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Evaluating the ecological capability of urban, rural and industrial development and estimating the current settlement of these areas using GIS in Larestan County, Iran

Mohammed Reza Khanbazi[1], Nima Masoudi[2], Masoud Masoudi[1]*

[1] *Department of Natural Resources and Environmental Engineering, Shiraz University, Iran*
[2] *Department of Food Science and Technology, School of Agriculture, Shiraz University, Iran*

*Corresponding author E-mail: masoudi@shirazu.ac.ir

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Abstract
The importance of using rational and systematic methods in the management and optimal use of resources, especially natural resources, is clear to everyone. Improper development of residential and industrial areas leads to the destruction of agricultural lands and natural resources and expansion towards vulnerable areas, such as flood basins and inappropriate slopes, which in fact causes the ecological balance and stability of the land to be disrupted. The necessity of evaluating the ecological capability of urban, rural and industrial development is to objectify the capability of the expected land. The purpose of this research is to evaluate the ecological capability of Larestan County for urban, rural and industrial development. In this regard, the county of Larestan was evaluated using information layers and summarizing them using GIS technology. The evaluation results were presented in two relatively suitable (2) and unsuitable (3) classes. In addition, in this research, the percentage of suitability classes in the estimation of the current establishment of urban, rural and industrial uses was done by superimposing urban polygonal layers, points of villages and industrial areas of the county on the ecological suitability map, and the status of these areas was determined. According to the obtained results, most of the urban, rural and industrial areas are in the third or unsuitable class. In the survey conducted in the rural areas of Larestan county, a large number of villages (83.33%) are placed in the third or unsuitable class, which are scattered throughout the county. 57.3% of the area of urban areas are placed in the 3rd or unsuitable class. The industries of Larestan county are mostly placed in the third or unsuitable class (76.92%), this actually shows that the establishment of industries in Larestan county has not been paid attention to the ecological capability and this can lead to environmental damage. This improper establishment shows that both the industries themselves may be harmed and the industries can cause serious harm to the environment.

Keywords
evaluation of ecological capability, Larestan county, GIS, use of urban, rural and industrial development

Introduction

Throughout history, cities have had a special place as centers of human civilization and have been studied from different angles by different scientists. The goal of all these efforts and investigations has been to create an optimal environment for human life (Molina-Torres et al., 2021). From the earliest days until now, many scientists have tried to propose solutions to solve the problems of the cities of their time (Ragheb et al., 2022). In 2018, the urban popu-

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lation was 55% of the total world population and it is predicted that this number will reach 68% by 2050 (Ritchie & Roser, 2018). The increase in population as well as the unbalanced urban development has faced the world with many problems such as poverty, hunger, increasing inequality within and between countries, marginalization, youth unemployment, health problems, increasing violence and terrorism, looting of natural resources and widespread destruction of the environment (Della Spina, 2020).

In recent years, what is often seen are disturbances and constructions that take place with the aim of urban development (Mohammadi et al., 2016). These challenges and problems indicate the fact that countries cannot continue their healthy life without paying attention to sustainable development (Handayanto et al., 2017). Urban development theories have recognized and analyzed urbanization and the development of cities by relying on one or more different factors, and some of these factors, such as economic conditions, political forces, and social conditions, have the greatest contribution to the urbanization process (Paller, 2021). Development is a dynamic, comprehensive and multi-dimensional thing whose purpose is to improve living conditions, human capabilities, expand facilities, benefit people, etc. (Pendari et al., 2017). Following the excessive expansion of cities and the economic, social and environmental problems caused by them, and with the introduction of the perspective of sustainable urban development from the 1970s and the energy crisis in this period in the 1990s (Van Beuzekom et al., 2015). New ways of preparing urban development plans are formed based on this new perspective (Rahai et al., 2019).

The purpose of evaluating urban development is to achieve the state of sustainability of urban communities, a process that aims to create or consolidate sustainable features in the economic, cultural and environmental life of the county (Cervero, 2020). Therefore, due to the importance of the category of sustainability in the development goals of cities, a wide range of social, economic, cultural, ecological and physical needs is considered to move towards sustainability, which can be defined and cared in the form of county sustainability indicators (Masoudi et al., 2020; Rahimi et al., 2020). In fact, this assessment is an effective step in order to obtain a plan to achieve sustainable development, because by identifying and evaluating the ecological characteristics in each region, development plans can be formulated in harmony with nature (Shafaqi et al., 2017). In order to evaluate the capability, there are several methods, all of which try to optimize the human use of nature based on sustainable development (Alavi Panah et a., 2001). Common evaluation methods in the world are based on the identification of environmental resources that affect the capability and suitability of an area for assumed uses, integration of information and finally, the use of fit models is to determine the best use or uses (Bali et al., 2015). In Iran, in order to achieve land development, the method of evaluating the ecological capability of the environment is multi-factorial, and the evaluation and classification of the land is done by comparing the ecological characteristics of the bio-environmental units and the literal ecological models of Iran (Asadifard et al., 2019; Jokar et al., 2021). In order to evaluate the ecological capability of urban development use, a literal model with three categories of capability (suitable, relatively suitable and unsuitable) has been presented (Makhdoum, 2006). In this regard, Geographical Information System (GIS) is a powerful tool in land use evaluations and increases the accuracy of work speed and reduces evaluation costs (Chang, 2016). This system has special features such as input and output of information and maps from other systems, the possibility of multivariate analysis and integration, the possibility of programming, preparation of spatial data database, analysis of neighborhood units and connectivity, interpolation, routing and many other features. It is one of the most important systems designed in recent years that can enable the implementation of advanced and complex planning techniques in the shortest possible time (Kazemi & Akinci, 2018). Romano et al. (2015) assessed the capability of rural areas in southern Italy using multi-criteria evaluation methods (Romano et al., 2015). Halil Akinchi et al. (2013) evaluated the agricultural capability of Yousefli area of Ertovin, Turkey, using GIS and AHP technique. For this purpose, they used the criteria of slope, direction, height and soil parameters, and after weighting the factors, they were divided into 5 fitness classes based on the FAO method (Akıncı et al., 2013). Dai et al. (2001) used GIS to evaluate the urban development of Lanzhou County and its suburbs in Northeast China.

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For this, they used environmental resources and mapping and concluded that GIS has a very high capability in environmental assessments (Dai et al., 2001). The most important goal of the current research is to determine the capability and quality of Larestan county regarding urban, industrial and rural development uses by studying the physical and biological factors involved in these uses. To achieve this goal, it is necessary to examine the role of each of these factors in order to evaluate the ecological capability of urban, industrial and rural development. Finally, in order to facilitate the analysis of the ecological capabilities of land uses, the percentage of urban, rural and industrial land uses has been calculated.

Materials and methods

Study area

Larestan county is one of the southern cities of Fars province, which is bounded by Hormozgan province from the south and east, Lamerd county from the southwest, Khonj county from the west, and Jahrom and Darab cities from the north. In terms of geographical location, the central and main city of county, namely Lar city, is located in longitude 54° 20′ E and geographical latitudes 27° 40′ N, and its average height above sea level is 850 meters. The distance between this city and the center of the province, namely Shiraz city, is 394 km, and its area is about 17,736 square kilometers, which is the largest county in Fars province. The total population of the county is equal to 282,266 people, of which 142,262 are men and 140,004 are women. This area has an arid and warm climate. This county has 7 wide sections including Central, Gerash, Evaz, Joyum, Benaruieh, Beyram and Sahara Bagh and has 7 cities including: Lar, Gerash, Evaz, Joyum, Benarvieh, Beyram and Khor. Figure 1 shows the location of Larestan county.

Figure 1
Location of Larestan county in the southern part of Iran.

Research methods

The applied ecological model of urban development includes three levels, which decreases from the first to the third level in the degree of suitability and quality of urban development. In order to evaluate the ecological capability for the development of urban use, the usual resource evaluation method called multi-factor evaluation method was used in the method of systematic analysis. In this research, the geographic information system was used as a tool in the identification, processing and analysis of data that can reduce the cost and time of evaluation, in the evaluation of land capability and planning. The current research is based on the ecological parameters

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of Larestan county. Necessary parameters (physical and biological) for evaluating the ecological suitability of urban development including height (E), geographical direction (As), rainfall (Cp), slope (So), prevailing wind speed (Cw), relative humidity (Ch), temperature (Ct), geology (mother rock) (Li), soil drainage (Pdr), soil depth (Pd), soil texture (Pte), soil granularity (Pg), soil evolution (Ps), water discharge (Wc), Soil erosion (Es), vegetation density (Vgo).

In addition, in this research, the percentage of suitability classes in the estimation of the current establishment of urban, rural and industrial uses was also obtained. To do this, urban, point polygon layers of villages and industrial areas of the county were placed on the map of ecological capability of urban, rural and industrial development and the status of these areas was determined.

Evaluation of the environmental suitability of the land

In the stage of information layers processing, to classify the different classes of each layer, the numbers of the classes of urban development parameters in the literal ecological model of Iran were used, and these codes are used to identify the type of subject data in the computer and model (Makhdoum et al., 2009). Each layer was divided into three classes according to three different classes of the model (Table 1). In the phase of combining effective layers, using functions such as overlapping functions, sharing (logic) and, integration, cutting and margin (privacy) in the geographic information system, the layers were combined and combined. In order to implement the limitations in the analysis phase, the main and secondary fault boundaries were set to 1000 meters and 300 meters according to the rules and regulations of the Ministry of Housing and Urban Development, and the river boundaries were set to 1000 meters according to the rules and regulations of the Ministry of Energy in the mentioned software. The area of urban use in the study area was also estimated to be 6187.91 hectares.

When a residential area, city, factory, workshop, etc. are developed in a region, the ecological parameters of the region must have the following conditions (Makhdoum, 2006):

1. Provide a stable and balanced support for the weight of the building.
2. absorb and decompose wastes, effluents, garbage and polluted air resulting from constructions.
3. To provide desired landscape, view and green space in terms of aesthetics and absorption of air and noise pollution.

In this study, comparing the characteristics of the land with the ecological model of urban development, the ecological capability of the mentioned area has been evaluated and classified. In the ecological suitability model, if only one indicator has the characteristic of unsuitable class, the area in question is assigned to the unsuitable area in terms of suitability. Also, in order to be considered part of the first class, all the indicators must have the conditions of the first class in terms of ecological characteristics (Bolean logic or And). This type of evaluation reduces the probability that an area has all the conditions of the first class. Other areas that do not belong to the suitable class one or to the unsuitable class, belong to the suitable class two. In this research, the investigated indicators were investigated in three general criteria of physiography, land cover and climate. In this way, each criterion and final class of suitability was determined based on the law of maximum limitation between indicators and three criteria. Below are three criteria:

1. Physiography (form of land): This criterion includes indicators of slope, height above sea level, position and form of land.
2. Climate: This criterion includes the indicators of average precipitation and annual temperature and prevailing wind speed.
3. Land cover: This criterion includes geological indicators, vegetation and soil. In the geological index, the mother rock index, in the vegetation index, the coverage density percentage (pasture and forest), and in the soil, the texture index, depth and drainage conditions have been investigated. These 3 criteria are described in Table 1.

Results and Discussion

One of the tasks of regional management is to guide the way and intensity of land use according to the estimated capacities. Capability planning based on ground suitability may be the best solution in preventing the continuation of existing crises and reducing their adverse effects. One of the prominent features of this research is the use of GIS in all work stages. For the purpose of sustainable development of the studied area and sustainable and suitable use, it seems necessary to identify the ecological characteristics of this area and evaluate its capability. In Larestan county, there was no suitable class for urban, rural and industrial development.

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Table 1. *Different classes of urban, rural and industrial development and their indicators* (Makhdoom, 2009).

Criteria	Indicators of each criteria	Classes		
		Suitable		Unsuitable
		Class 1	Class 2	Class 3
Climate and weather	Average annual rainfall (mm)	500 - 800	Any climate except inappropriate conditions	In the path of tornadoes and strong monsoon winds
	Average annual temperature (°C)	18 - 24	Any climate except inappropriate conditions	In the path of tornadoes and strong monsoon winds
	Prevailing wind speed (km/h)	up to 35	Any climate except inappropriate conditions	<50
Physiography (Earth shape)	Land type	plain	-	High and mountainous lands
	Slope (%)	>10	10 - 15	<15
	Elevation above sea level (m)	500 - 1500	0 - 500 or 1500 - 2000	<2000
Geology	Mother stone or Lithology	Basalt flows, sandstone, alluvial sediments (continental plateau alluvium)	Limestone and clay, granite, fissured tuffs, interlayers, loess and alluvium	Found and hidden faults, marl mother rock, marl layers under the mother rock, earthquake prone, schist, sand dunes and floodplain
Soil	Soil texture	loam, clay loam, sandy clay	Sandy, sandy loam, loam, clay loam, sandy loam, sandy loam, sandy clay loam	Silty loam, silty, silty clay loam, silty clay, clay, regosol and lithosol
	Soil depth	Deep	Deep to semi-deep	Shallow to no soil
	Soil drainage conditions	Good to perfect	Average to good	Imperfect
Vegetation	Vegetation cover % (pasture and forest)	>25	50 -25	<50

The results of the studies of ecological parameters are shown in the form of a map of areas prone to urban development in the study area in two relatively suitable (2) and unsuitable (3) classes in Figure 2 and the percentage of classes in Figure 3. The results show that most of the county (86.8%) is in the 3rd class or unsuitable. This result is in good agreement with study result of Masoudi and Jokar (2015) in Shiraz County, Iran. Beheshti and Manouri evaluated the ecological suitability of Sahand county in East Azerbaijan province using MCDM method to investigate the use of urban development, and the results show the dominance of the middle class in this county (Beheshti and Monavari, 2017). Azari and Shirzadi evaluated the ecological capability of Bagh Malek county in Khuzestan province for the use of urban development using the AHP method. The results showed that 46.65% of the entire study area has a

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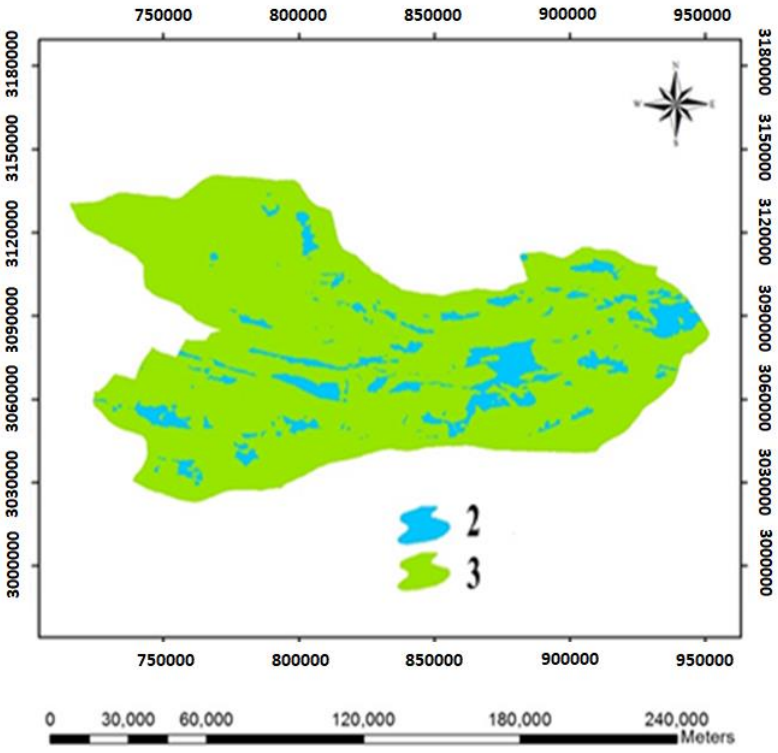

Figure 2
Land capability classification map for urban, rural and industrial development.

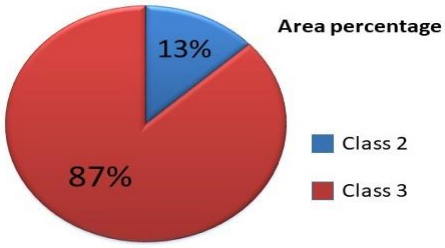

Figure 3. *Percentage of urban, rural and industrial development classes.*

completely unsuitable capability for urban development (Rezapoor Andabili and Mirsanjari, 2020). In addition, in this research, the percentage of suitability classes in the estimation of the current establishment of urban, rural and industrial uses was also obtained, which is visible in Table 2. According to the obtained results, most of the urban areas of Larestan are in the third class or unsuitable. In the survey conducted in the rural areas of Larestan County, a large number of villages (83.33%) are placed in the third or unsuitable class, which are scattered throughout the County.

The industries of Larestan County are mostly placed in the third or unsuitable class (76.92%), this actually shows that the establishment of industries in Larestan County has not been paid attention to the ecological capability and this can lead to environmental damage. This improper establishment shows that both the industries themselves may be harmed and the industries can cause serious harm to the environment. These results are in good agreement with study results of Masoudi et al. (2017) and Jahantigh et al. (2019) in Darab and Chah bahar counties in Iran.

Region	Class 2	Class 3
Urban (area)	42.7 %	57.3 %
Rural (number)	16.7 %	83.3 %
Industrial (number)	23.1%	76.9%

Table 2
The percentage of suitability classes in the estimation of the current establishment of urban, rural and industrial uses.

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Conclusions

In Iran, the evaluation of the ecological capability is based on the evaluation of several factors. In this research, the evaluation of the ecological capability of urban development with a comprehensive approach has paid attention to all the ecological parameters within the scope of a management domain as a planning and land management unit, which in this direction, physical and biological parameters were studied and identified. One of the prominent features of this research is the use of GIS in all work stages.

This research showed that the best evaluation methods are those that perform the evaluation process using a multi-factor evaluation model and using effective ecological (physical and biological) factors. It should be remembered that there is always a significant relationship between the natural environment and the choice of a suitable platform for the development of the County. Paying attention to the rapid process of urbanization and the resulting bio-environmental crisis and the results of the present research, the necessity of homogeneous resource management becomes more obvious.

The main suggestions of current study are:

1. in the evaluation method of ecological capability, the GIS as a suitable tool in the decision-making process can reduce the cost and time of the evaluation and help the experts in choosing the appropriate solutions.
2. the current perspectives of urban development, which are based on economy and welfare, should be changed to an environmental perspective that is all-perspective, and henceforth, urban development plans should be based on the assessment of ecological capability and the principles of land use.

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Conflicts of Interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

Data Availability Statement

The datasets used and/or analyzed during the current study are available from the first author on reasonable request.

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