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Burn or sink
Planning and managing the land

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Cover photo by Giuseppe Mazzeo. Rising wheat fields on the hills of Conza della Campania, Irpinia. January 31, 2023.

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TeMA Journal of Land Use, Mobility and Environment

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BURN OR SINK
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Spatial analysis of green space use in Tabriz metropolis, Iran

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Abstract
The growth and development of urbanization in the last few decades, as well as the land use changes around and inside big cities have been considered as one of the most essential challenges of global sustainable development. The increase in the desire for urbanization and improper management has changed the use of green spaces and gardens around and inside the cities to profitable residential and commercial uses. Accordingly, considering urban parks and green spaces and recognizing their spatial inadequacies is of utmost importance for optimal use by citizens. This research aimed to evaluate the use of green space in the city of Tabriz and the way it is distributed in the urban areas of Tabriz city. This study was an applied research, and its methodology was descriptive-analytical. Moreover, class difference limit model, cluster analysis, and GIS software were used to analyze the data. The results of the study indicated that the per capita use of green space in Tabriz city was much lower than the international and national standard, the spatial distribution of green space use was not the same in different areas of Tabriz city, and was more unbalanced. The results of the cluster analysis method showed that the regions in Tabriz city are at different levels in terms of green space indicators. The results of the class difference limit model showed that the regions of the city of Tabriz do not enjoy balanced green space, and the green space is not distributed evenly among different regions.

Keywords
Green spaces; Sustainability; Spatial distribution; Tabriz metropolis.

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1. Introduction

The world's population has overgrown in recent decades, and this increase in population has been more significant in the metropolitans of developing countries. Today more than 57% of the world's population lives in cities, while in Iran, the urban population has increased from 30% in 1956 to more than 74% in 2021 (Abedini & Kalili, 2019; Zanganehshahraki et al., 2011). It is anticipated that by 2050, the number of urban population will reach 6.3 billion, and nearly 90% of the urban population will grow in developing countries (United Nations, 2015). With the rise in global urban population and subsequent urban physical expansion, the importance of urban green spaces now and in the future can hardly be over-emphasized (Boulton et al., 2018; United Nations, 2018; Nor et al., 2017; Haase et al., 2014). Urban green spaces are defined herein as all spaces primarily covered by vegetation in urban areas including forests, parks, gardens, and greenery along riparian and transport corridors (Biernacka & Kronenberg, 2019; Nath et al., 2018; Wilkerson et al., 2018). Urban parks and green spaces are public capital (Macedo & Haddad, 2015). Urban green spaces are considered highly essential capital that can help cities decrease undesirable effects of rapid urbanism and urban development in a sustainable way (Abu Kasim et al., 2019), and they have significant effects on urban ecosystems (Cao et al., 2021). Green space, as an area in the urban environment, is dedicated to nature and can be utilized as a space for play, recreation, and socialization (Byrne & Sipe, 2010). Jane Jacobs (1961) believes that parks, are the most valuable urban spaces since they are often in direct contrast to hectic and dense urban living (Jacobs, 1961). At present, the concept of "a green city" is widely being propagated at various spatial and political levels (Grunewald et al., 2017). Some examples are the UN's Sustainable Development Goals (SDG 11) (United Nations, 2015), the Convention on Biological Diversity (CBD) (United Nations, 1992), the Biodiversity Strategy to 2020 (European Commission, 2021), and the Green Infrastructure Strategy (European Commission, 2013). This issue is of particularly importance, especially in cities where social and ecological components, including green space, are under urbanization pressure (Taylor & Hochuli, 2017).

Today, urban green spatial planning advances from creating landscaped areas with social and aesthetic value to the consideration of urban green as a kind of modern urban multifunctional infrastructure that supports both social, economic, and ecological processes and also allows cities to become more polycentric. The possibility to locate housing, work and leisure along and around ample landscaped public space which allows free transit movement without congestion and with guaranteed quality of healthy well-being (Wolf & Dagmar, 2019; Kazakov et al., 2018). The carried out scientific studies in the recent years have divided the advantages of urban green spaces into four categories of benefits related to economy, health, life quality and environment (Benedict & McMahon, 2002). Urban green spaces can have long-term positive economic effects (Crompton, 2005). Urban green spaces provide advantages for human health (Jansson, 2014), and the lack of these spaces might harm to human health (Coutts et al., 2010). Urban green spaces can increase the attraction of urban regions and neighborhoods for residents and provide the chance to improve their quality (Jansson, 2014). Results of different studies about different aspects show the importance and value of urban green spaces for the welfare of citizens (Jabbar et al., 2021). Ecologic benefits of urban green spaces include formulating services, decreasing pollution, adjusting weather, and decreasing global warming (Jansson, 2014). Unfortunately, these spaces and their roles have been neglected, especially by politicians and planners, and there are also several problems with their establishment (Hosseini & Sedighi, 2015).

To establish a live able and sustainable city, urban and environmental planners in emerging economies need to pay special attention to green spaces planning. However, the current process and practice of improperly dealing with urban green spaces, particularly in emerging economies, indicate that if this trend continues, destruction and undersupply of green spaces and agricultural lands will significantly threaten sustainable urban development and the ecological balance of our cities. Urban and population growths in Iran, like many other developed or emerging economies, resulted in environmental pollution, which requires policies to be

controlled. Green space the expansion is one of the most essential factors in reducing environmental externalities. In this country, growth of urbanization – both as sprawling suburban development and infill densification – has been accompanied by declining levels of gardens and agricultural lands, which has led to a significant reduction of urban green spaces (Teimouri & Yigitcanlar, 2018).

Tabriz city has not been an exception and has suffered from such problems even more than many other Iranian metropolises. The city has been losing its green spaces swiftly for various reasons: a) Converting open spaces during the urban development process to, for example, residential, commercial, industrial, or mixed uses. Citizens of Tabriz, who once lived among massive gardens and green spaces, now face the perils of rapid urbanization; and b) Pressure of the construction industry on policymakers that have become the victim of wrong decisions. Subsequently, the quality and quantity of green spaces have been reducing dramatically almost daily to contribute to the personal profits of investors, land/property owners, and developers.

Additionally, the disproportionate distribution of these spaces at neighborhoods and city levels has resulted in unjustly planning of this vital land use type. This to study has been conducted with the objective of studying the situation of regions of the Tabriz metropolis in access to parks and urban green spaces. Parks and urban green spaces should be considered among the most essential factors of sustainability in the accelerating and irregular growth of urbanism; if they are managed and planned productively and correctly, they would have valuable and appropriate effects on the health, emotions and spirit of citizens and also on improving the view and perspective of the cities. Despite although in recent years, some projects have been launched in the city of Tabriz by urban managers for improvement and development of urban green spaces, some problems, such as turning the city into one of the most polluted metropolises in Iran, formation of unofficial residential areas in different regions of this city, etc. have made the need for balanced development of urban green spaces in this metropolis an inevitable issue.

1.1 Literature review

As rapid urbanization has changed human settlements into cities, far away from the natural environment, the need to contact nature has become a challenge for urban policymakers and planners. Access to UGS has been shown to contribute to human physical and mental well-being (Muller et al., 2018; White et al., 2017). Recently, attention has been drawn to the urban green landscape in urban issues, indicating that urban green prosperity should be a significant component of urban development policies and plans (Waldheim, 2006). Green spaces are part of urban open spaces, filled with other kinds of plants and vegetation and also activities for different age groups that contribute to health, feeling of safety, comfort, well-being, and aesthetic value of urban areas and communities (Groenewegen et al., 2006), providing ecosystem services such as climate regulation, capturing pollutants, or flood regulation (Geneletti et al., 2020), also promoting community integration, neighbors interactions, and delivering a favorable place for health, relaxation, and nature contemplation (Houlden et al., 2019; Ma et al., 2019). In general, urban green space is considered a public good that allows free access to all citizens and provides pockets of nature for all residents, including urban parks, squares, median strips, roadsides, sidewalks, etc. (De la Barrera et al., 2016). Given the importance of urban green space, unequal access to them is considered an environmental justice issue (Wolch et al., 2014), which in this case can be understood as the equal distribution of green infrastructure without discrimination within a city.

Byrne et al. (2009) showed that in the United States, urban parks have been distributed unfairly. Wolch et al. (2014) tried to compare urban green spaces especially parks in the green cities of the US and China. Results of this survey show that the distribution of such spaces is often unequally and inappropriately for the benefit of primarily white and wealthier communities. Nadja and Dagmar (2014) concluded that although most areas are supplied with more UGS compared to the per capita target value of 6 m^2, there is

considerable dissimilarity by immigrant status and age. To address rising concerns about socio-environmental justice in cities and to evaluate the (dis)advantages of applying UGS threshold values for urban planning, visitor profiles and preferences of a site-specific case, the park and former city airport Berlin-Tempelhof are analyzed. Results from questionnaire surveys indicate that the identified dissimilarities on the sub-district level are not the same as socio-environmental injustice in Tempelhof, but point to a mismatch of UGS and user preferences. In addition to evaluating UGS distribution, the match between the quality of a park and specific cultural and age-dependent user needs should be considered for successful green infrastructure planning rather than focusing on target values.

Li et al. (2021) pointed out that spatial justice of parks was one of the main concerns in the environmental studies. The findings of this survey help urban planners and policymakers to set more reasonable policies and plans for the improvement of spatial equality and justice, in the case of parks in urban areas. Akbari (2022) in a study concluded that Region 10 of the metropolis of Shiraz by achieving 3.498 has the highest number of parks and green spaces. After region 10 in this city, region 4 with the score of 2.013, region 3 with 1.776, region 6 with 0.938, and region 9 with the score of 0.404 are in the next ranks. Other regions of the city of Shiraz achieved low scores, and region 8 of this metropolis with -3.167 had the lowest score. Region 8 which is considered to be the historical and cultural context of the city of Shiraz includes the lowest per capita of green spaces in the urban projects. Li and Fan (2022) in a study the evaluation simulation of urban green space landscape planning scheme based on PSO-BP neural network model concluded the PSO-BP neural network can combine the principle of landscape ecology, integrate more evaluation indicators of ecology and urban development into the urban green space landscape planning scheme, and simply understand and predict human behavior, to make a more comprehensive evaluation and prediction. Experiments show that PSO-BP neural network has smaller error and better generalization ability than BP neural network. The PSO-BP neural network rating model can analyze its more reasonable proportion according to the relationship between different types of green space and indicators, and give corresponding adjustment suggestions, which has guiding significance for the modification and adjustment of urban green space landscape planning scheme.

Puplampu and Boafo (2021) in a paper concluded that, the overwhelming number of stakeholders understand and are aware of the beneficial values of urban green spaces but highlight poor planning, coupled with land tenure challenges, as a threat to the conservation of green spaces. Land use and land cover change analysis shows that the urban built environment has expanded from 55.1% to 83.79% at the expense of the natural environment, including green spaces, which have declined from 41% to 15% over 27 years. Existing areas of green spaces, including the Achimota forest, the University of Ghana campus and street trees on major roads, were valued at US$ 37,610,980 for carbon sequestration and storage, US$ 1,478,173 for air pollution regulation, and US$ 458 for avoided runoff. A rapid assessment of the availability, accessibility and management of urban green spaces in the Accra metropolis can be an essential step towards identifying and mapping their consumptive and non-consumptive use-value and introducing appropriate interventions necessary for enhancing the city's resilience in an era of climate change. Ghasemi and et al. (2022) in study for the purpose of analyzing the spatial distribution pattern of urban green spaces in Tehran, the nearest neighbor method and multi-distance spatial cluster analysis used. As a result, the spatial distribution pattern of this land use strongly resembled a clustered pattern, and the accessibility and distribution of green spaces in Tehran were unequal. Also, based on the Cocoso method, which was used to analyze access to green spaces and parks, districts 10 and 11 are by far Tehran's most deprived districts. Distribution of services in the city based on per capita in the form of comprehensive and detailed plans, financial and technical problems of municipalities, lack of approach to planning and sustainable development on a national, regional and local scale in Iran's planning system, lack of integrated urban management in the Tehran's city management system, the emphasis of most urban planning theories in Iran on planning

processes and ignoring social and spatial structures are some of the main reasons for this disparities. To reduce inequality between the districts of Tehran, it is essential to devise effective regional planning and adopt balanced and impartial policies for equal accessibility of resources in all urban districts. The findings enhance our understanding of the level of urban inequity and the potential causes of inequality concerning accessibility to green spaces in metropolitan areas. This study also sheds light on the critical role of policy-making in this process. These findings have implications for urban managers regarding of the accessibility, allocation, and distribution of urban services in different cities of Iran and the world.

Altunkasa et al. (2017), studies mapping and determining the effectiveness of green spaces and socio-cultural facilities as providers of urban ecosystem services and urban services in the case of Adana, Turkey. Firstly, green spaces and socio-cultural facilities per capita have been determined and indexed for the neighborhoods in the city. Then, a distance-based method for estimating the effectiveness of these facilities was used. The distances between the various neighborhoods and between a given facility and the farthest threshold have been measured and these values have been used to determine the facility effectiveness change value for each neighborhood. Then, effective values have been calculated and indexed by incorporating the green space and socio-cultural facility values and the effectiveness change values for the neighborhoods. Finally, point-based effective green spaces and socio-cultural facilities index values have been converted to continuous surface values in a GIS (geographic information system) environment in order to utilize as a base map for urban physical planning purposes. According to the outcomes of this study, the distribution of green spaces and socio-cultural facilities of the neighborhoods are imbalanced and index values of these facilities range in between 45 and 84 out of 100. Bianconi et al. (2018), in a study with issue of urban regeneration in contemporary cities, adopting a strategic vision which includes the use of vegetation and green infrastructure to create a network of public spaces. Especially, urban periphery lacks of public spaces, meaning a public use of urban space for outdoor activities and social networks. The extraordinary program for the Italian peripheries, addressed to all the metropolitan cities and provincial capitals in 2016, inspired to Renzo Piano idea of "re-sewing" urban fabrics, has been a good opportunity for testing new approaches to urban regeneration. The case study investigated in this study is the financed project for the city of Perugia, which provides different interventions aimed at improving (and developing new) public spaces through vegetation enhancement and a large area destined to vegetable social gardens as a strategy for urban infill. By recovering public spaces with social purpose and providing a comprehensive strategy for aesthetic improvement of the city, the case study provides a representative example, how greening the city may promote together biodiversity conservation and urban regeneration.

Basu & Nagendra (2021) concluded most users value the park as a recreational space, but are largely unable to access provisioning services such as food and fodder. This poses a particular challenge for low-income residents. In the large parks with high vegetation cover, visitors could identify a variety of trees, plants, and birds, while in the smallest neighborhood park which has the least amount of greenery; they could only identify a small number of species. Parks were visited more by men than by women, who cited challenges of lack of time, and lack of safety. Park entry fees also acted as barriers, for low-income groups. The two parks located in wealthy and gentrifying neighborhoods were almost exclusively accessed by middle class and wealthy visitors, because of the entry fee. Surveys of willingness to pay found that wealthy visitors were keen to pay an entry fee and did not seem to understand the implications of such a fee on exclusion, low-income visitors expressed negative views. A central role of the urban park as a 'public space' within a city is to nourish the sense of community. Yet some parks have been converted into landscaped and designed areas with high public investment, and entry charges, with limited provision for harvesting ecosystem services. Thus even in public spaces like parks, we observe stark gender and income inequalities, leading to the uneven access to green space. Scheiber & Zucaro (2023) concluded 2030 has been set as the target for achieving most of the sustainable development goals and in this path urban open and green spaces have

been identified as drivers and accelerators for increasing resilience and adapting cities to climate change. The pandemic has acted as a further catalyst for the reorganization and re-assessment of the role of open spaces. This work focuses on the system of urban open and green spaces whose planning and design, through a systemic approach, can address current and future urban challenges such as climate change. The main aim is to provide local decision-makers with urban open and green spaces planning and design principles based on a mixed-method approach adopting Malta as a case-study. Findings suggest that EU and international strategies advocate open and green spaces as an indisputable requirement for increasing resilience, energy sustainability and adaptive capacity of urban systems. However, in comparison, there is still scope for improvement when considering Malta's planning framework. While there is a growing sentiment for the appreciation and need of green open spaces from the users, important characteristics are still lacking within the planning processes.

Khavarian-Garms et al. (2023) in a paper concluded the principles of the 15-minute city concept include the following: (1) Proximity. The 15-minute city highly values proximity, which has also been a fundamental principle of earlier movements such as the garden city and the neighborhood unit It follows a proximity-oriented strategy that focuses on the redistribution and relocation of urban amenities and resources within neighborhoods allowing residents to access the six core functions of living, working, commercial, health care, education, and entertainment with a 15-minute walk or bike ride. (2) Density. The 15-minute city views density as a critical strategy for ensuring that residents have adequate access to daily necessities without relying on private cars (3) Diversity. The 15-minute city aims to increase neighborhood diversity through two mechanisms: (1) software diversity, and (2) hardware diversity (Moreno et al., 2021). Software diversity is about creating communities that represent a diverse range of cultures, ethnicities, and economic and social classes. Hardware diversity aims to create multi-use neighborhoods that include residential, commercial, and recreational uses. Carlos Moreno, inspired by Jacobs, sought to transform the 15-minute city from the mono centric urban structure into a polycentric form. Based on the chrono-urbanism philosophy, he believed that job localization can improve people's quality of life by preventing them from wasting time on daily commutes and therefore lowering carbon emissions (4) Digitalization. While digitalization was not originally among the 15-minute city's principles, the capabilities provided by smart solutions during the pandemic. convinced advocates of the concept to leverage smart city technologies to supplement other principles. (5) Human scale urban design. The need to return to a human scale was one of the major lessons of the COVID-19 pandemic for cities. The scale and form of a 15-minute city are defined based on human needs and characteristics. This concept advocates redesigning public spaces for the benefit of citizens rather than cars. It promotes investment in walking and biking paths so that city dwellers can fulfill their daily needs within a 15-minute walking or cycling distances. (6) Connectivity. Making a connection between neighborhoods by public transportation helps to avoid isolated neighborhoods and ghetto enclaves. It ensures a continuous integration of individual neighborhoods into the broader urban structure. Within 15-minute city neighborhoods, active mobility modes like walking and cycling are combined with public transportation, increasing public transportation efficiency, and addressing first/last mile connections. (7) Flexibility. The 15-minute city concept advocates the transformation of single-function public and semi-public spaces into multi-purpose areas to maximize the utilization of buildings and spaces. It aims to assign multi-purpose roles to public and semi-public spaces that are already being used for a specific purpose at a particular time of day or on certain days.

2. Methodology

This study was applied research using descriptive-analytical method. The data had been collected using library-field studies and the spatial data of the study area. Class difference limit method, TOPSIS model, Cluster analysis method and GIS software were used for data analysis. The variables utilized to rank the

areas of Tabriz city using the Cluster analysis model and TOPSIS model included: population, size, the area of green space, the area of permanent and seasonal green spaces, tree-planted spaces, the area of urban and local parks, the area of expanded green space, the ratio of green space to the population of the regions, the ratio of green space to the size of the regions, and the recreational space of the parks.

2.1 TOPSIS Model

The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is a multi-criteria decision analysis method, which was originally developed by Ching-Lai Hwang and Yoon in 1981 with further developments by Yoon in 1987, and Hwang, Lai and Liu in 1993. TOPSIS is based on the concept that the chosen alternative should have the shortest geometric distance from the positive ideal solution (PIS) and the longest geometric distance from the negative perfect solution. It is a method of compensatory aggregation that compares a set of alternatives, normalizing scores for each criterion and calculating the geometric distance between each alternative and the ideal alternative, which is the best score in each criterion. Criteria weight in the TOPSIS method can be calculated using the Ordinal Priority Approach, Analytic hierarchy process, etc. An of TOPSIS assume is that the criteria are monotonically increasing or decreasing. Normalization is usually required as the parameters or criteria are often of inconsistent dimensions in multi-criteria problems. Compensatory methods such as TOPSIS allow trade-offs between criteria, where a poor effect in one criterion can be negated by a good result in another criterion. This provides a more realistic form of modeling than non-compensatory methods, which including or excluding alternative solutions based on hard cut-offs. TOPSIS methods require the independence of criteria for being utilized real-life. However, independence of criteria is hard to guarantee in real applications as such, TOPSIS methods might produce biased rankings. TOPSIS is based on the premise that the best solution has the shortest distance from the positive-ideal solution, and the longest distance from the negative-ideal one. Alternatives are ranked using an overall index calculated based on the distances from the ideal solutions. The TOPSIS method can be explained as a set of stages shown below:

Step 1: data matrix

…	C1	C2	…	…	…	Cn
A1	X1	X2	…	…	…	Xn
A2	X1	X2	…	…	…	Xn
A3	X1	X2	…	…	…	Xn
…	…	…	…	…	…	…
AM	X1	X2	…	…	…	Xn

Step 2: The data matrix is de-scaling using the following relation:

$$nij = \frac{Xij}{\sum Xij}$$

Step 3: Calculation of the entropy: The entropy of each index is calculated using the following relationship:

$$Ej = -K \sum_{i=1}^{n} \left(n_{ij} \mathrm{Ln(nij)} \right)$$

$$\mathrm{K} = \frac{1}{Ln(m)}$$

The entropy value of the indices is a value between zero and one:

$$0 \leq \mathrm{Ej} \leq 1 \rightarrow (\forall \mathrm{j} = 1, 2, \ldots, \mathrm{n})$$

Step 4: Calculation of the degree of standard deviation: The standard deviation of each index is calculated using the entropy value of that index through the following equation (Hekmatnia & Mousavi, 2015):

$$Dj = 1 - EJ$$

Step 5: Calculating the weight of each indicator: Using the following relationship, the weight of each of the indicators can be calculated:

$$Wj = \frac{Dj}{\sum Dj}$$

Step 6: Balance the de-scaling matrix:

$$\begin{bmatrix} n11 & n12 & \dots & \dots & \dots & n1n \\ n21 & n22 & \dots & \dots & \dots & n2n \\ \dots & \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots & \dots \\ nm1 & nm2 & \dots & \dots & \dots & nmn \end{bmatrix} \begin{bmatrix} w1 & \dots & \dots & \dots & \dots & \dots \\ \dots & w2 & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots & \dots \end{bmatrix}$$

$$\begin{bmatrix} w1n11 & w2n12 & \dots & \dots & wnn1n \\ w1n21 & w2n22 & \dots & \dots & wnn2n \\ \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots \\ w1nm1 & w2nm2 & \dots & \dots & wnnmn \end{bmatrix} = \begin{bmatrix} v11 & v12 & \dots & \dots & \dots & v1n \\ v21 & v22 & \dots & \dots & \dots & v2n \\ \dots & \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots & \dots \\ vm1 & vm2 & \dots & \dots & \dots & vmn \end{bmatrix}$$

Step 7: Find positive and negative ideal solutions.

$$A^{+} = [v1, v2, \dots vn] = [\max \ vi \ j \in J+), (\min j \in J-) i = 1,2, \dots, m)$$
$$A^{-} = [v1, v2, \dots vn] = [\min \ vi \ j \in J+), (\max j \in J-) i = 1,2, \dots, m)$$

Step 8: Obtain the separation values: The separation measure is the distance of each alternative rating from both the positive and negative ideal solutions which is obtained by applying the Euclidean distance theory. Eqs. Show the process for positive and negative separation calculations respectively.

$$D+ = \sqrt{\sum (\mathrm{Vij} - \mathrm{Vj}^{+})2}$$
$$D- = \sqrt{\sum (\mathrm{Vij} - \mathrm{Vj}^{-})2}$$

Step 9: Calculate the general preference score. The overall preference score CLi for each alternative Ai is obtained as shown in the following equation.

$$\mathrm{CLi} = \frac{D^{-}}{D^{-} + D^{+}}$$

2.2 Class Difference Limit Model

This method can be implemented by using statistical formulas, especially by using the highest and lowest data values. The model includes the following steps:

Step 1. Determining the different frequencies of data:

$$R = \mathrm{Max\ xi - Min\ xi}$$

Step 2. Determining the number of classes, using Sturges formula:

$$K = 1 + 3.3 \mathrm{Log_n}$$

Step 3. Determining the class difference limit value:

$$H=\frac{R}{K}$$

Step 4. Creating the data matrix.

2.3 Cluster Analysis Method

Cluster analysis is a statistical method for determining homogenous groups or clusters (Asayesh & Estelaji, 2013). It includes a wide set of techniques designed to find a group of similar items in a data set (Holand, 2006). The purpose of cluster analysis to divide the observations into homogeneous groups in which the observations of each group are similar and the observations of different groups are not that similar to each other (Hekmatifarid, 2003). In other words, cluster analysis is a multivariate analysis that seeks to organize the information related to variables in which the components of each cluster are similar to each other and the members of each cluster are not similar to the members of other clusters (Hajipour & Zabardast, 2005; Kalantari, 2008).

Accordingly, areas having the most similarities in terms of factor scores are grouped in one cluster (Melki & Sheikhi, 2018). In other words, cluster analysis divides the observations into homogeneous groups so that the observations of each group are similar to each other and the observations of different groups not are that much similar to each other (Goldasteh et al., 2010). The purpose of cluster analysis to divide a set of data into discrete clusters with common characteristics (Vermunt & Madison, 2002). Classifying homogeneous areas of this method is done in different ways. Determining the correlation coefficient and measuring the distance, especially the Euclidean distance, are among the most important methods of determining homogeneous regions (Bayat, 2018).

Therefore, there are different methods for combining components in clusters, including hierarchical cluster analysis. Hierarchical analysis is performed using condensing or discriminating method (Salehi et al., 2016). The steps of cluster analysis can be summarized as follows:

- (1) Collecting the data matrix in which the regions are placed in a column and are subjected to cluster analysis. Its rows are also made up of attributes that the desired areas are zoned on this basis;
- (2) Standardizing the data;
- (3) Calculating the similarity between the pairs of original data matrix areas and standardized data;
- (4) Using a cluster method for categorizing the similarities and forming a tree diagram or dendrogram. This diagram shows the similarity between all people both in pairs and hierarchically (Pourtaheri, 2019).

3. Study area

The city of Tabriz, one of the most ancient cities in Iran, is the capital of the East Azerbaijan Province. Tabriz city, located in the northwest of Iran, is in a mountainous area at an altitude of 1,350 meters at the junction of the Aji River and Quri River and is surrounded by mountains from the north to the south. This city with a population of 1,612,000 people in 2020 and an area of 237 km^2 is the fourth largest city in the country after Tehran, Mashhad and Isfahan.

Like other populated cities in Iran, Tabriz city has experienced the phenomenon of rapid urban growth leading to the formation of urban sprawl growth, an increase in the area of the worn-out texture, informal and slum settlements in peripheral areas of the city. During recent years, due to high numbers of immigrants and a high population growth rate, Tabriz city has undergone an irregular and rapid growth and has experienced incredible population and spatial change. This city has a strategic position in Iran, acts as a connection point between Iran and Europe and has always been considered to be one of the major cultural, political and economic poles of Iran (Rahimi, 2016) (Fig.1). Tabriz is divided into 10 districts according to the

municipality regulations and the comprehensive plan. Urban green spaces in Tabriz are classified into two groups: a) Artificial green spaces a combination of equipped urban parks, urban squares, trees planted in residential areas, and green spaces on streets; b) Natural green spaces all the green spaces that are naturally existing and preserved (Teimouri & Yigitcanlar, 2018).

Fig.1 Location of study area

4. Results and discussion

4.1 The role of green space in urban sustainable development

Cities are alive and dynamic systems and green spaces are a part them; due to their effective role in reducing urban density, creating guiding and supplemental routes, as well as improving the performance of educational, cultural, residential facilities, and reserving lands for the future expansion of the city, they are considered valuable. The importance of green space ecology is because the oxygen needed by a person can be obtained in 30 to 40 m^2 of a green space (Izadi & Gorji, 2018). Green spaces are considered as the breathing lungs of the city; the lack or absence of which means the lack of physical and mental health of its citizens. Along with industrial development and increasing urbanization, its importance has also increased. Having urban parks and green spaces are among the practical strategies that have recently received more attention to deal with the problems of urban and modern societies.

The evidence shows that the existence of natural complexes (parks, forests and green belts) and their elements (trees and water) in the boundaries of cities has a significant impact on the quality of life of citizens from various aspects it also has social and psychological benefits in addition to ecological efficiency such as weather purification, the reduction of noise pollution, the reduction of wind effects and the stability of microclimate. Using the park reduces pressure and stress and deepens thinking; it also keeps city dwellers young and gives them peace and comfort (Cherisura, 2004). Undoubtedly, the creation of green spaces has long been one of the favorite issues of humans due to its special relationship with nature. Despite the disturbances that humans have unknowingly and perhaps knowingly created in nature through burning forests and turning pastures into agricultural lands by setting foot in the agricultural revolution, they have always sought to cure the nature by building gardens and planting scarab trees (Heidaribakhsh, 2007).

Paying attention to urban green space issues is more important the time that the considered urban use becomes related to urban sustainability. The new dimension of urban sustainability in today's heterogeneous and unsustainable cities is called social sustainability being interconnected with the role of parks in increasing the participation rate of citizens. Optimal distribution of urban green space is a factor for

ecological (environmental, economic, social and psychological) efficiency for citizens it can prepare the context for ecological sustainability of cities (Deh Cheshmeh, 2016). Therefore, incorrect positioning of urban green spaces would ultimately lead to the creation of anomalies such as: low use of the created green space by users, limitations in providing suitable architectural design, limits in the selection and arrangement of appropriate plants, disturbances in the urban landscape, problems related to the irrigation and soil modification, the lack of proper social interaction, management and maintenance problems, reduction of psychological and social security, etc. (Varesi et al., 2007).

The importance of green space is not hidden for anyone; especially the essential of entertainment is evident. In most discussions, parks and green spaces are emphasized as an important factor that can increase the quality of life. Therefore, everyone's access to urban services and social justice dictates that all urban classes can equally enjoy green spaces and urban parks as well as leisure places and not certain classes of citizens choose parts of the most beautiful views of the cities for their lives so that gradually all these views become exclusive to these prosperous classes of the society.

4.2 Green space and urban planning

The functions of green space in the city are the followings:

- (1) Urban green space, as an alive part of the physical construction of the city, plays an essential role in coordination with the lifeless part of the body, texture and appearance of the city. The creation of wide green spaces between uses that are incompatible with each other stabilizes safety and plays an essential role in reducing the burden of environmental pollution.
- (2) Environmental functions: In this section, green spaces help to improve the ecological conditions and reduce the amount of pollution. Accordingly, the impact of urban green space on the quality of the city's bioregion should be emphasized more than any other factor. For this purpose, it should be noted that the effect of the green space on the bioregion of the city reaches its maximum level when, firstly, the green space is correctly located in terms of climate, secondly, trees and shrubs are used in the design of the green space (Rahimi, 2019).
- (3) Socio-psychological functions: Although the function of green space in the physical construction of the city and its environmental functions can also increase social and psychological efficiency, in the design of green space, the main goal is bringing man and nature closer to each other to achieve it is social and psychological effects. Every person in any situation needs a few hours of silence and peace every day. This need will increase in the future with population density in residential environments and apartment living. Therefore, from this point of view, the creation and development of urban green spaces where people can spend at least one hour a day in peace and away from the hustle and bustle of everyday life is an absolute necessity (Qurbani & Teimuri, 2014).

4.3 The structure of green space in Tabriz

- *Parks* The area of the park and green space is currently 578.8 hectares; the share of this land use is about 2.4% of urban land and its per capita is 3.8 square meters.
- *Gardens and agricultural lands.* This land use includes lands dedicated to gardens and agricultural lands inside the city, whose area is currently 2891 hectares. The share of this land use in the city is equal to 11.8% and its per capita is equal to 18.9 square meters.
- *Natural lands.* This use includes the areas dedicated to natural forests and human plantings whose area is 187.6 hectares in Tabriz. The share of this use from overall land of the city is 77.7% and it is per capita is equal to 1.22 square meters (Teimuri, 2015).

- *Natural spots.* These spots are not adequately distributed inside the city and the city is empty of big spots. While there are ample spots of mountainous lands in the outskirts and around the city (northeast and south of the city) and due to the northeast direction of the prevailing winds, air currents blow from part of these lands towards the city. Small green spots in some parts of the river bank are also among the few remaining spots. These spots have been destroyed and broken into pieces due to the construction and the passing of horse tracks on the river bank.

In general, the green space structure of Tabriz city can be divided into two general categories including artificial green spaces and natural green spaces: 1) Artificial green space: A combination of equipped urban parks, urban squares, refuges, trees planted inside and around residential areas, green spaces along the streets, etc. as well as all green spaces that have been cultivated and developed by people and city managers., 2) Natural green spaces: all green spaces that exist naturally and have been preserved.

4.4 Green space changes in Tabriz

The slow period in the changes of green space

The extent of urban green space in Tabriz during 1976 was distributed in different parts of the city suitably most parts of the city were located at reasonable distance from these uses. So the coverage of the city's green spaces and gardens in this period had an area equal to 5916.53 hectares for a population of 597976 people and it covered about 23.31% of the city area.

City population	Rate of changes in the area in hectares	Percentage of the total area of the city	Area in hectares	Year
597,976	-	23.31	5,916.53	1976
971,482	435.92	22.13	5,631.61	1981
1,089,000	655.58	20.19	5,125.03	1986
1,340,000	172.18	18.33	4,652.85	1996
1,398,060	278.89	17.23	4,373.96	2001
1,545,491	2257.87	8.34	2,116.09	2011
1,612,000	407.07	6	1,709.02	2021

Tab.1 Changes in the green space of Tabriz city since 1976-2021

In 1986, the area of green space in the city decreased by 5480.61 hectares, and an area equal to 435.92 hectares of green space was destroyed and changed in these 10 years period. These changes continued until 2006 and the area of green space decreased to 4373.96 hectares and 17.23% of the total urban area; these changes have been faced with an increase and decrease of the number of changes in different periods so in these 20 years period, i.e. from 1986 to 2006, the most significant amount of changes were related to the years 1986 to 1991 with 505.58 hectares of green space reduction. Therefore, despite the changes and destruction of green space in the mentioned period, the movement of changes has been slow during these 30 years study period, the percentage of green space has decreased from 23.31% to 17.23% of the total area of 25 thousand hectares.

The rapid course in the changes of the green space

The intensity of green space changes has increased in the last fifteen years. The percentage of green space in 2006 was 17.23%, which decreased to 6.73% in 2022. In fact, in this 15-year period of study, more than 2664 hectares of urban green space have been destroyed and it has turned into a great urban crisis. Most of these changes were also related to the years 2006 to 2011, where the area of green space has decreased from 4373.96 hectares to 2116.09 hectares. The intensity of changes in the green space of this period has been very fast and in 5 years (2006-2011), more than 50% of the urban green space has been destroyed,

showing the lack of proper management of urban green spaces and the spread of rapid changes in this period.

4.5 Recognition of public parks and green space

Urban parks are considered a subset of public open spaces and green and open organs of the natural green structure of the city. This category of public open spaces has social efficiency and ecological benefits of the city and is designed and equipped for public use, leisure, recreation, meeting with friends and social and cultural gathering purposes. Bagh Golestan Park the area of Imam Khomeini Street and 22 Bahman Square, Valiasr Park and Baglar Baghi Park in the west of Valiasr street, El Goli Park in the southeast of Tabriz in the area of Shahid Bakri Blvd. Mashrouteh Park (Taleghani) in the south of the city and in the Shahid Kasai road, Kausar and Laleh parks also in the vicinity of the same highway, could be highlighted among the urban-scale parks. According to the Tabriz green structure development plan, Eram Park and Tabriz Grand Park in the north, the development of Eynali Mount. Park, the Shamim Complex and the development of El Goli and Abbas Mirza in the south of the city can form a coherent and intertwined structure of green spaces in urban and suburban areas which as effective in enriching the environmental qualities of Tabriz city. On a regional scale, parks such as Moallem, Bahar, Parvin Etsami, and Family could be identified.

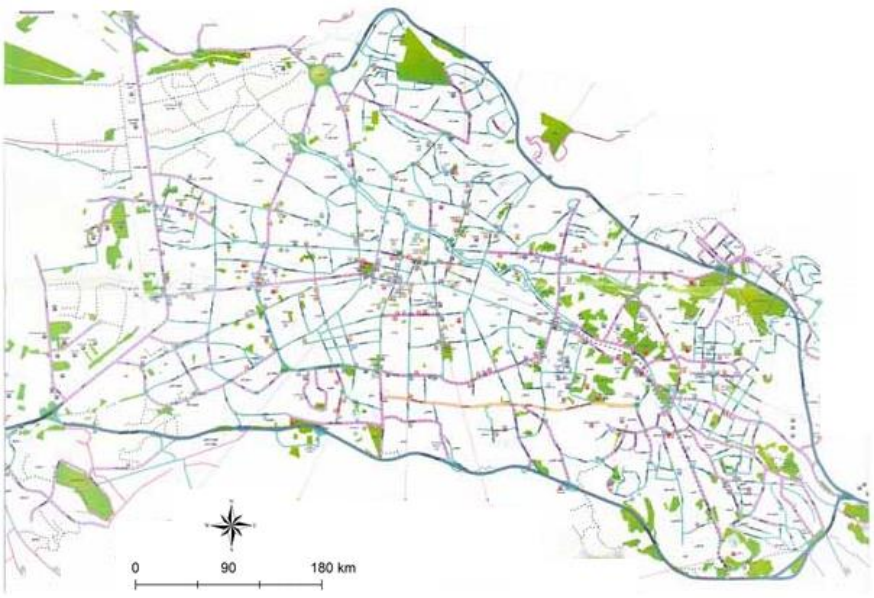

Fig.2 Distribution map of parks in Tabriz city

4.6 The analysis of access to green spaces

Examining the neighborhood green space of Tabriz city shows the lack of this use in old context. Therefore, due for the lack of parks and green spaces in this type of contexts, having access to them has problems to citizens. Hence, to achieve ecological development, as one of the principles of urban sustainable development, logical planning appropriate to the urban context is necessary for citizens to have access to these valuable urban parts. Network analysis is one of the tools that measures the time of having access to such urban vital elements based on the type of roads and, determines the areas outside service delivery their access radius, and also determines the appropriate places to create these valuable spaces in the heart of different neighborhoods of the city (Teimuri, 2015).

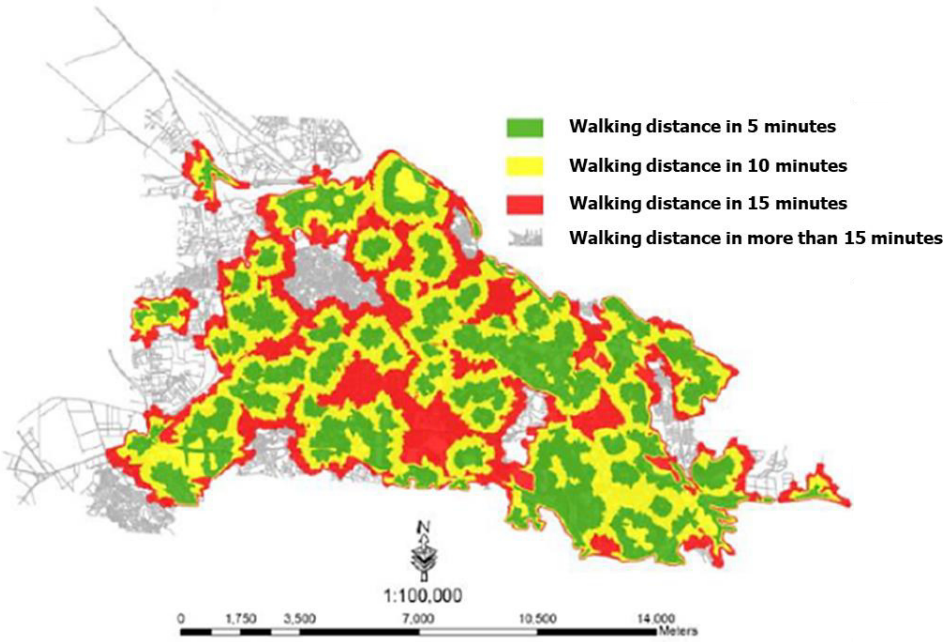

Fig.3 Walking access to urban parks in minutes

According to the considered network analysis in all the roads of Tabriz city, the attractive radiuses of parks have been calculated for the citizens. This radius has been analyzed in 5, 10 and 15 minutes and the maximum time a person can walk to the parking lots has been estimated to be 15 minutes. Using this analysis, the out-of-service areas of urban parks all over the Tabriz city have been estimated. The map shows that there is a small area of the city of Tabriz having access to the park within 5 minutes; however, the majority of urban parks are accessible within 15 minutes for citizens. Most urban contexts, with a higher density in buildings and population, have the least access to urban parks. District 8 has a small area due to its location in the historical, commercial and old context and the number of parks of this area is few. Districts 3 and 4, which are adjacent to district 8, also have more density in terms of urban construction and population. Therefore, planning to increase the number of parks in proportion to the population density of these areas seems essential.

4.7. Ranking of regions of Tabriz with TOPSIS Model

The result of the Topsis model shows that in terms of green space indicators, regions 6, 5, 7 and 2 are in the first to fourth ranks and regions 1, 3 are in the fifth and sixth ranks and regions 8, 10, 4 and 9 are in the following ranks.

4.8. Evaluation of the sustainability of green space in Tabriz

The results indicate that the regions of the city of Tabriz do not enjoy balanced green space and the green space is not distributed evenly among different regions.

x	fi	percent
388-2138	5	0.5
2139-3888	4	0.4
3889-5639	0	0
5640-7390	1	0.1

Tab.2 Distribution of green space between the regions of Tabriz city with class difference limit method

4.9. Classifying Tabriz districts using cluster analysis model

In this research, the hierarchical cluster analysis method has been used for further application in geographical studies. Accordingly, considering the purpose of the research and the data, the average link method, as one of the methods of forming agglomeration clusters in the hierarchical cluster analysis method, was utilized. This technique groups the districts that have the most similarity in terms of scores into a cluster. In this way, the scores of each factor indicators the degree of importance of each district.

Regions	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Classifying	2	1	2	3	1	1	1	3	3	**3**

Tab.3 Classifying Tabriz districts based on green space indictors

The utilized classification in the cluster analysis showed that the places located in one level were very similar to each other, but they were significantly different from the places on other levels. The result of using the cluster analysis technique in grouping regions in terms of their green space indictors has been as described in Table 2 and Figure 4: meaning that regions 2, 5, 6, 7, were on the same level which is called the first level (having many and essential green space indictors), region 1, 3, were on one level, which is called the second level (having less green space indicators less than the first level) and regions 4, 8, 9, 10, were on one level which is called the third level in terms of having on green space indicators (Fig. 4 and 5).

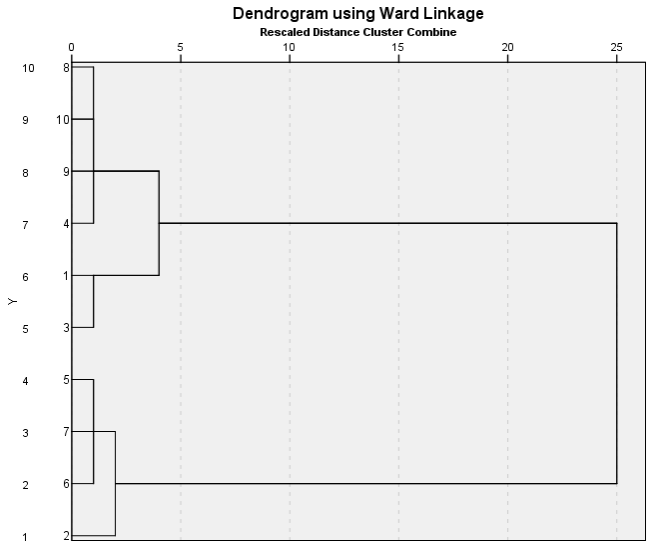

Fig.4 Tree diagram of Tabriz city regions based on green spaces indictors using Ward method

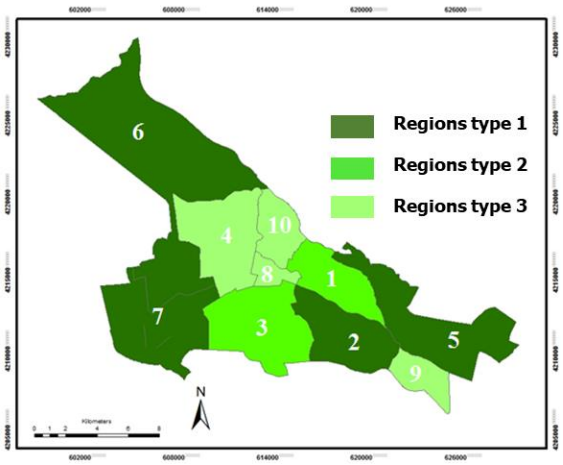

Fig.5 Map indicating the type of Tabriz regions in terms of having green spaces use

5. Conclusions

With the emergence of environmental crises in cities and the reduction of the general level of people's lives, the sanitation of urban environments and the preservation of the environment for future generations have become significant. Improving the productivity of green spaces should be considered with their ecological improvement, because valuable ecologic elements are significantly decreasing in cities. Urban green spaces as the urban breathing center play a key role in urban sustainable development and healthy urban environment, therefore, green spaces have a privileged position in the spatial development programs of cities to achieve a balanced, and sustainable development. At present time environmental pollution is increasing in most great cities, the coordinated and equitable expansion of urban parks and green spaces would play an influential role in creating environmental sustainability in cities. Having access to favorable per capita parks and green spaces for citizens, avoiding air pollution and noise pollution, air conditioning, and having a pleasant environment for urban life are among the ecological benefits that would be met with a principled design based on the climate and natural conditions of the city, which at the same time would lead to the visual beauty of the city and increase social interactions as well as suitable recreational spaces in the city, and create a favorable environment at all levels.

In the past, the city of Tabriz has been the attention of statesmen due to its gardens and suitable urban green spaces as well as favorable weather, and has functioned as the capital of the country. However, in recent years, due to the increase in the speed of construction and urbanization, Tabriz metropolis it has suffered from critical ecological elements, especially green spaces, and has lost these valuable spaces for economic gain in the form of development plans and urban physical developments of the city. The rate of changes in green spaces was somewhat slow from 1956 to 2006 and decreased from 5,916.53 hectares to 4,373.96 hectares. But after 2006, the changes occurred more quickly and more intensively, and the area of green spaces decreased to 1709.02 hectares in 2022, accordingly various factors played a role in these changes.

The lack of proper management of developments, directing the developments to the surroundings and gardens and green spaces, having income generation attitude towards green spaces by municipalities, and the lack of proper monitoring of the performance of municipalities on maintaining green spaces, were among the main factors in the changes of the green spaces of Tabriz city in the past years. The survey of the area and per capita of parks in the whole city showed the lack of parks and green spaces all over the city, especially in dense urban contexts, including districts 1, 3, 4, 8, 9 and 10. Moreover, using network analysis it was determined that citizens in districts 5, 7 and 3 had poor access to parks and green spaces. Also, using the TOPSIS model and class difference limit method, it was determined that the distribution of green spaces and parks in Tabriz has been unbalanced. Finally, with the continuation of this trend the lack of proper planning for the development of urban green spaces, environmental problems such as various kinds of urban pollution would spread and Tabriz would become an unhealthy and unsustainable city and the health of citizens would be endangered.

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Image Sources

Fig.1: Author's elaboration;

Fig.2: Tabriz Municipality;

Fig.3: Teimouri & Yigitcanlar, 2018;

Fig.4, 5: Author's elaboration.

Table Sources

Tab.1 to 3: Author's elaboration.

Author profile

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