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Sustainable Development and Expansion of Green Regions in Karaj and its Suburbs Using GIS Software

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Abstract

Designing environments fitting the creation of urban green networks in line with the enhancement of citizens' quality of life is enumerated amongst the necessities that can prevent the immethodical and illegal growth of urban blocks towards inappropriate directions within cities' realms. Due to the emigration and geographical changes of the recent years, Karaj has encountered population growth that will be accompanied by imbalanced expansion and development of the city. The present study uses GIS software to examine all of the maps pertinent to the status quo of the region and analyze the data and consider the influential characteristics so as to determine the various districts in Karaj and, finally, come up within a suggested plan with an appropriate green network so that an ecological balance and coordination of urban green spaces could be achieved.

Keywords: Sustainable Development, Urban Green Networks, Ecological Balance, GIS Software, Karaj.

Introduction

During the recent years, population growth in Tehran has been followed by adverse outcomes. Spatial discordance, disorganized growth and unjust distribution of the land uses, per capita shortages and improper siting are amongst these outcomes. In the meantime, some land uses, including the green spaces, have been less attended for various reasons (Bakhshi, 2001: 29). Urban green region is a phrase referring to the open spaces featuring natural coverage. The existence of such areas plays a determinative role in the elevation of citizens' quality of life. The present study aims at analyzing green spaces in Karaj and offers a green sustainable development plan based on land and ecological factors' sustainability analyses. Inappropriate siting of urban green spaces eventually leads to the creation of such disorders as low use of the created green spaces by the society members, creation of limitations in the offering of appropriate architectural designs, creation of constraints on the selection and arrangement of proper vegetative cover, confusion in the urban visage, problems related to irrigation and soil modification, lack of proper social interactions, management and maintenance problems, reduction in the social and psychological security and so forth (Rahmani, 2003: 17). The importance of using geographical information system (GIS) in urban planning has become clearly evident with the rapid expansion of the cities and cumbersome increase in the volume of the information that is required to be processed for urban management (Farajzadeh, Sarvar, 2002: 180). The present article tries using GIS for Karaj to offer a plan for elevating the citizens' quality of life.

Study Background:

In an article titled "an analysis of the spatial-locational distribution of green spaces use in district three of Zahedan", Dr. Ebrahimzadeh

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analyzed the problems resulting from the industrial centers fuels and waste materials and the effect of correct green space development on the expansion of such pollution. In this study, there is obtained a per capita for the green space use based on the then current status of district three of Zahedan and the population growth has been estimated until 2015. Based thereon, the required per capita of urban green spaces development has been obtained and it has been used to suggest preventive measures parallel to the ceasing of inappropriate urban pollution expansion (Ebrahimzadeh, 2008). In another article entitled "urban green space siting using GIS in Khorram Abad" that was conducted by Mr. Varesi, it has been shown that urban space per capita in Khorram Abad are quite far away from the standard levels and that the urban green spaces have been distributed completely unbalanced in various regions in such a manner that some regions have green spaces in excess of what they needed and some regions have been given no share of green spaces. Based on this, the land uses and the required per capita of green spaces have been attained and appropriate places for green spaces have been suggested according to the status quo of the region via taking advantage of GIS software (Varesi, 2008). Also, in another article named "modeling appropriate residential neighborhoods in Ardabil based on AHP in GIS" that was carried out by Mr. Fereidun Baba'ei, the improper urban development has been posited as the root cause of many of the social depressions and isolations and the unfavorable effects of urban and housing development on the general health of the citizens and the factors giving rise to the enhancement of citizens' quality of life have also been identified (Baba'ei, 2011).

Analytical Basics of Land Fitting the Urban Green Spaces:

Generally, there are three methods for the development of urban green spaces each of which will be used depending on the position of the location wherein the urban green spaces land use is going to be analyzed and in respect to the potentials and general objectives to which these analyses are intended. The recreational spaces classification method is the first in this general paradigm. Based on this pattern, the designer seeks the creation of recreational spaces and disregards the other areas. Also, s/he bases his work on the creation of a recreational green space. This was first proposed in the former Soviet Union. The urban design and planning is conceptualized as the science and art of organizing the land uses and establishment of the buildings and connective routes in such a way that it features maximum practicality in economic terms and provides for comfort and beauty (Sa'eidniya, 2005). Urban land use planning, as the primary core of the planning (Chapin, Stuart, 1979: 10-15) is, in practice, a process wherein the land use and spatial-locational scattering pattern of urban uses are specified for the purpose of easing the social life and enhancing the welfare of the citizens. The second method is the investigation of ecological factors in an extensive manner and it is predominantly applied in landscape design. The method is substantially used in western countries. In this regard, as understood from its definition and in regard of its practical duties, urban management system is obliged to make plans for urban development and reconstruction and implementation of the relevant urban designs and plans (Razaviyan, 2002: 50). From the perspective of Peter Hall, as a general activity, planning is the creation of an organized series of interventions that lead to the achievement of a certain goal(s) (Hall, 1992: 6). Recognition is the first step in planning. Nowadays, besides daily increasing rate of urbanization and contextual problems of urban plans (Pour Ahmad, 2006: 174), urban management performance weakness is amongst the factors that have contributed to the disordering of the urban land uses in such a way that confusion in land use distribution and misappropriation of resources and services have resultantly come and this has resulted in an insecure environment for the citizens (Razaviyan, 2008: 102). The third method is the ecological factors' thresholds applied parallel to the preservation of biodiversity. The method is mostly applied in regions wherein the environment is suffering destruction or damage subject to the human activities (Mahmoud and Al-Said, 2011: 159). Nowadays, land proportions' analysis is of great importance in urban planning for the urban development and identification of highly preferred and appropriate lands parallel to contextual development. The analysis of land use applicable in GIS has been identified in the different kinds of situations. Ecological grounds are called the constituents of the principles of urban green spaces' development.

The urban region of Karaj is under such conditions in terms of human activities. Karaj is situated in a hot and arid region for which reason the best method of improving the disorganized situation of urban growth therein is the very ecological factors' threshold method. Aided by this method, the required limits for the preservation of ecological balance can be investigated and considered. The method investigates and analyzes the ecological factors and their effects on the urban green spaces system.

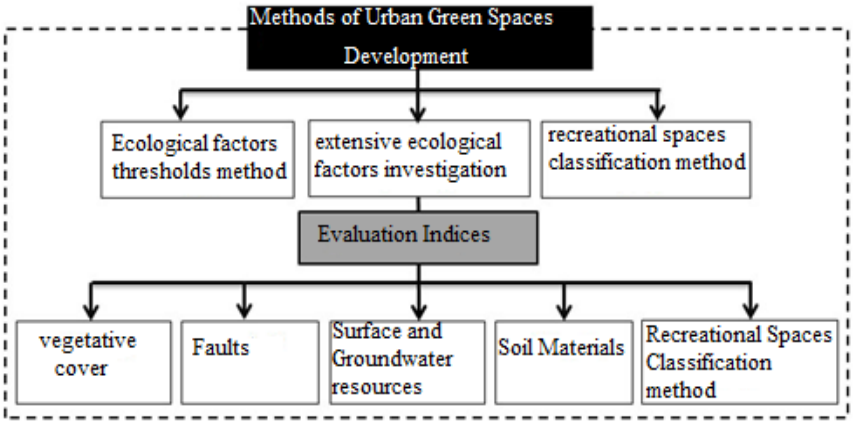


Diagram 1: illustration of methods of urban green spaces development (source: authors)

Study Method:

To create an appropriate ecological threshold and urban green spaces, several important issues should be precisely investigated. Information such as land use, elevation, slope, water system, soil properties, vegetative cover and faults should be taken into consideration as the primary factors in land use analysis. Based thereon, the files in CAD format of the current status of Karaj were obtained from survey organization to be used for the investigation of the abovementioned cases. Evaluations are conducted based on a series of quantitative and qualitative principles. The information incorporates series of checkered maps pertaining to various factors required for spatial analysis. The evaluation factor is extracted from topographical maps. Moreover, slope is the factor calculated using GIS. Eventually, the proposed plan of the region's green spaces is obtained through pushover analysis and combination of various kinds of maps. The process has been fully explicated below.

Case Study Introduced:

Alborz Province is situated in the southern slopes of Alborz Mountain Range within a 20-kilometer distance from the west of Tehran. The province reaches to Mazandaran province in the north and it shares borders with Shahriyar County and Markazi Province in the south. Savejbolagh County and Qazvin Province limit the western borders of the city and Tehran is positioned in its east. The vast Karaj plain, with an average elevation of 1320 meters from the sea level, embraces the path by which the import and export goods are carried from Turkey and Azerbaijan borders to Tehran and vice versa. Alborz Mountains separate Mazandaran Province and Karaj. Karaj is amongst the large and highly populated cities in Iran. The population of the city reached 1377450 people as documented in a census undertaken in 2006. In terms of population, Karaj takes the fifth rank following respectively the lead of Tehran, Mashhad, Isfahan and Tabriz. After Tehran, Karaj is the second largest migrant-receptive city in Iran and it is to be considered as one of the new metropolitans according to its youngness in contrast to the other large cities in Iran. The overall map of Tehran Province region and its connection to Alborz Province and the neighboring cities has been demonstrated in image (1).

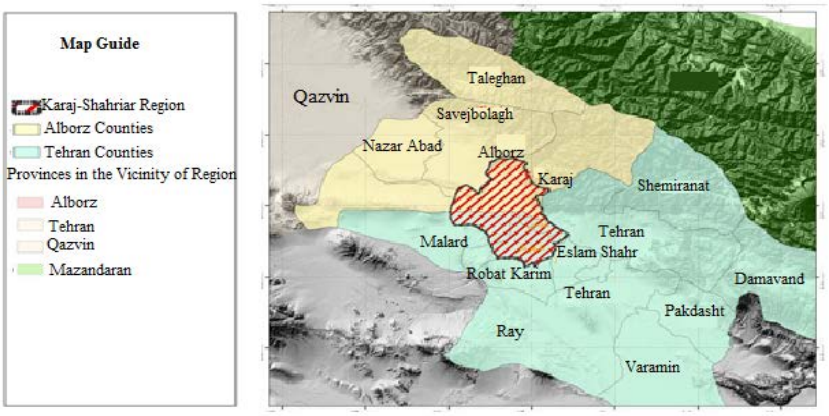


Fig. 1: urban areas of Tehran Province and its peripheral counties [1] (source: authors)

Case Study Analysis using GIS:

According to the expansion method of Karaj, the analysis of the current status and consideration of various factors for arriving at an appropriate siting for the urban green spaces is deemed necessary. In this section, the indices influencing the correct siting of the urban green spaces are introduced and each of them is then analyzed within the area of Karaj. The following diagram displays the influential indices.

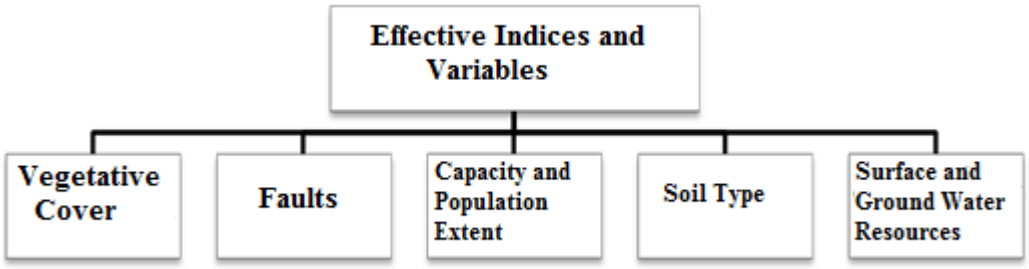


Diagram 2: analysis of the indices and variables (source: the authors)

The following images exhibit the regional land types and the positions of the land uses existing in the region. The land types are of particular importance considering the effect they exert on such other factors as extensiveness of the surface waters and vegetative cover. Furthermore, the position of the existent land uses is an important input because it shows the effect of humans and the practicality of green spaces' expansion.

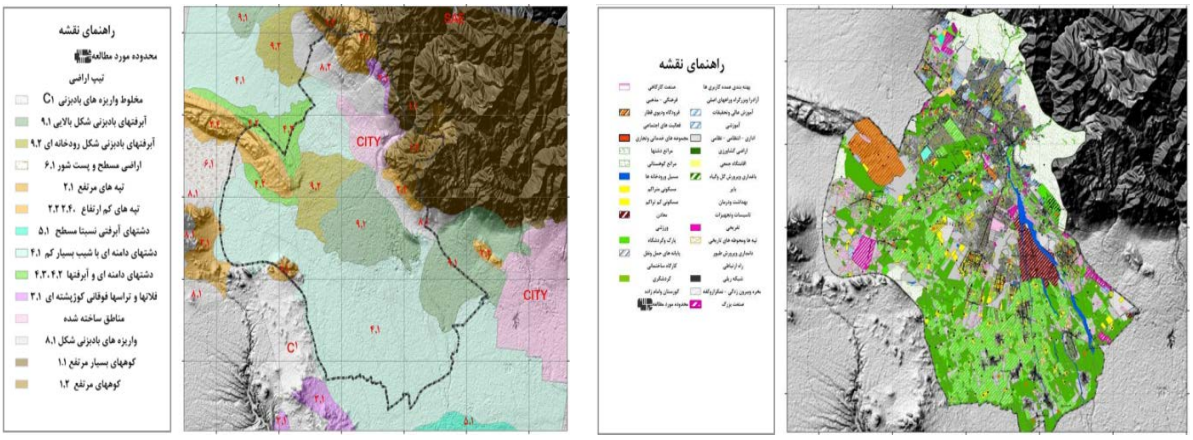


Fig .2: land type map (the right image) [1] and the current status of land use (the left image) [1] (source: the authors)

- *Surface Water and Groundwater Resources:*

Alborz Province is under the influence of a river flowing in the southern slopes of Alborz and it occasionally causes floods in the city. In addition, the groundwater and surface water levels are important factors that should be taken into account in the formation of the urban green structure. The following images depict the zoning of land subject to the flood risk as well as the zoning of the surface and ground water resources (image 4).

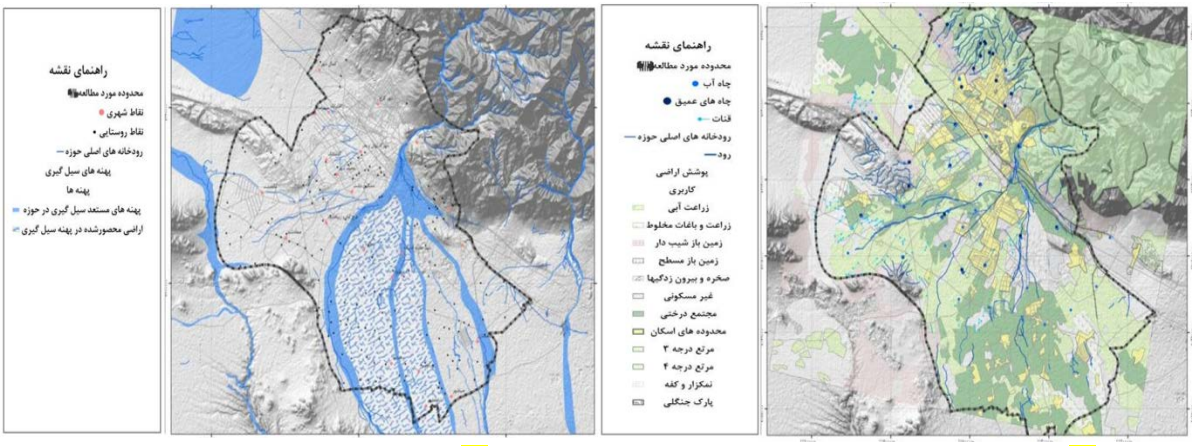


Fig .3: zoning of land at flood risk (the right image) [1]; figure (6): surface and ground water resources (the left image) [1] (source: the authors).

- *Soil Materials:*

Soil materials constitute another factor that is highly influential in the limiting and/or development of urban green spaces. Soil materials can be investigated alone as a special item and it can set a proper grounding for the formation of the intended region. According to the aforementioned cases, the soil map of the region has been prepared based on soil materials (image 5).

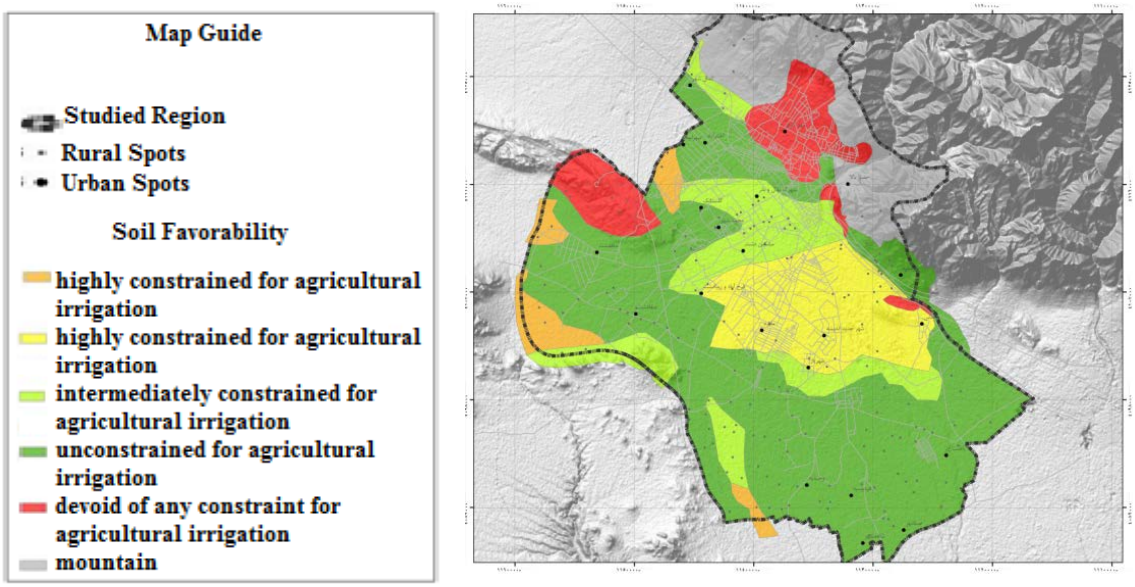


Fig .4: soil optimality [1] (source: the authors)

- *Investigation of the Population Capacity and Extent:*

Karaj has existed since long ago as a residential domicile in Iran and it possesses many new and old textures. According to the city's independence and its conversion to province, the population growth of the city is clearly visible in the city (image 6).

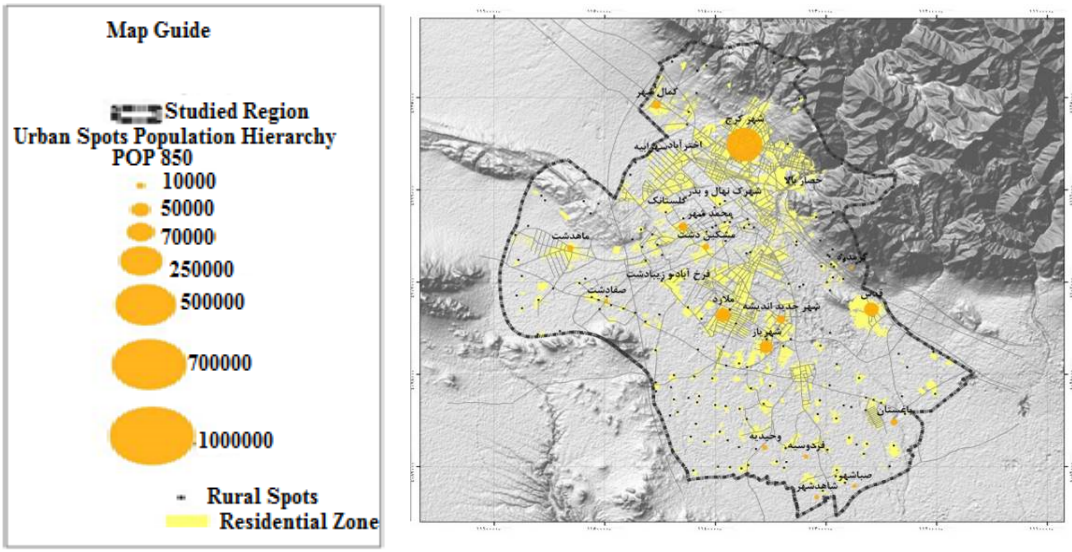


Fig .5: the areas' population hierarchy [1] (source: the authors)

The residential zoning of the city is per se a factor that can guide the need for urban green spaces development and the need for urban green spaces is in itself a reason for the formation of urban green spaces development system.

- *Faults:*

Iran is an earthquake-prone region. Due to the same reason, the recognition and investigation of highly risky faults is amongst the factors that have to be taken into account for the creation of a safe life. One of these faults is situated near Karaj. The trend of the population zones movement towards the risky zones is determined according to the demographic and fault scattering maps. Population and fault map combination provides for a map called the risky population regions that can per se provide for an appropriate navigation of urban green regions as an improving factor.

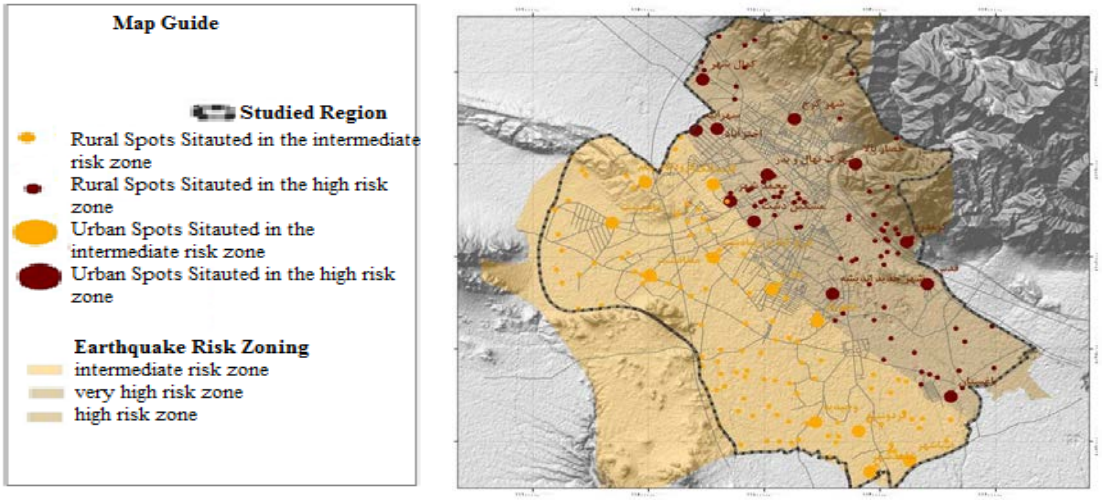


Fig. 6: residential areas' distribution system according to the earthquake risk zoning [1] (source: the author)

- *Vegetative Cover:*

Vegetative cover is a potential that can be utilized in an appropriate manner via creating a series of reformations as the ancillary forces for the formation of urban green spaces. The analysis of the current status vegetative cover is amongst the issues that should be attended to (image 8).

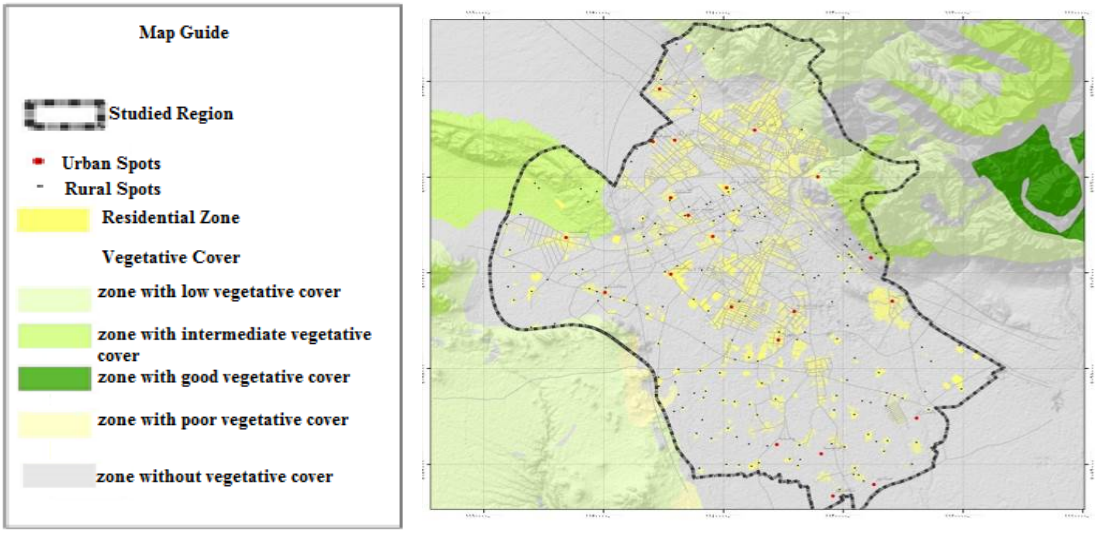


Fig. 7: vegetative cover of the region [1] (source: the author)

Discussions:

The present study evaluates the factors that are effective in offering urban green region patterns. To do so, all of the factors have been directly contrasted with one another. Generally, there is a series of constraints and potentials in implementing any plan. For example, some of the land uses existing in the region have undergone certain conditions that have rendered them unchangeable. Due to the same reason, one layer that is considered as an influential element in the formation of urban green region is the zoning of the land uses existent in the region (image 9).

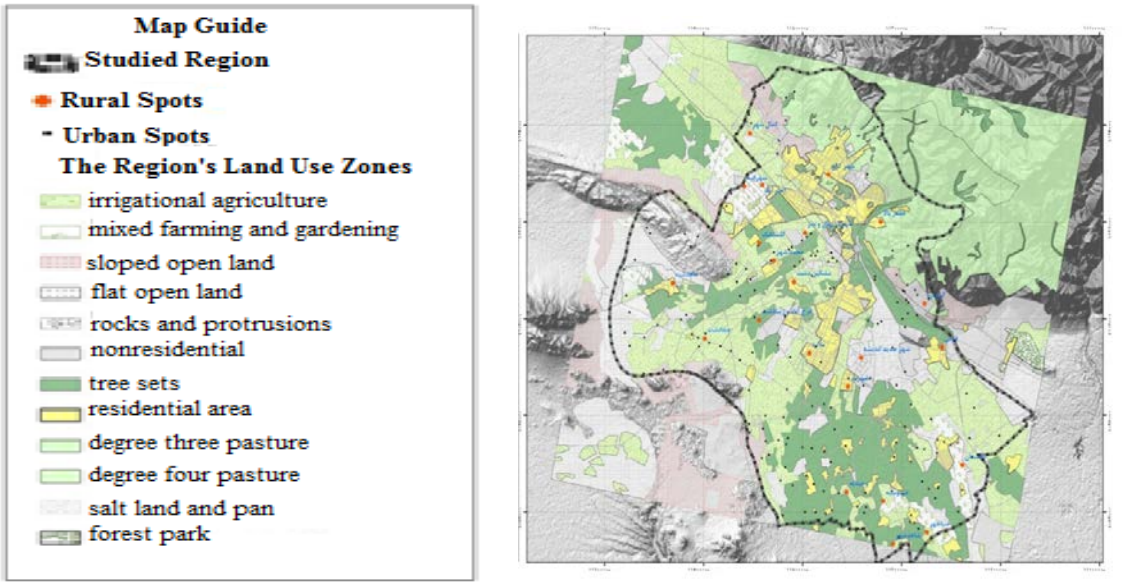


Fig. 8: zoning of the area's land cover [1] (source: the authors)

Generally, the development trend and limitations are considered within the format of two layers for completing and creating the urban green spaces (image 10).

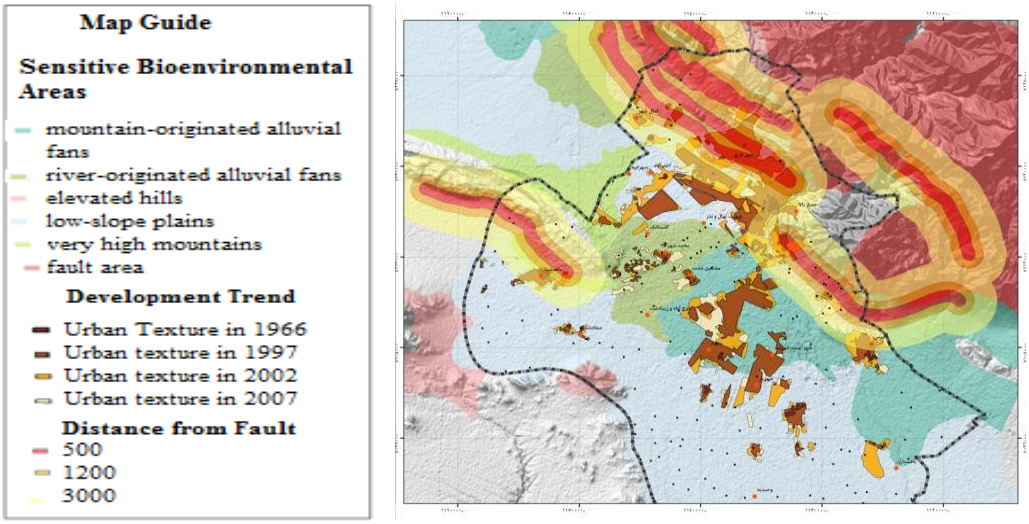


Fig. 9: evaluation of the development trend in respect to the limitations [1] (source: the authors)

The preliminary goal of the present article is the evaluation of combining the ecological factors threshold and appropriate land use analysis of the urban green spaces and this was carried out for Karaj. The use of the landscape recognition principles indicates that the open space incorporates paths that appropriately encompass the nature inside the city in a regional, urban and adjacent region's scale. The current research paper posits concepts appropriate for the green structure designing and planning and they are deemed applicable for the optimal development of urban green spaces. Sustainable development and expansion of the urban green spaces, such as green roads, cause establishment of a relationship between the existent green spaces and, eventually, an urban green belt in an extensive and proper manner in a place and this, besides creating an appropriate space for the users, contributes to the reduction of improper urban development in this region. The obtained plan is the result of having all the useful and limiting factors interacted with one another and it has been offered within the format of a suggested plan named urban green belt for Karaj (image 11). Besides creating an appropriate urban ground, the suggested green belt prevents inappropriate expansion of the city towards faults and this gives rise to a proper urban view.

Zoka'ei and Mazaheri reported similar results in a study aiming at the determination of environment status for achieving the goals of sustainable development (Soltanipour, 2016).

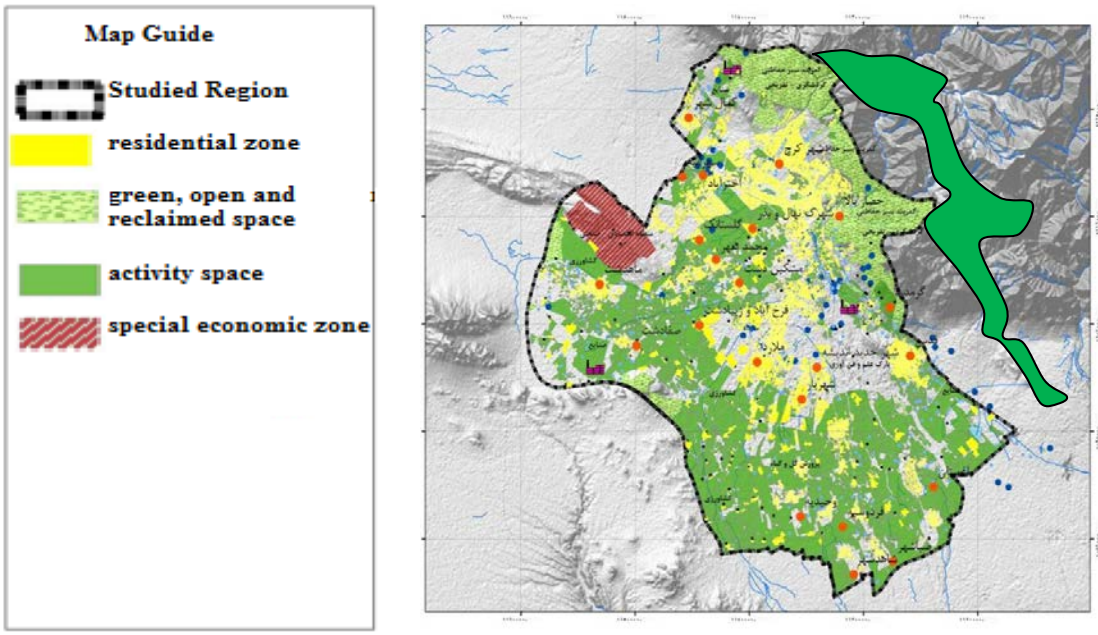
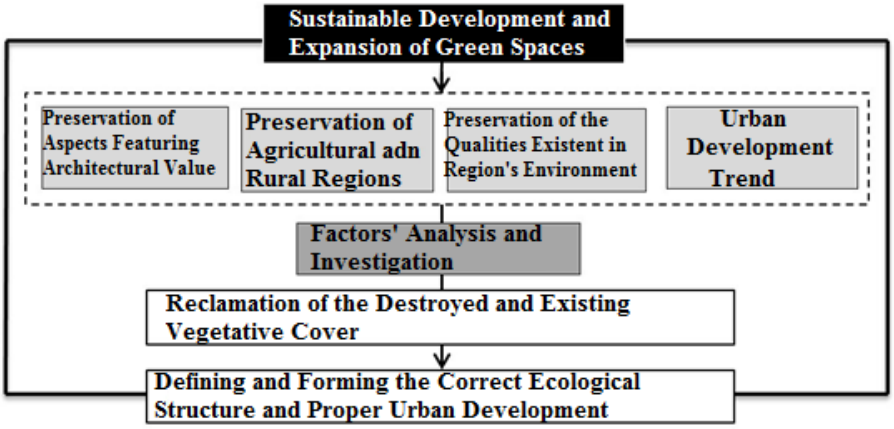


Fig. 10: the suggested plan within the format of urban green belt [1] (source: the authors)

Conclusion:

It is necessary to define a structural scale for the land uses applicable in the urban green spaces in regard of defining and forming a correct and principled ecological urban structure. The appropriate structure of the urban land uses, particularly urban green spaces, besides adding to the spatial and functional beauty of the city, exerts important psychological effects on the citizens' life. The correct definition of the space organizes and directs the social interactions, behavioral norms and psychological comforts. In line with achieving this goal and arriving at a principled and correct pattern of the urban green spaces, various factors should be taken into account, including the urban development trend, preservation of the existing quality of the regional environment, protection of agricultural and rural regions and, finally, safeguarding of the aspects featuring architectural value. The development of cities is formed subject to the effects of various factors like land price, local access points and local facilities. The constraining factors are also not devoid of effect in the expansion trend of the urban development. Based thereon, the entire aspects of urban development should be investigated and considered. Agricultural and rural regions are important functional aspects of the cities and they exert a large deal of effect on defining and organizing the urban green spaces so they have to be especially taken into consideration. The preservation of environment and architectural spaces is also another influential and important factor in regard of the structural analysis of the land uses. The next stage following the analysis and examination of these factors is the consideration of the reclamation of the existent and destroyed vegetative cover by way of which an optimum result can be obtained regarding the defining and forming of a correct ecological structure and appropriate urban development.

Table 1: the definition and formation trend of correct ecological structure and appropriate urban development



(Source: the authors).

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