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Evaluation of Landscape Structure in Eram Park Using GIS

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ABSTRACT: The method of sampling unit was applied according to the importance of the park in urban landscape structure with the initial purpose of planning method to maximize environmental sustainability and recognizing the structural elements within the park. SWOT technique has been applied to analyze collected data and evaluate the strengths and weaknesses, opportunities and threats of affected areas. We used Geographical Information System (GIS) tools to apply neighborhood functions for extracting correspondent data in structural elements of landscape. The results of present study show that the volume of green spaces decreases in the surrounding area due to construction and farmlands activities.

Key words: Park, Landscape structure, Environment, Planning, Design, Ecology, SWOT, GIS

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INTRODUCTION

The active part of urban environment and its activities is similar to any other ecosystem because of changes and sustainability process (Aminzadeh & Ghorashi, 2007). The important section of this Biotope (Plants and live creatures) is living in green space areas, but the most important point is their location (based on ecosystem diversity and original area) that situated in open and untouched areas. Urban green space is an important element not only because of being a recreational space and tourist attraction in the urban area but also it is a center to provide environmental services such as air purification, pollution absorption, development balance, decreasing surface water, biodiversity, reducing sound pollution and finally is a place for better living (Bahraini & Aminzadeh, 2007; Alexander, 1987; Dunay and Plater-Zyberk, 1991; Frey, 1999; Mazumdar, 2000; Rowely, 1996). Open and untouched areas are also important to preserve buffer for critical areas, future urban development support, air flow and pollution purification network; they are also ecologically important as well. These opportunities would be Productive when they are considered as an active part of a general urban landscape (Clay & Daniel, 2000; Daniel & Vining, 1983). Parks are only one single item of the total life elements. Therefore, these elements in urban landscape structure need to be evaluated. It is essential for landscape structure to have a plan as a goal which can maximize environmental sustainability (through fitting landscape structures).Physical, biological and cultural resources are three main bases of planning and decision making process in sustainable development. They also describe landscape structure by making different combinations of mosaic patches. It is important to study changes and their causes for prediction and controlling of the structures (Farino, 1998). Landscape can be defined as a part of land, that is observed in a comprehensive view, without any consideration to any single element (Hobber, 1996) by combination of human (society) and natural impacts (Burgi, 2004).

The science of landscape ecology considers matrix, patches and corridors as the main elements of landscape structure. Matrix is the main ecosystem of land use (Forman, 1995) that plays a key role in landscape and its usage (Ingegnoli, 2002) and can be considered as an important main controller of land movement (Forman and Gordon, 1986). Patches are regions with a special physical or biological condition isolated from the surrounding environment (Ingegnoli, 2002) and can be divided in to 5 groups according to the formation resources; disturbance patches, remnant patches, environmental resource patches, ephemeral patches, and human activity patches (Forman, 1995). To understand the nature of patches' distribution, their primitive condition and their time and relationship spaced regarded should be considered. Corridors connect 2 places or patches at the same time they can make a fragmentation between the 2 places or patches. Corridors can also be divided and classified based on the formation resources (Ingegnoli, 2002). Since any particular structure is important by providing a special function, the study and right recognition of patches, matrix and corridors can define the usage of landscape.

On the other hand, functioning process, changes, and land development can be controlled through right recognition, planning and exertion influence on identity, formation, location and other specialties of these elements. It can lead the urban environmental quality to a more suitable condition.

MATERIALS & METHODS

Zanjan is located within 43˚ 27² to 48 ˚ 55² eastern latitude and 36 ˚ 25² to 37 ˚ 15² northern longitudes and that is 325 kilometer far from Tehran. Eram Park with an area of about 20 hectares is one of the 3 wide Zones of green space in Zanjan and is located at the far western part of the city on IRAN- TURKEY transit road via Tabriz city. Nowadays, this Park has a regional and local attraction for family picnic and passenger stop over to rest. There is an ample rainfall all through the year in the region. The highest precipitation is in spring (April and May) followed by mid-autumn and winter. The annual rainfall average is 297.1 mm. Average temperature in Zanjan is about 11 ºC, Maximum 40 ºC in July and Minimum -28.6 ºC in February and March. The annual average moisture is 53% with the highest percentage in Feb (85%), and March (86%). The lowest is in September (20%). An average yearly glacial day in the region is about 25 day/yr. The main wind blows from east with an average speed of 11.48 to 12.03 km/h. This region is located in moderate semi-humid area according to Koppen climate definer, and falls within semi-dry (De martonne) and cold semi-dry (Emberger). Geologically Eram Park is located around volcanic complex and is a part of Karaj formation. Amand geological structure is the most developed formation among all present units in the region. This complex consists of sediment and volcanic stones, which are almost made of tuff, shale, gravel, and andesite. The soil in this region falls within average permeability land that consists of 15% to 75% sand. The Surface texture of soil is moderate (Loam) and the bottom texture is heavy (clay loam) and there is a large amount of lime powder in different layers of soil. Plant coverage mainly consists of trees such as Fraxinus excelsior, Locust and Service tree and other kinds of trees are also available, Such as Populus nigra, Thuja orientalis, Platanus orientalis and Elm. The Most part of the patches has high plant density coverage but a small part of it especially in the western-side has no plant coverage.

The base of planning and decision making for sustainable urban development is highly dependent on physical and biological aspects. As it was mentioned, landscape structure, which is the reflection of reactions between natural elements and human, is assumed as function of time, and needs to be recognized; however, land and environmental functions can be assessed and controlled. Green space patches, open space patches and constructed patches are selected among several landscape structures; according to the research purpose .The most effective elements in this content include extent, time and study expenses in the region. It was also tried to explain current structural conditions according to the functions and sustainability and finally provide necessary solutions to change or influence on nature and location of patches. Sampling unit method was used to evaluate landscape structure to know the structural elements of study area. In the present investigation 9 shuttles (in size of 50x50

m) on 9 parts of study region (4 shuttles out around the park and 5 inside the park) are studied that are in a similar environment and each uses different structural conditions are studied. Geographical information system (GIS) tool with mapping ability, local query and decision making facilities was used (Karimi, 2003, Kenverski, 2004 and Demers, 2005). Functions and variables have been used such as digital map, format transformation, and transformation (Makhdoum et al., 2003). This includes attribute query function, statistical analysis, topographic functions, data revitalization and neighborhood. Several software and modeling techniques such as editor, built, clean, geo-referencing, X-tools, and special analysis, auto desk map, academic Ilwis, Arc info, and Arc GIS have been used to meaningfully complete present work. Then the average size of patches, the average of nearest neighborhood distance between patches and the number of patches were calculated in each shuttle to understand and find out the selected spaces (open, green and constructed). Finally through comparison of each patch's structure and their subsequent comparison with those of structures located outside the realm of park, ample data was generated for a more precise planning. The SWOT method has been applied as one of the most practical methods since 1960s to evaluate organizations, projects and study subjects in different sciences. In fact, this method tries to evaluate the efficiency of the whole network by mixing external factors such as opportunities and threats and internal strengths and weaknesses factors. (Arabi, et al, 2000 and OTA, 1994). The SWOT methods were also used at this project to study and evaluate the final landscape structure and to present practical suggestions.

RESULTS & DISCUSSION

Based on the results of present investigation, description of each shuttle is brought out (Table 1). Table 2 & 3 show characteristic of area of study. Considering the results of tables 2 and 3, we may conclude that:

A) Within the park

1. Moving from the western part to the central part, more green spaces are available, but from the central part to the eastern we see lesser green space can be found, because of man - made constructions.

Table 1. Description of each shuttle within and around park

Shuttle Nos.	Location	description
1	Within park	Open remnant space patch, power transmission line corridor, path corridor and stream corridor
2	Within park	Tree planted green patches, trance patch, stream corridor and asphalt road corridor
3	Within park	Tree planted green patch, stream corridor and asphalt road patch
4	Within park	Tree planted green areas and hand-planted green spaces patch, pool patch, construction patch, stream corridor and asphalt road corridor
5	Within park	Farmlands patch, tree planted and planted green spaces patch, construction patch, remnant open space patch, and asphalt road and path corridor
6	Park vicinity	Remnant open spaces patch, farm land patch, residential constructions patch, tree planted green spaces patch and path corridor
7	Park vicinity	Farmlands including single planted trees patch, residential construction patch, remnant open space patch, asphalt way corridor and power transmission lines patch
8	Park vicinity	Farmlands including single patched trees, residential constructions patch, path corridor and irrigation canal corridor
9	Park vicinity	Bare spaces patch, Zanjanroud river floodway corridor and path corridor

Table 2. The status of structure, green, open, and built spaces in selected shuttles within the Eram Park

Shuttle No.	Mean patch size (m^2)			Mean nearest neighborhood distance(m)			Patch number		
	Green space	Open space	Built space	Green space	Open space	Built space	Green space	Open space	Built space
1	-	215.78	50.31	-	3.5	-	-	2	1
2	348.65	212.83	105.72	-	8	90	1	2	2
3	255.28	133.63	190.40	8	18.5	60	2	2	2
4	172.60	235.94	314.67	5.5	4	32	3	2	2
5	162.47	196.99	188.19	8.5	4	9	3	3	3
Total	939	995.17	849.29	22	38	191	9	11	10

However the eastern part has more green space than western part.

2. From west to east, there is an increase in the number of denser construction patches inside the Park. It is indicative of unorganized construction within the park.

3. From west to east, green spaces reduces. Thus fragmentation is obvious.Thus the best road to connect upper and downer patch of the park is through shuttles No. 2 &3 in south and No. 4 in north part of the Park.

B) vicinity of the park

1. There is a very large amount of green space in southern and northern areas of the Park. Such green spaces are scanty in the eastern and western parts due to uncontrolled construction projects and river floodways, respectively.

2. Although there are many patches (for instance 7 patches), in the eastern part, no more constructions should be permitted and the remnant space should be used as empty, or green space or related land use could be applied.

3. Constructed and under construction areas are mostly located in eastern and northern sides of the Park. Southern and western parts are still saved because of river floodway, garden and farm lands. Fortunately these parts are declared as preserved farmlands by the government.

Table 3. Structure, Green, open, and built spaces status in selected shuttles around the Eram Park

Shuttle No.	Mean patch size (m^2)			Mean nearest neighborhood distance(m)			Patch number		
	Green space	Open space	Built space	Green space	Open space	Built space	Green space	Open space	Built space
6	187.16	193.42	161.73	8	8	15	2	3	3
7	-	78.29	322.71	-	16.5	-	-	7	1
8	212.54	315.06	75.78	-	5	22	1	2	3
9	-	269	155.86	-	4	-	-	2	1
Total	399.7	855.77	716.08	8	33.5	37	3	14	8

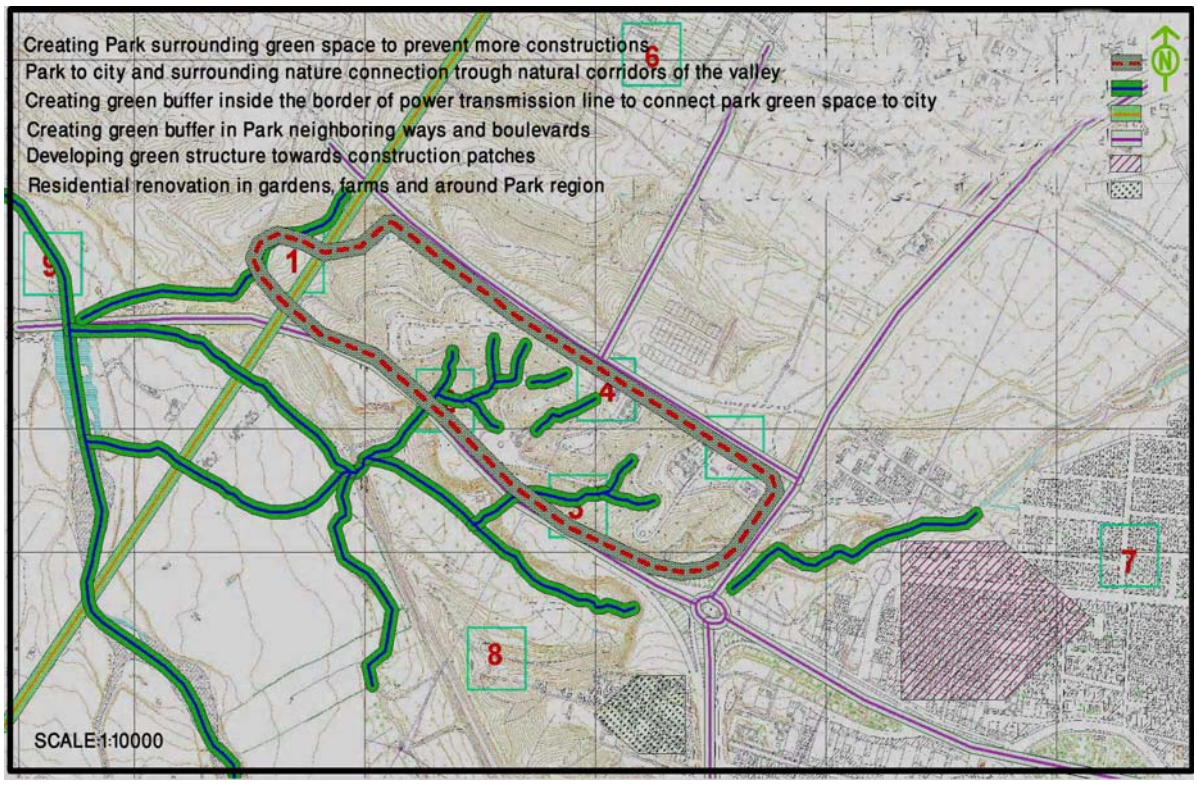

Fig. 1. Map of landscape structure strategic plan

Table 4. Zanjan Eram Park Summary of results and landscape structure suggestions using SWOT Method

Decision making and study field	Current situation and Changes process	Opportunities and Strengths	Threats and Weaknesses
Evaluation of Landscape structure	- Generally the structure of the region consists of many general landscapes including vast open lands, built lands, fragmenting roads, hand planted green lands, gardens, natural corridors of river and floodways which surrounded ERAM Park. - These patches and corridors have been scattered completely imbalanced and separately through out the region. There are some green, open and constructed patches inside the park that are located near each other without any logical proportion and have a noticeable disturbance as surrounding lands.	- Existence of open, green and large patches in upstream lands of the park. - Existence of Zanjanroud natural corridors as main drainage of the study area at downstream of the park. - inhibiting northern, southern and northeastern surrounding of the park from uncontrolled constructions - Existence of green large patches inside the park - Existence of small floodways inside the park as ecological aerial corridor of the park surrounding.	- Existence of traffic ways fragmenting corridors of the park from open green surrounding patches - Developing construction patches at eastern, northern and north east of the park. - Construction at downstream lands of the park. - Imbalance among open, green and constructed patches. - Great difference of the patches type at eastern, northern and north eastern sections around the park with southern and western sections. - Existence of railroad as dividing corridor. - Unsuitable dispersion of green, open and constructed patches inside the park. - Dumping garbage in stream whose leachates finds its way in to the canals of park.

CONCLUSION

This study shows that green space mass inside the park is on a good and reasonable rate; mainly because of planting trees; but outside the Park, there are lots of constructions and also farmlands which have some constructions within them and thus have lesser green spaces with large open and uncontrolled areas.

To promote ecological sustainability and fitting landscape inside and outside the Park, the following recommendations are proposed:

1)Preserving current green space in the park (specially the parts in good condition) and its further development (as green corridor streets),

2)Developing current texture and gravity from central part of the park to the eastern and western parts (by fitting open areas),

3)Preserving current open and green patches inside and outside the park and prohibiting fragmentation,

4)Dispersing and fragmenting construction patches inside and in surrounding areas of the park,

5)Decreasing the average of closest neighboring distance between open and green patches by increasing location connections among them and doing vise versa for constructed areas,

6)Preserving and clearing current underground corridors in the southern part of the Park and further development of connections between open and green patches in the Park and mainland matrix.

7)Construction of green corridors with at least 12 meters width within the Park borders, not in lines and various green spaces, to prevent continual construction in the park, and finally

8)In larger scale, connection of Eram Park to other Parks in the City by green or water transmission corridors between them.

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