended and focused tourism and industrial development, but it lacked sufficient power to sustain agricultural development. Moreover, it was shown that the ecological power of the island concerning urban and business development and environment protection was average. Nevertheless, the environment protection use needed to be prioritized in policymaking due to the protection value of the region (the existence of special habitats).

## **6. Conclusion**

Qeshm Island is the largest island of the country and has a special status in it due to its natural, cultural, economic, business, and security capabilities. As the island was registered in the list of global geoparks in 2016 and gained national and international value, the necessity of considering the future developments of the island and their compatibility with the natural, economic, and cultural characteristics of the island seem more pressing than ever. On the other hand, the geological, natural, and cultural attractions of Qeshm Island have been introduced in the form of 25 geosites that are actively protected according to the protective strategies developed for the management of Qeshm International Geopark. In this way, evaluating the ecological power of the island, determining its power to accommodate various uses, and considering this in policymaking processes are ways to achieve land-use planning and develop according to the principles of sustainable development. Evaluating the ecological power of Qeshm Island concerning agricultural, environment protection, extended tourism, focused tourism, urban and business development, and industrial development showed that Qeshm Geopark had high power for extended and focused tourism and industrial development, while it lacked the sufficient power to supply agricultural development. Moreover, it was shown that the ecological power of the island concerning urban development and environment protection was average. Thus, the following suggestions and solutions could be offered for the future development of Qeshm Geopark based on the above findings.-It was found that the power of Qeshm Island was considerable concerning extended and focused tourism, and it had

significant natural and cultural resources in the field of tourism and was registered as an international geopark. Thus, it seemed necessary to expand the required infrastructure to an acceptable level. Indeed, based on the high ecological power of the region, paying attention to infrastructure and underlying factors would improve the status of the island remarkably.

-As Qeshm Geopark had significant power concerning industrial development, the future industrial development of the island should be geared toward green industries. The necessity arose from the number of the local people seeking job opportunities, the existence of special habitats in the island, and the tourism performance of it.

-Apart from the natural and cultural power of Qeshm Island in the field of tourism, the existence of Qeshm Free Trade Zone significantly increased the importance of the island from the perspective of tourism. Thus, increasing tourism facilities qualitatively and quantitatively and the required public places to offer services to passengers could play pivotal roles in terms of employment, economic development, and tourism attraction.

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