Analysis of the manufacturing industries prone lands locating using GIS (Case study: Mahshahr)

Saeed Khajavi [1], Hakimeh Hamid [2,*], Masoud Choramin [3], Ali Akbar Parmoon [4], Iman Davarpanah [5]

[1]Department of Civil Engineering, Shoushtar Branch, Islamic Azad University, Shoushtar, Iran
[2]Department of MSC in land use planning, Mahshahr Branch, Islamic Azad University, Mahshahr, Iran
[3]Young Researchers and Elite Club, Dehdasht Branch, Islamic Azad University, Dehdasht, Iran   [4]Department of water, Science and Research Branch, Islamic Azad University, Yasouj, Iran
[5]Young Researchers and Elite Club, Dehdasht Branch, Islamic Azad University, Dehdasht, Iran

Abstract: Projects and manufacturing industries locating has a critical role in a country's economy and development of such activities is considered as important issues for regional planners. Using effective parameters in locating and need for simultaneous examination of the evaluation criteria and environmental requirements provides field for using Geographic Information System (GIS) tool. So the present paper attempts to analyze the desirable places for locating manufacturing industries by considering prone lands in Mahshahr and to rationale it in ARCGIS using multivariate assessment methods such as (AHP). In the final integration of data layers, the results showed that the optimal places were near the Jarahi River, which are generally used for agriculture. In contrast, North and West are the most inappropriate places for the establishment of manufacturing industries.

Key words: Locating; Prone lands; Manufacturing industries; GIS; Mahshahr

1. Introduction

Locating is the process by which the best place can be determined based on the circumstances for a specific use and the available resources and facilities. Locating is in fact the simultaneous analysis of the spatial and descriptive data to find one or more spatial position with desired descriptive characteristics. Performing locating studies require expertise such as: operations research, decision-making methods, environment, geography (geology and climate), engineering economics, computer science, mathematics, marketing, urban design, etc. Making decision for locating industrial projects is of particular importance and even years after the operation of an industrial project its developmental role in a region can be referred. Determining the place of the manufacturing industries is economically important in initial investment when establishing the plant. In the meantime, in most parts of the country, establishment of production units has been done regardless of geographic and environmental issues and this will cause damage in different parts of the country. On the other hand, the environmental power of different regions of the country in North, South, East and West are not the same and establishing an industry in the North of the country doesn't mean establishing it with the same conditions in other places and is not able to use a

specific formula for locating (Razavian, 1997). Failure to locate the manufacturing industries with high cost will result in the recession or complete closure of the factory. Khuzestan as the main center of the crude petroleum and natural gas extraction is one of the rich regions in Middle East and the world and due to the proximity to the Persian Gulf, it has valuable capabilities and place in business affairs and presence of ports such as: Khoramshahr, Mahshahr, Abadan and Imam Khomeini has geopolitically highlighted the region. In this regard, today Mahshahr has achieved a leading position in the manufacturing industrial products and establishing industrial estate is increasing in this city (Wikipedia, the free encyclopedia). This is while the majority of these industrial units faced with several problems due to the lack of attention to the industries locating standards and natural issues, especially climate. Therefore, the present study is intended to examine and analyze how to locate manufacturing industries in the study region scientifically considering the land use.

2. Materials and methods

To use and benefit from the manufacturing industries locating model, components related to land use and the land shape of Mahshahr are used. Then, in the analytic hierarchy process, criteria and sub-criteria calculation was included and

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* Corresponding Author.

options final rating was studied based on Analytical Hierarchy Process (AHP).

3. Location of the study area

Bandar-e Mahshahr is a city in Khuzestan province, Iran, with longitude 49° and 13′ and latitude of 30°and 33′ (30°33′32″N 49°11′53″E). Height of this city is 3 meters above sea level. Present Mahshahr consists of two parts, ancient Bandar-e Mahshahr and the other known as industrial area. Bandar-e Mahshahr has a total area of 2713 Hectares which is the largest city after Ahvaz in Khuzestan. The city is connected to Ahvaz and Ramhormuz from North, to Shadegan from the West and from the East to Behbahan and from South to the Persian Gulf. Mahshahr is the only city of Iran that has a creek (inlets of sea branching to the land) which is called Khor-e- Mosa and is strategically and economically very important. Khor-e- Mosa is located in South of Mahshahr and has many branches one of which passes through Mahshahr. Of course in past other branches were in the city but they are disappeared. One of the branches destroyed was a branch starting from the city main creek (which still exists) and led to the Chamran-Bahonar intersection. It is located 18 km from Bandar Imam Khomeini and 95 km of Abadan and 110 km of Ahvaz. (Map 1)

Fig. 1: The political and administrative range of Mahshahr (Statistical Center of Iran, 2011)

4. Reviewing the current status of manufacturing industries

Mahshahr is a port and industrial city and highway of cargo land, marine and rail transit from important and strategic port of Imam Khomeini. Constructing harbors for oil and commodity exports and then establishing Petrochimi Bandar Imam BC (former Iran-Japan) as well as establishing the Petrochemical Special Economic Zone and the construction of huge petrochemical industries attracted many people from neighboring and even non-adjacent towns to this city that in recent years the value of property in Mahshahr has grown to unprecedented levels and has become a resettlement city with high density. Economic activity and Mahshahr port development depends mainly on the capabilities of the harbor, Customs and proximity to beaches and also proximity to oil and gas resources of Khuzestan plain and its related activities. The economic importance of this city on one hand is due to Imam Khomeini port which in 1997 along with Mahshahr port assigned one fifth of the share of reception of ships of all country ports in the north and south coasts to themselves and on the other hand, to the presence of liquefied natural gas refinery and oil and petrochemical export ports as well as Razi, Farabi and Bandar-e-Imam Petrochemical Complex and Petrochemical Special Zone (Map 2). One of the important activities of the city is extraction of petroleum (Khuzestan Province Administration of Industry and Mines, 2013).

5. Binary comparison of the land use sub-criteria

Six land uses were applied to locate and analyze the spatial distribution of manufacturing industries which a brief overview of these comparisons is discussed in the following. Land use sub-criteria in second level are presented in Table 1.
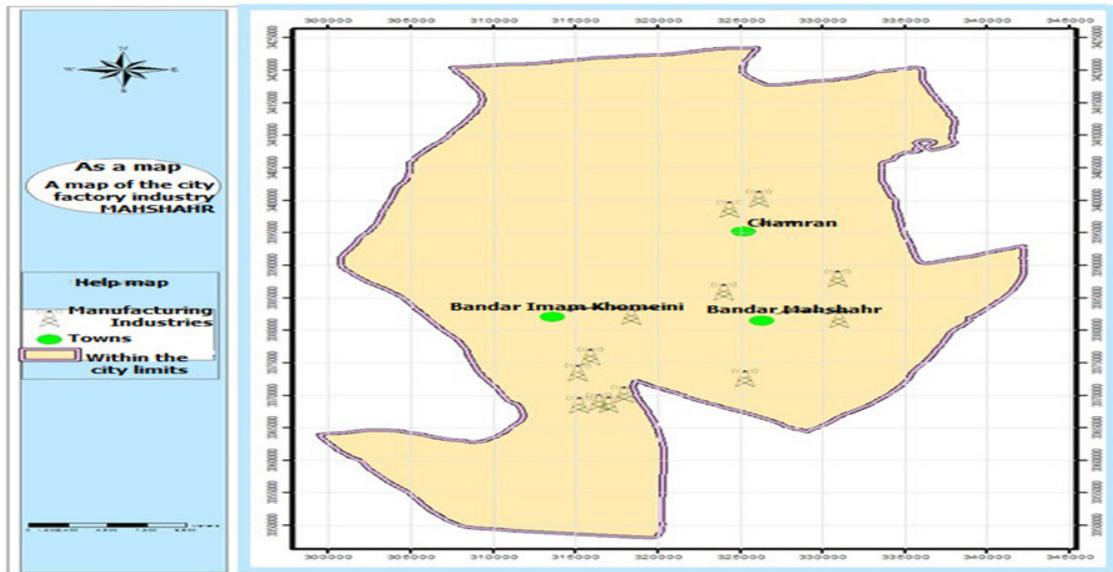
Fig. 2: The position of manufacturing industries in Mahshahr

Forest land use is given 1.2 values than range land use that is range land use has a value twice the value of forest. Agriculture land use due to its nature is required to be near the manufacturing industries in an appropriate distance to better use the agricultural lands. Therefore, manufacturing industries should be placed near or with a proper distance from the above uses and optimal locating should be done.

Table 1: Binary comparison of the land use sub-criteria

Sub-criteria	Ranges	Forest lands	Accommodations	Farmland	Salt marsh	Desert lands
Ranges	1	2	3	1.4	3	2
Forest lands	1.2	1	3	1.5	3	1
Accommodations	1.3	1.3	1	1.6	2	1.2
Farmland	4	5	6	1	5	5
Salt marsh	1.3	1.3	1.2	1.5	1	1.3
Desert lands	1.2	1	2	1.5	3	1

6. Final calculation of the land use sub-criteria geometric mean

The sub-criteria importance coefficient is obtained from normalizing the numbers i.e. dividing each number to sum of them, which final calculations are as follows:
• Range: 1.4425
• Forest lands: 0.9826
• Accommodations: 0.5143
• Agricultural land: 3.7976
• Salt: 1.1486
  The desert lands: 0.9183

7. Final calculation of land use sub-criteria importance coefficient

The final calculation of the importance coefficient of each of the land use sub-criteria are as follows separately:
Ranges importance coefficient: 0.1792
Forest lands importance coefficient: 0.1220
Settlements: 0.0639
Agricultural land importance coefficient: 0.4718
Salt marsh importance coefficient: 0.0488
Desert lands importance coefficient: 0.1141

8. Integration of land use information layers

Map 3 shows the final layer of land use. Six uses of Mahshahr land uses are in the form of land use sub-criteria that include: Agricultural land use, salt marsh use, desert land use, settlements use, ranges use, forest land use. The basis for the group weighting of this map is expressed in table (1). As was observed mathematical relationships applied to form land use layer is provided based on the weight obtained from hierarchical model (AHP) which was user-oriented. In this map, from the most inappropriate to the most appropriate places are classified in different colors. In other words, the portions of uses that have the greatest impact on locating manufacturing industries are shown. Using the layers criterion and multiplying each layer in the relevant weighting and summing them with other land uses, final layer of lands use weighting was prepared. Map 3 offers the most appropriate locations according to the integration of consistent neighboring sub-criteria.

9. Binary comparison of land shape sub-criteria

Table (2) provides the paired comparison matrix of land shape sub-criteria. Four sub-criteria in this matrix are known as the land shape sub-criteria and are compared as paired with each other.
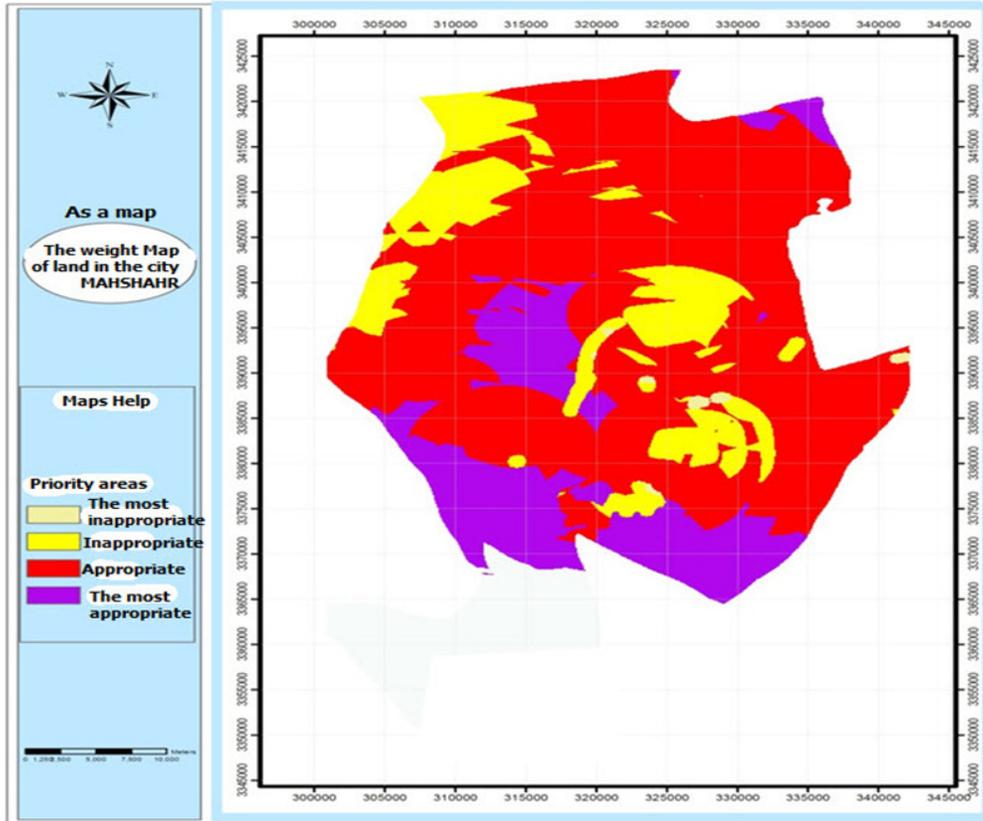

Fig. 3: The most appropriate places by integrating land use sub-criteria

Table 2: the paired comparison matrix of land shape sub-criteria

Sub-criteria	Soil type	Seismicity	Slope	Lavational classes
Soil	1	1.2	2	3
Seismicity	2	1	3	2
Slope	1.2	1.3	1	2
Lavational classes	1.3	1.2	1.2	1

10. Final calculation of the land shape sub-criteria geometric mean

The final calculation of the geometric mean of each of the land shape sub-criteria is separately as follows:

Soil type: 0.6988
Seismicity: 0.5
Slope: 0.7598
Lavational classes: 0.6389

11. Final calculation of land shape sub-criteria importance coefficient

The final calculation of the importance coefficient of each of the land shape sub-criteria is separately as follows:

Importance coefficient of soil type: 0.2876
Importance coefficient of seismicity: 0.4067
Importance coefficient of slope: 0.1660

Importance coefficient of Lavational classes: 0.2027

Accordingly, the seismicity sub-criteria value compared to the slope sub-criteria is defined as 2, i.e., the seismicity sub-criteria in locating industrial plant has a double value than soil type use or lavational classes compared to the slope obtained 1.2. This means that the value of slope is considered as twice the lavational classes in the primary comparison.

12. Integrating land shape layers

As mentioned in the previous sections, land shape is among the uses that are of high sensitivity in relation with the manufacturing industries location. The sub-criteria of lavational classes, soil type, seismicity and slope are known as the land shape sub-criteria. Map 4 is a combination and integration of land shape sub-criteria,

considering their normal weight. In this map seismicity has the greatest impact and other sub-criteria including slope, soil type and lavational classes have assigned the next ranks to themselves. In the map of integrating sub-criteria, the best places in terms of land shape are provided. The map was obtained following the calculation of land shape layers weight in paired comparison matrix and AHP. According to the above relationship, all 4 criteria are integrated based on the coefficient of weights related to them and summing them with other land shape criteria and the final layer of land shape was prepared using Index Overlay method that the best places are presented in map 4 by combining the sub-criteria of land shape.
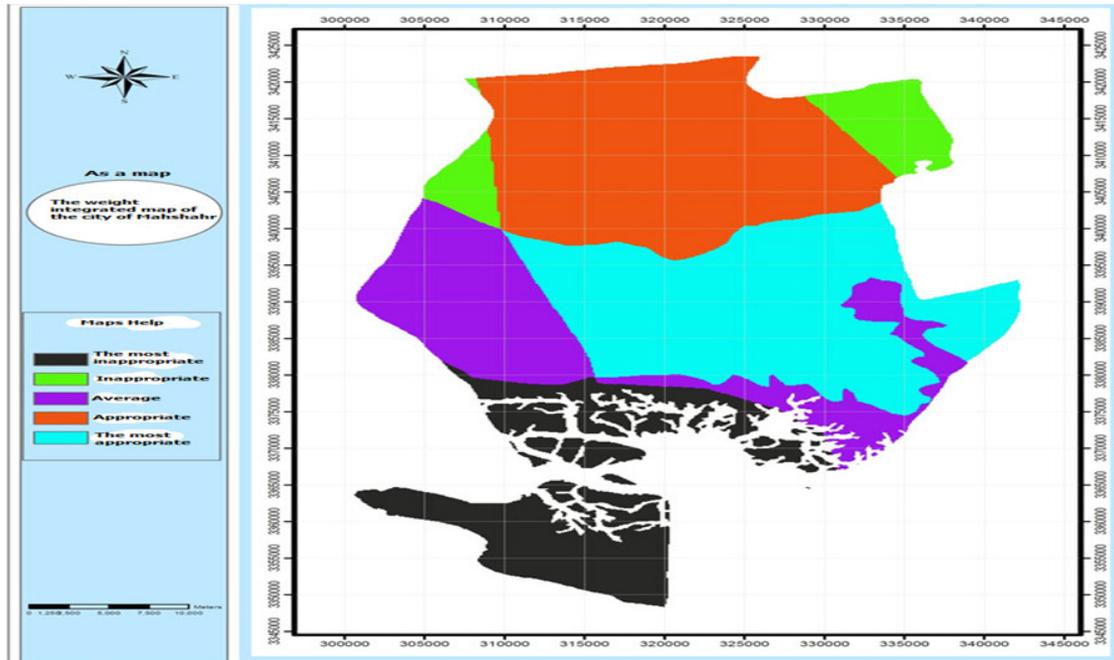

Fig. 4: The best locations by integrating land shape sub-criteria

13. Discussion and Conclusion

Identifying areas suitable for the establishment and development of economic activities are among the important issues for planners and managers at large scale. Locating the projects and industries can have a positive performance in solving the economic, social and cultural problems of different areas. Meanwhile, country industries managers and decision-makers, according to logistics and industrial development strategies views try to rally industrial units as a complex or town and to organize it. In this paper, locating prone lands for manufacturing industries within the city of Mahshahr in Khuzestan province was examined and analyzed using Geographic Information System (GIS) and environmental factors. Accordingly, following the determination of effective criteria in locating manufacturing industries at different levels, the hierarchy analysis of each of these criteria, sub-criteria and their weight was determined to form the final layer. Then the map of each of criterion was prepared by Rastery format. Each of the desired criteria was categorized according to its sub-criteria using Reclassify command and desired weight, and the map of each of the first level criteria was prepared for the ultimate combination by command Raster calculator. The final map of prone lands for manufacturing industries was determined by Index overlay method. The result of this study demonstrates that the potential and desirable locations for the establishment of manufacturing industries are mainly in the central areas and partly in the East of the city. These places are close to Jarahi River and have mainly agriculture use. In general, in the process of selecting industrial locations, especially manufacturing industries, we should consider the awareness of the public and private investors in zoning and economic savings as a valuable and multi-dimensional strategy due to legal and environmental restrictions and move toward increasing the knowledge and expertise in this field.

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