

East Azarbaijan's Eco-Environmental Potential for Industrialization: Functional Systems Analysis Models

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Abstract

The objective was to model and establish East Azarbaijan's potential for industrial development based on regional eco-environment conditions. A variety of sites in the province were visited, and digital maps of ecological parameters with valuation weight for each layer were generated. The Analytic Hierarchy Process (AHP) was used to weight the influence of several ecological parameters. Results revealed relative restrictions for industrial development in East Azarbaijan, which should be taken into account in planning prospectus industrial expansions. Based on the System Analysis Models, no provincial area was found highly suitable for industrial development, while 21% of the province was suitable, and 79% lacked any suitable potential for industrial development. The data provide novel information and insights into prospective management of industrial investments in light of East Azarbaijan's eco-environmental unique properties.

Key words: Ecological capacity, industrial development, systems analysis, East Azarbaijan

1. Introduction

Urbanization is connected to industrial development while generating employment and economic growth. However, it causes air, water, and soil pollutions, which threaten human health and welfare and compromise environmental quality. Thus, establishing appropriate zones for industrial development is a priority that should be accomplished using effective scientific and ecological criteria [1,2]. Determining industrial development capacity depends on a variety of social, economic and environmental factors that must be considered in refining urbanization and industrialization policies [3]. In light of the accelerated urbanization trends in the North West Iranian province of East Azarbaijan and especially in the metropolitan Tabriz area, the environment has been exposed to increasing pollutions. The impetus for this research was enlightening future roads of urbanization and industrial developments considering the regional ecology.

The objective was to model and establish East Azarbaijan's industrial capacities using a systems analysis models approach.

2. Materials and Methods

2.1. Study area

This study was conducted in the North West Iranian province of East Azarbaijan, an economically and environmentally important and densely populated region. This region has approximately 2.81% of total country area [4]. East Azarbaijan is a mountainous area with 40% of its surface being high mountains, 28.2% foothills, and 31.8% intermountain plains (Figure 1).

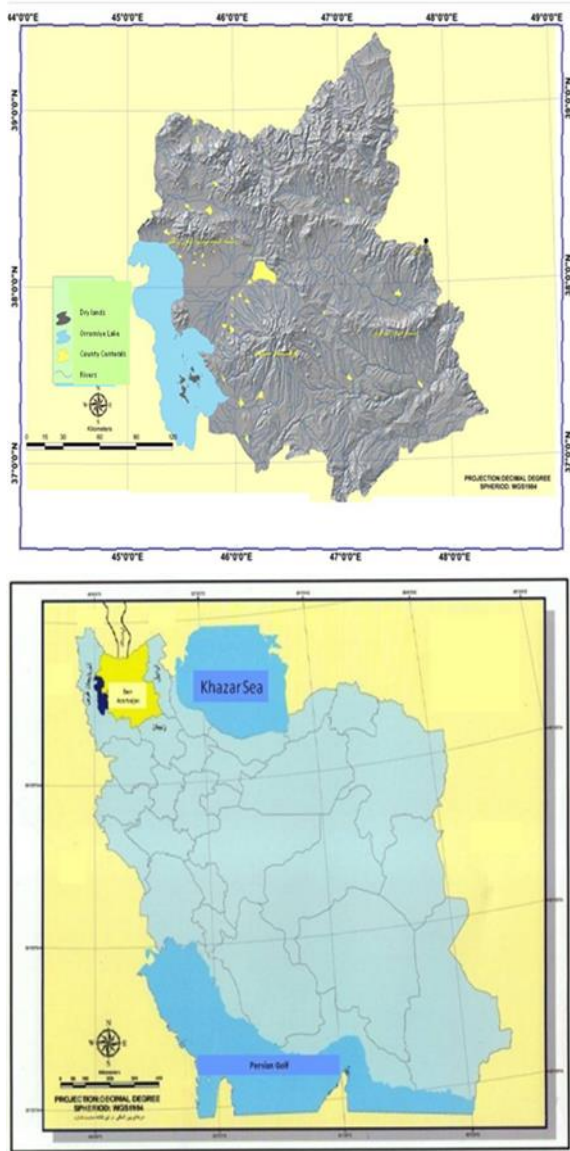


Figure 1. Location of the study area, East Azarbaijan, in North West of Iran

2.2. Research methodology

2.2.1. Data collection

The data required to establish ecological capacities of East Azarbaijan were collected using two major methods. The first method included data from literature and libraries, companies, research institutes, science departments and organizations (i.e., environment and natural resources), and ministries (i.e., power, environment, industries and mines). The second method involved 1) field visits and 2) evaluation and comparison of the current land

ecological properties using the initial data collected using the first method. The data parameters (15 layers) collected were: slop (S), evaluation (E), aspect (A), geology (Ge), fault (F), distance from surface water source (DSw), distance from grand water sources (DGw), transfer of water from tanks (Wt), soil depth (Sd), soil texture (St), soil erosion (Se), climate (Cl), protected area (Pr), land use (Lu), and vegetation (Vg).

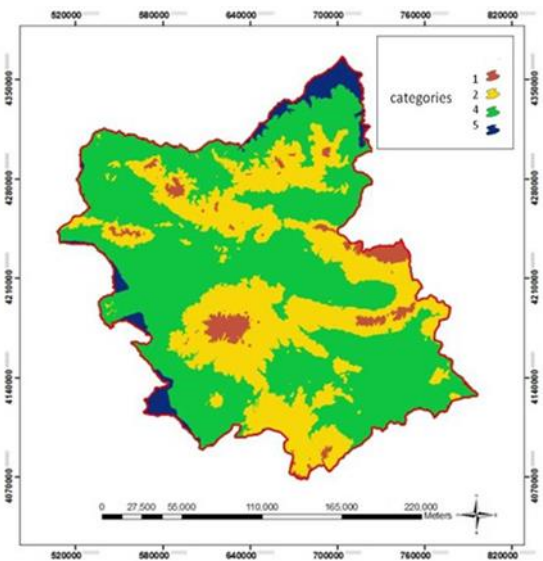


Figure 2. Weighed elevation map of the study area

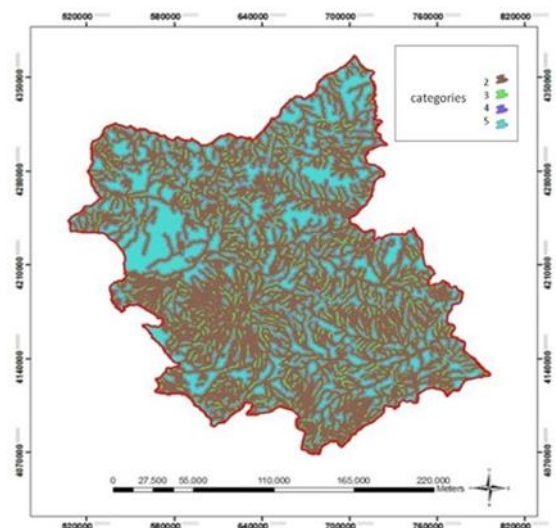


Figure 3. Weighed distance from river map of the study area

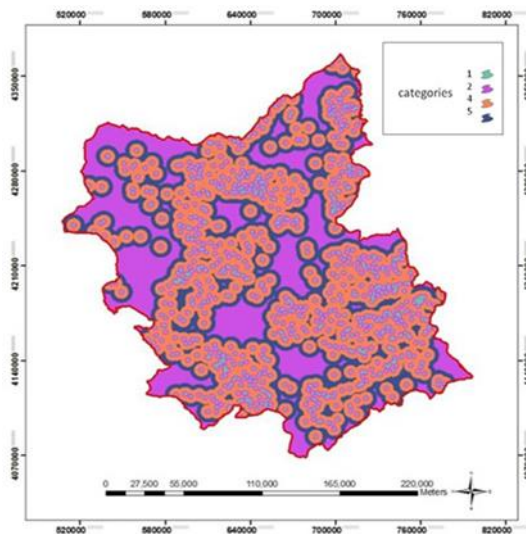


Figure 4. Weighed distance from water resources

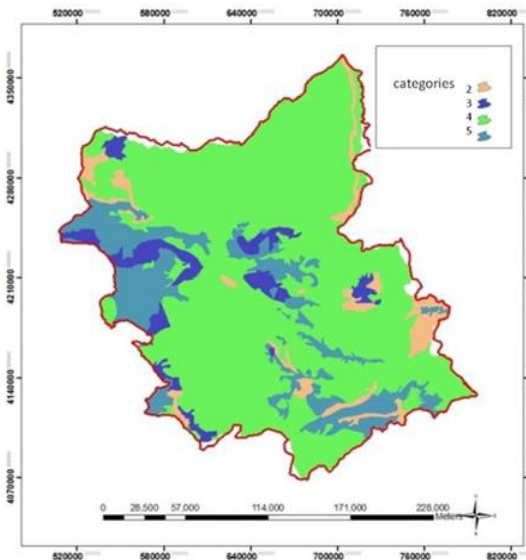


Figure 5. Weighed soil tissue map of the study area

2.2.2. Maps analysis and weighing

To facilitate parameter identification and analysis, data were classified using a Functional Systems Analysis Model approach [5] to later weigh and rank each ecological parameter. The contribution of each of the above 15 parameters (information layers) to locating industrial sites was established using a 5-category Analytic Hierarchy Process. For each parameter, categories 1 and 5 represented the highest and lowest suitability for industrial development, respectively. Examples are illustrated in Figures 1 and 2.

2.2.3. Modeling and model evaluation

Functional Systems Analysis Models [5] were refined, renovated, and adopted for East Azarbayjan to incorporate its ecological properties. Multivariate linear equations were developed to categorize different locations in terms of industrial development capacity. Three capacity classes were defined including C1, C2 and C3, defined respectively as highly suitable, suitable, and unsuitable for industrial development. The models fitted for consideration as highly suitable (C1) and suitable (C2) for industrial development are:

$$C1 = S(4,5) + E(4,5) + A(4,5) + Cl(4,5) + Se(4,5) + Sd(4,5) + St(4,5) + Ge(4,5) + F(3,4,5) + DSw(4,5) + DGw(3,5) + Vg(4,5) + Pr(3,4,5) + Wt(4,5) + Lu(3,4,5)$$

$$C2 = S(3,2,1) + E(3,2) + A(2,1) + Cl(2) + Se(3,2,1) + Sd(3,2) + St(3,2) + Ge(1) + F(2,1) + DSw(3,2) + DGw(2,1) + Vg(3,2,1) + Pr(1) + Wt(2,1) + Lu(2,1)$$

3. Results and Discussion

3.1. Ecological property data

The evaluation was made using the 15 ecological parameters (information layers) according to the predictions of the Makhdoom's Functional Systems Analysis Model (2004). The properties are related to soil texture, soil erosion, soil depth, regional climate, slope, elevation, aspect, vegetation density, protected areas, land use, rock, faults, transfer of water resources, deep and semi-deep wells, and rivers.

3.2. Models evaluation

According to the Makhdoom's analysis model of weighted ranking, East Azarbayjan was divided into several environmental regions, each including its own ecosystem. Outcomes of this modeling revealed that 9843 square kilometers of the provincial lands had potential for industrial development. Because of the relative limitations in several ecological conditions, East Azarbayjan had no region considered as highly suitable for industrial development. The province

has regions that are considered suitable for industrial development (Table 1). Counties of Myaneh, Herris, Tabriz, Bostan Abad and Shabestar possess promising prospective for industrial development due to their special ecological conditions (Figure 6).

Table 1. Ecology-Based Industrial Development Potential in East Azarbayjan

Row	County	AreaKm	Ecology-Based Industrial Potential ¹	Ecology-Based Industrial Potential ¹
1	Malekan	837.465	*	185.5
2	Charoimag	2944.545	*	322.5
3	Hashtrood	2294.594	*	622
4	Maragheh	2191.503	*	201
5	Myaneh	5704.862	*	1395.75
6	Bostan	2685.166	*	913.25
7	Sarab	3543.762	*	587.5
8	Herris	3241.687	*	1002.75
9	Tabriz	2270.13	*	943.25
10	Varzeghan	2277.230	*	327.5
11	Marand	3337.556	*	102.75
12	Jolfa	1718.384	*	376
13	Ahar	3146.264	*	572
14	Kaleybar	3762.211	*	495.5
15	Oskoo	1516.766	*	331.75
16	Shabestar	2591.262	*	837.75
17	Ajabshir	741.507	*	138.75
18	Bonab	802.351	*	183.5
19	Azarshahr	1140.327	*	304
20	Total	45846.572	*	9843

¹Category 1 and 2: highly suitable and suitable for industrial development, respectively.

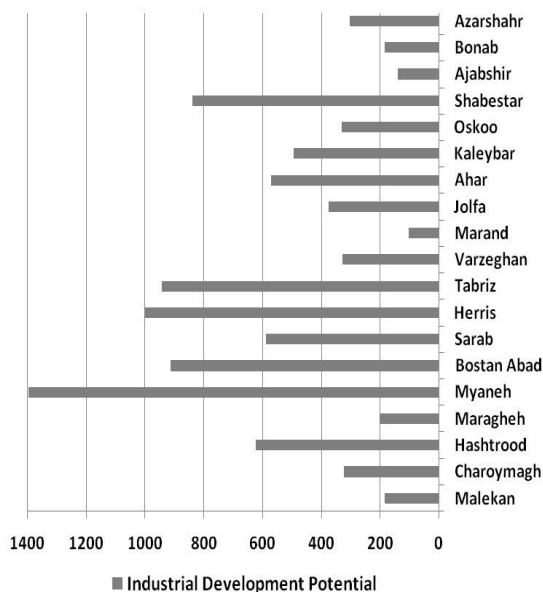


Figure 6. Ecology-based industrial development capacity in East Azarbayjan regions

Jaafari [6] located appropriate regions for industrial construction and activity in Qom province, using a systematic method and GIS analysis. Soltani [7], similarly, identified appropriate regions with industrial prospective in Qazvin, having analyzed environmental resources from two ecological and socio-economic perspectives. Soltani [7] found that Qazvin province had 1 land unit within class 1, and 11 land units within class 2 industrial development potential. Likewise, suitable places for industry development were located within 50 km area around central Iranian city of Isfahan using weighed linear models method and the Boolean logic. Also, the ecological power of Hamadan in west of Iran was estimated using the Makhdoom's model with several information layers, with 7% of the province found to be suitable for industrial expansion [8]. Moreover, using a multi-criteria evaluation approach and AHP, we recently modeled ecological capacities of Tabriz suburb and Marand region [1,9].

This study provides novel data on potential for industrial development in East Azarbayjan with its unique and diverse ecotourism properties. Due to its large manufacturing settlement, East Azarbayjan possesses suitable industrial innovation and development capacities. The province contributes about 13.3% to Iran's GDP and is one of the major industrial zones in the country. Because the most important and largest industries (>55% of large manufactures) are located in Tabriz, this region is exposed to increasing environmental pollutions [10]. This critical information should be incorporated into state decision-and-policy-making processes to facilitate prospectus industrial and financial programs for industrial development and expansion in East Azarbayjan.

4. Conclusions

Ecological parameters were quantified, analyzed and modeled in analytic hierarchy processes to weight the influence of each parameter on industrial development capacity in East Azarbayjan. Discoveries revealed relative restrictions on industrial expansion in several regions. No provincial area was found to be highly suitable while 21% of the province was considered suitable for industrial development.

The data establish East Azarbayjan's ecological capacities for industrial development, offering novel insights and prospects towards optimizing ecotourism and industrialization in North West of Iran.

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