



A study of geomorphologic factors restricting the expansion of Ardebil city using analytical hierarchy process (AHP)

Fariba Esfandiary

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Abstract

Cities occupy vast and expansive terrain. Land is composed of several topographic and geomorphological units. As cities expand and develop, they encounter with topographic and geomorphologic units and issues pertaining to them also increase. Ardebil with its increasing population and urban sprawl is a city that is not an exception to this rule and its expansion has been influenced by the dynamics of the natural environment. In this paper, the hindrances to the expansion of this city, often due to geomorphologic factors, are discussed. To this end, topographic maps of 1:5000 and geological maps of 1:100000 were prepared followed by a field study that yielded images of geomorphologic phenomena in the region. After matching the maps with the geomorphologic phenomena in the region, these maps were scanned in Arc view GIS, digitalized and theme maps of altitude, slope, slope direction, lithology were prepared. The values of each of these factors were determined using the AHP, and faults, networks of watersheds, slopes, slope direction, thickness of matrices etc were plotted on lithology maps in GIS environment. Finally, after overlaying the maps, sensitive and susceptible points of the region were identified and zonation maps of unstable and sensitive points were prepared in GIS environment.

Keywords: *Expansion obstacles, morphological factors, unstable points, Ardebil, GIS, AHP*

Introduction

The city of Ardebil is the capital of the Ardebil province and is located between the latitudes $37^{\circ} 45'$ and $39^{\circ} 42'$ north and longitudes $47^{\circ} 25'$ and $47^{\circ} 30'$ east and covers an area of about 4072 Km². Several studies have been carried out on this issue in the world as well as in Iran which includes, the work of Teimoori (2004), Ghaffari (2001), Fathi (2006), Basirat (2003), Eqbal (2004), Shafi'ee (1994), Esfandiary (1998; 2008), Ostad (2000), Bird & Boomer (2004), Boomer & Rodriguez (2002), Dai *et al.*, (2002), Koho, (2009), Katz (2007).

Methods and Materials

The present study probed into eight processes restricting urban development and the relative importance of each was explored. This was accomplished by using the paired comparison

method (hierarchical). In the initial stage, by taking into account their quantitative and qualitative values, the factors were rated from 1 to 8 (from least to most important). Next, to determine relative weights of the main parameters, mean geometrical matrices were constructed for each and the relative weightage of each was computed.

Processes restricting city expansion in the study area are as follows:

1. Land settlement
2. Slope
3. Earthquake
4. Climatic factors
5. High levels of underground water
6. Pollution of surface water
7. Lack of adequate sewage disposal system in the city
8. Existence of adequate agricultural land around the city

The following calculations were performed:

W1= 0.31 coefficient of significance of elevated levels of underground water

Author's Address

University of Mohaghegh Ardabili, Iran
Email: fariba_sfandyary@yahoo.com



W2= 0.22 coefficient of significance of ground subsidence

W3= 0.15 coefficient of significance of the existence of land suitable for agriculture in the periphery of the city

W4= 0.11 coefficient of significance of slopes

W5= 0.07 coefficient of significance of the lack of appropriate sewerage system in the city

W6= 0.05 coefficient of significance of climatic factors

W7= 0.03 coefficient of significance of earthquakes

W8= 0.02 coefficient of significance of pollution of surface water

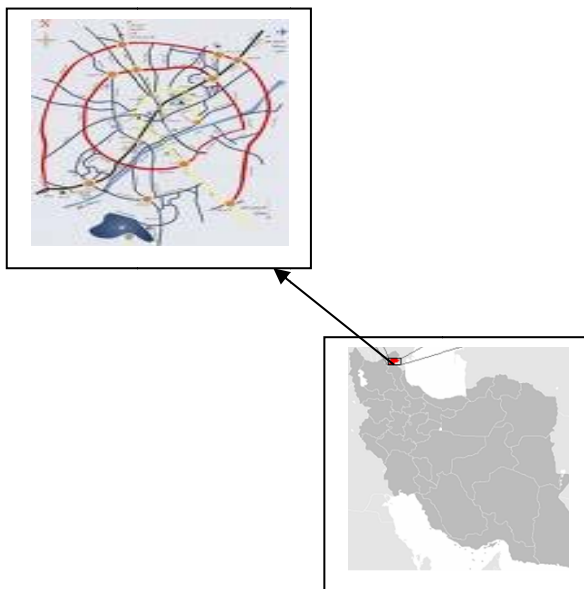
$$\lambda = \frac{85.32}{n(8)} = 9.48$$

$$CI = \frac{\lambda - n}{n-1} = \frac{0.48}{7} = 0.06$$

$$CR = \frac{CI}{RI} = \frac{0.06}{1.45} = 0.04$$

Given that CR (relative stability) in the above computation is less than 0.1, acceptable stability is implied in the paired comparisons.

Figure1: Geographical position of the study area



Results and Discussion

The zones in the north, west and north western parts of the city, on account of having sufficient water, appropriate slope, and fertile soil, possess

adequate capability for cultivation (figure 5); on the other hand, the southern and western parts of the city possess less potential for agriculture and cultivation.

Other likely restricting factors are the Ardebil airport, located in the north-west of the city, the industrial town of Niyaar to the east of the city and the expansion of irrigation and drainage networks of the Ardebil dam to the west and north of the city. On the whole, the existence of areas suitable for agriculture in the periphery of the city is considered to be the primary factor limiting future expansion of the city. From a topographical view, a negative slope of greater than 9 degrees is not suitable for city expansion.

In terms of base rock characteristics, the existence of layers of clay beneath the base rock, schist, and sand hills, flood plains, and visible and invisible faults restrict the expansion of the city. From the point of view of pedology, shallow soil with a sand texture, heavy or partially heavy clay soil, or hydromorph soil with inadequate conditions for drainage and soil with very fine grains and particles have been estimated as conditions detrimental to city expansion.

Dry river beds, flood-prone areas and passages of natural waterways are not considered to be conditions favorable to urban expansion. Paths of tornados and heavy seasonal winds and the areas with where the speed of permanent winds exceeds 50 km per hour have been evaluated as unfavorable to city expansion. Forest areas (density of tree coverage of greater than 60% and grass coverage of more than 50%) and irrigated land are considered to be unfavorable for city expansion. On the whole, it can be concluded that the expansion of the city in the southern, south-western and north-western areas appear to be reasonable. Among these areas, considering the conditions of the land and scatter of villages, the southern zones are suggested as the most favorable zones for future expansion of Ardebil. However, expansion in other directions is possible provided certain conditions are met. Figure 6 illustrates the mapping of the most unfavorable points in the city in view of surface water pollution, sewage disposal into the agricultural land of Sina town (figures 2 & 3) and obstruction of roads (figure 4). It is evident this map can provide guidance to environmental planners in tackling the obstacles to the expansion of the city of Ardebil.



Figure 2: Sewage disposal into agricultural land in Sina town



Figure 3: Sewage disposal into agricultural land in Sina town



Figure 4: Insufficient dimensions of most streams and canals along roads in the city, leading to less than optimal capacity for maximum surface water drainage



Figure 5: Agricultural land in the periphery of the city as a hindrance to city expansion

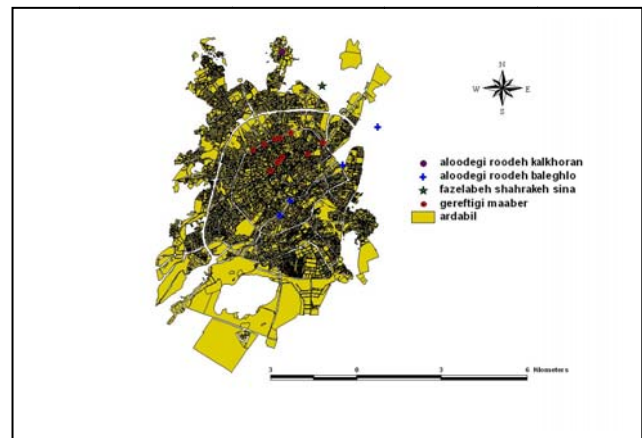


Figure 6: Zonation of unfavorable points in terms of city expansion

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