Effectiveness of spatial justice in sustainable development and classification of sustainability in Tehran province

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This paper aimed to investigate the level of Tehran province sustainability in terms of environmental sustainability, current condition, and identifying effective environmental sustainability indicators within the province levels. The methods used in this research are descriptive-analytical for an effective assessment of non-quantifying issues. After that, the level of each province obtained through normalization of standard data in Excel software. Shanon Entropy evaluated the weight of each province and analyzed data in Arc GIS software mixed with Inverse Distance Weighted (IDW) model gave a clear understanding of spatial characteristics of each indicator and single-sample T-test used for spatial illustration of the IDW model on environmental sustainability. The results obtained from this research show that Tehran province is at the lowest level of sustainability among other provinces. The environmental sustainability in Tehran province with a mean of 157 is less than 165 standard deviation, and therefore the indicators of exploitation of varied natural sources of energy and water resources were known as the most important indicators.

Introduction

According to the World Environment and Development Committee (United Nations) programs report in October 1987, it was coincident with several disasters and environmental crises that occurred in different parts of the world: the drought crisis in Africa that endangered 36 million lives and over one million people died. In India's Bhopal, pestilent leakage in a refinery killed more than two dozen people and hospitalized more than two hundred thousand people. In Mexico, the exploding of liquid gas reservoirs resulted in the deaths of thousands and the loss of thousands of others. In Russia's Chernobyl, the nuclear reactor explosion spread radioactive

substances throughout Europe and increased the risk of human cancers. Also, in Switzerland, the entry of mercury and other agricultural chemicals into the Rhine River destroyed millions of fish and nearly 60 million people died of diarrhea caused by drinking water and malnutrition, most of the child victims. (Hauff 1987).

After the huge negative impact of humanity on the environment, sustainability becomes one of the biggest human challenges and concerns that the idea of protecting valuable environmental heritage has become an international concern (Khan et al. 2019, Peña-Alonso et al. 2019, Song et al. 2019). Today the world is witnessing the continuation of various meetings, reports and various environmental statements such as (2009) Copenhagen Summit & Sustainable Development, (2012) Rio20+ UN Conference on Sustainable Development, (2014) UN Climate Change Conference & Sustainable Development, (2015) COP21 & the Paris Agreement for Sustainable Development, (2015) New York & the new Sustainable Development Goals (SDGs), and (2018) COP24 in Katowice, Poland. It is well understood that development without environmental considerations reduces the quality of human life and natural resources, and necessarily it must be sustainable and with environmental capacity accordingly.

According to available literature in spatial justice in Iran, they have been applied in single issues (Hosseini et al. 2018, Egri–Tánczos 2018) or local level (Jalilisadrabad et al. 2018). Spatial justice in metropolitan areas in developing countries has been always misunderstood, when it refers to equity and fairness and sometimes it loses the real and true meaning of environmental and even spatiality. Therefore, instead of being more in the environment and geographical side becomes more on the law and legal side (Demian 2016). In this study the criteria have been taken from the environment and then based on each province we have provided a map of land-use concerning Tehran.

Meanwhile, sustainability is intended to protect the systems that protect human lives on the planet, as well as to ensure the continuity of humankind and other species. The concept of sustainability and development together form the basis for sustainable development, which means development that meets the current needs without compromising the capabilities of future generations. Also, there is a relationship between sustainable development, spatial justice, and environmental development, and these concepts are not separate from each other (Raco 2005, Meng 2018, Jones 2019, Munro et al. 2017). According to (Roberts–Toffolon-Weiss 2001), this relationship is expressed as a threefold set of sustainable development. In this series, three aspects of the economic, social, and environmental development of sustainable development centered on space. Since equilibrium, equality, and equity in the distribution of resources between spaces are important, this can prevent spatial imbalances and preserve existing resources for future generations and achieve intergenerational justice. Rapid urbanization due to socio-political issues and uneven development on a national and regional scale in developing countries has

made these countries a lot of human and environmental issues in the south metropolitans (Nezdei 2020). Therefore, the present study will point out three main objectives: spatial classification of Tehran's cities in terms of environmental sustainability, the overall situation and spatial development, as well as the identification of the most effective indicators of environmental sustainability in Tehran province. The triple goals of the research will be followed in the following questions:

1. Where is the spatial level of Tehran province counties in terms of environmental sustainability?
2. How is the Tehran province in terms of environmental sustainability and its spatial function?
3. What is the effectiveness of the environmental sustainability indicators in Tehran province counties?

Literature review

Sustainability

Sustainability becomes one of the growing issues as literature shows climate change (Sarkar et al. 2020, Balogun et al. 2020, Pachauri 2008), energy (Li–Wang 2019, Ghodsvali et al. 2019), food security (Fanzo 2015, Soltani et al. 2020, Ravar et al. 2020) water scarcity (Moumeni 2016, Bagheri–Babaeian 2020, Mahdavi et al. 2020), biodiversity (Hosseini et al. 2019, Khishtandar et al. 2017, Lowe et al. 2019). Changing demography (Hallett et al. 2019, Ghodsi et al. 2019) Geopolitical instability (Suárez-de Vivero–Mateos 2017, Helbig et al. 2017) unequal development (Charoenratana–Shinohara 2018). Sustainability and sustainable development issues have been rooted in different dimensions of human life and become one of the most important issues in different disciplines and different levels of decision making. Without any doubt, human activities as plan, program, and project without addressing sustainable development issues will reduce current and future capacity for effective sustainable development. Spatial development classification becomes an important key sustainability issue in metropolitan areas (Trigunasih et al. 2018, La Rosa et al. 2017). The classification of spatial sustainability in urban areas illustrates the level of their involvement to produce and consume natural resources which in the long term can meet resilience, food security, health, and poverty challenges.

Sustainability issues

The environmental challenges have always been the subject of interest from thinkers and authorities in different countries. So many concerns about environmental issues have shown themselves to be in the form of summits, conferences, and meetings of the international community. In this research, we refer to various activities in this field. As a prime example, in 1969, the United Nations Human and Environmental

Report, and the U Thant Report focused on preventing global environmental degradation, and more than 2,000 scientists were involved in the preparation of this report. In 1972, The First United Nations World Conference and its Environment Program, Human and Environment, was held in Stockholm, Sweden under the earth, the Declaration, and its Operational Program for the Protection of the Environment message. In 1975, the UNESCO Conference on Environmental Education was held in Belgrade, Yugoslavia and led to the global environmental education framework establishment and the issuance of the famous Belgrade Charter. In the same year, the International Human and Environmental Congress was held in Kyoto, Japan, and the congress emphasized the same issues as the 1972 conference. In 1979, the First World Climate Conference was held in Geneva, Switzerland, and the conference focused on the preparation and monitoring of climate change research. In 1981, The First United Nations Conference on the Developed Countries was held in Paris, France. The main topic in this conference was about providing a set of guidelines and measures to help the underdeveloped countries. Then, the United Nations Commission on the Environment and Development was established in 1984, which announced the establishment of cooperation between developed and developing countries as well as the implementation of global development plans for environmental protection. Subsequently, our Joint Future Report, entitled Brundtland Report, was published in 1987, which presented the basic principles of the concept of sustainable development. In the same year, the Montreal Protocol was published, which included the results of research on adverse effects on the ozone layer. Three years later, in 1990, the Second World Climate Conference included the further development of climate change research and monitoring programs, as well as the creation of a global climate change monitoring system. In 1992, the United Nations Conference on the Environment and Earth (Earth Summit or Rio Conference) in Rio de Janeiro, Brazil, was held in Rio Declaration and Agenda 21, the principles of sustainable development, along with a framework for future actions and tasks were introduced. The Kyoto Conference on Climate Change in Japan was launched in 1997, and the Kyoto Protocol was signed at the beginning of 2005 to reduce emissions of carbon dioxide and other greenhouse gases among the countries. The United Nations Millennium Declaration was launched in 2000 and includes eight Millennium Development Goals by 2015. The 2002 World Summit on Sustainable Development in Johannesburg, South Africa reaffirmed its previous commitments to the Rio Conference and set out guidelines for its future work. In 2009, the Third Climate Conference was held in Geneva, Switzerland. It supported a further global monitoring system on climate change, to effective environmental disasters forecasting. In the same year, the World Summit of Group 20 was held in Pittsburgh, USA, and the Group of 20 countries introduced an agreement on the creation of balanced economic development. In 2012, the United Nations

Conference on the 'Rio 20+' was held in Rio de Janeiro, Brazil, 20 years after the Rio Conference held in 1992, where the Rio 20+ conference was held, in which topics were devoted to the global green economy. In 2015, the United Nations Sustainable Development Summit in New York, the United Nations 2030 Agenda for Sustainable Development, was published in New York to include 17 Millennium Development Goals to be introduced by 2030. The UN Climate Change Conference in Paris in the same year, France, and its contents included an agreement on reducing greenhouse gases to reduce and limit global warming (Tomislav 2018). Therefore, several measures have been taken in response to the emergence of environmental concerns by various organizations. Today, many researchers use the results of what is mentioned in literature and as a result, the scope of studies related to sustainable development, especially its environmental dimension, is developing.

Conceptual Framework

The concept of environmental justice and spatial justice

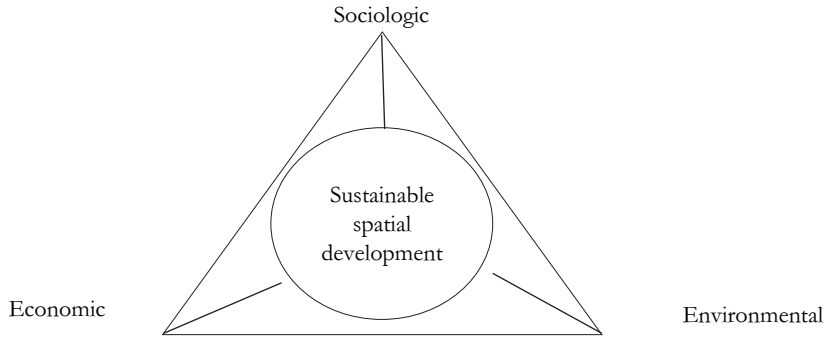
The roots of environmental justice shaped a movement in the United States in 1987 and have spread all over the world. It involves the concept of 'environment' as 'everything', including where we live, our place of work, the place of our games, our worship, going to school, and also the whole physical and natural world. This relatively new national movement is called the Economic and Environmental Justice Movement. Two decades ago, the concept of environmental justice was not accepted in civil rights, human rights, or among social groups. Environmental justice leaders later became well known as the Michigan Alliance. This increased the number of ecological distribution conflicts around the world in the 1980s and 1990s and caused so many improvements at the local level by new movement in urban and rural areas (Martinez-Alier et al. 2016). Environmental justice is defined as 'fair treatment and meaningful interference of all people, regardless of race, color, nationality or income, respecting the development, the implementation of environmental laws, guidelines and policies' (Bullard et al. 2007). Politicallys wise environmental justice refers to the identification of vulnerable environments through the degree of human vulnerability and political involvement in terms of creativity and managing environmental policy (Schlosberg 2004).

The term 'spatial justice' has not ever been used up to these days, and even now there is a tendency among geographers and planners to avoid the explicit use of 'spatial' traits in describing justice and democracy in contemporary communities, to neglect the spatiality of justice, or place it within concepts such as territorial justice, environmental justice, urban deprivation, and the reduction of regional inequalities of absorption and digestion (Soja 2009). Spatial justice is not independent of the other forms of justice: social (Bell 2019), economic (Leonard 2018), and

environmental (Pulido–De Lara 2018), and space (Raymond et al. 2016) is a common element of their links, spatial justice can act as the center of a variety of concepts of justice (Dadashpoor et al. 2015, Cardoso 2007). (Roberts–Toffolon-Weiss 2001) expressed the relationship as a threefold set of which sustained development emphasized. In this series, three aspects of the economic, social and environmental development of sustainable development centered around space (Greer 2003).

Figure 1

Sustainable spatial development



Source: Bell–Cheung (2009).

Concept of sustainability and sustainable development

The term Sustainability is derived from the Latin root *sus-tinere*, which means 'keeping' and indicating strength and durability over time. Based on this, stability indicates a paradigm that aims to protect life support systems on the planet. Also, to ensure the continuity of the human race and other species (Bell–Cheung 2009). Today, sustainability along with the concept of development is very common and is referred to as sustainable development, which has different definitions: The World Commission on Environment and Development (WCED 1987): Sustainable development is development that fulfills current needs without compromising the capabilities of future generations. According to Harwood (1990), sustainable development is an infinite development system in which it focuses on achieving more human benefits, more efficient use of resources, and in balance with the environment. World Wide Fund for Nature (WWF), International Union for Conservation of Nature (IUCN), and UNDP (1991): Sustainable development is a process for improving the quality of human life, in the way that the ecosystem's capacity can carry it (Lélé 1991). Sustainable development is a trend-oriented process that can be repeated forever. Vander-Merwe–Van-der-Merwe (1999): sustainable development is a program that changes economic development and is a process to ensure the quality of life, protecting valuable ecosystems, and so on. In the definition of Sterling (2010), sustainable development is an economic and

environmental compromise. A new development path that enables sustainable development in the long run. (Duran 2015) specifies a sustainable development that protects the environment, because a sustainable environment causes sustainable development (Klarin 2018). The common theme of all these definitions is the securing and protection of environmental heritage. This is how it ensures the continuity of the human race and other creatures.

Debate on sustainable development, three aspects are recognizable:

Economic sustainability: A sustainable economic system should be able to produce goods and services continuously. Hence, it protects harm agricultural and industrial production (Harris 2000). The social dimension of sustainable development: A sustainable social system must properly distribute justice and provide social services, such as health, education, gender justice, politics, responsibility, and participation (ibid.). Environmental aspect of sustainable development: A sustainable environmental system must ensure the sustainability of basic resources, and not exploit excessive, equilibrium, renewable or non-renewable fuels. Environmental sustainability includes biodiversity conservation, atmospheric stability, and other ecosystem features (ibid.).

Regarding environmental sustainability indicators, some international organizations are active in providing environmental sustainability indicators, most notably for the description of below:

1. Balaton Group;
2. International Institute for Sustainable Development (IISD);
3. Organization for Economic Co-operation and Development (OECD);
4. Scientific Committee on Environmental Issues ((SCOPE);
5. United Nations Commission on Sustainable Development (CSD);
6. United Nations Development Program (UNDP);
7. UN Environment (UNEP);
8. United Nations Statistical Division (UNSD);
9. World Bank.

In this section of the research, some of the aggregate indicators are mentioned: According to the FEEM SI Sustainability Model, the environmental sustainability indicators consist of air pollution, energy, and natural heritage, also this model has social and economic indicators (www.eaere.org). According to the United Nations Conference on Sustainable Development in 2001, environmental sustainability indicators include the atmosphere, land, oceans, seas and coasts, fresh waters, and biodiversity (Wu–Wu 2012). Indicators according to the Environmental Sustainability Index (ESI) include air quality, water content, biodiversity, land, water content, reducing air pollution, reducing water pressure, reducing load and pressure on the ecosystem, reducing waste and consumption pressure, reducing population growth, environmental health, preserving the population. On the other hand, the ESI Index also includes several social, institutional, and participatory indicators

(Environmental Sustainability Index Report 2000). According to the Organization for Economic Cooperation and Development, the components of environmental sustainability or indicators include climate change, ozone depletion, air quality, waste and waste production, and recycling, water quality, water resources, forest resources, marine resources, and biodiversity (OECD Environmental Indicator 2000) as well as indicators provided by the World Bank. It contains indicators related to environmental sources such as agricultural resources, forests, marine resources and waters, underground resources, fossil fuels. Also, the relevant pollution indicators are climate change, Eutrophication[1], or water enrichment, and toxicity. On the other hand, indicators related to life support sources in the environment include biodiversity, oceans, and lands. Indicators related to human activities in the environment include health (water quality, air quality, manifestations of human activities in the environment), food security and quality, urban housing, scrap and waste generation, catastrophes (Hammond et al. 1995). According to the research firm's sustainability assessment, the indicators include air, collective awareness, biodiversity, aquatic, global indicators such as CO_2 and greenhouse gases, underground water, human activities, land-use, Soil, Surface, Water, and Wetlands (http://www.sustainablemeasures.com).

According to the Environmental Performance Index (EPI), environmental sustainability indicators are divided into two categories: environmental health and environmental vitality, which include environmental health index and environmental vitality category including air quality, water resources, biodiversity and habitats, productive natural resources, and sustainable energy (Hák et al. 2007). In early 2004, the European Environment Agency (EEA) presented its proposed indicators, including climate change, fisheries, water, agriculture, energy, transport, biodiversity, waste and scrap, air, and land pollution (ibid, 16). According to the Global Environmental Outlook (GEO), the indicators are atmospheric, natural disasters, forests, biodiversity, coastal and marine areas, and sweetwaters (ibid, 18). Therefore, among the references and resources related to the environmental sustainability indicators, there is much to gain in choosing the type and selection of indicators. According to the final summing up of the nature of 'Environmental Sustainability' indicators, the World Bank, ESI, GEO, EPI, FEEM SI, UNCSD, OECD, and EEA are sources of water, energy resources, Air quality and pollutants, waste, and waste production, land and soil resources: agricultural and natural lands as shown in Figure 2.

[1] The aquatic reaction to nutrition increasing (e.g. Nitrogen and phosphor); usually these nutritious materials enter to rivers by Chemical fertilizers from agriculture sector. http://eco-literacy.net.

Figure 2

Conclusion of the nature of environmental sustainability indicators among different resources

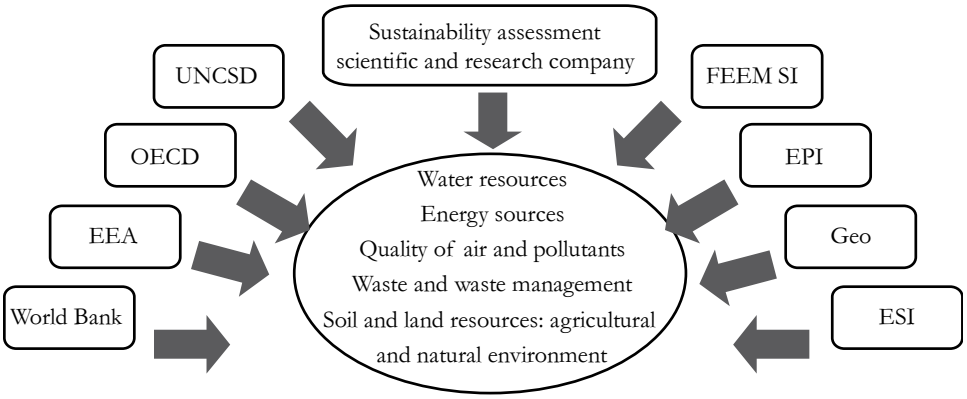
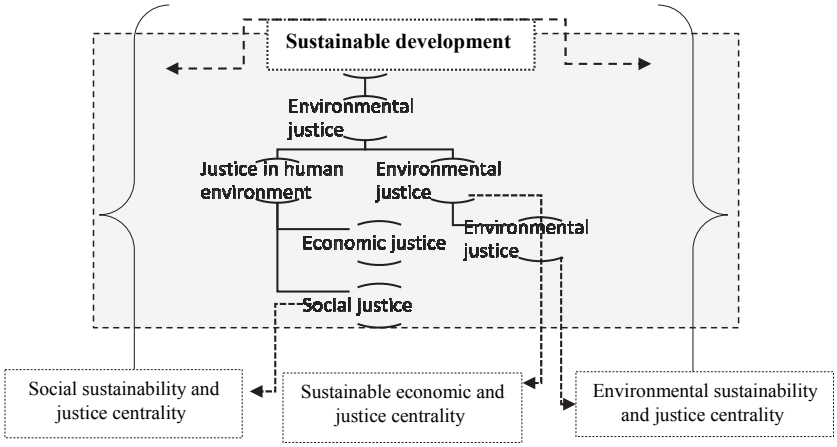


Figure 3

Conceptual framework

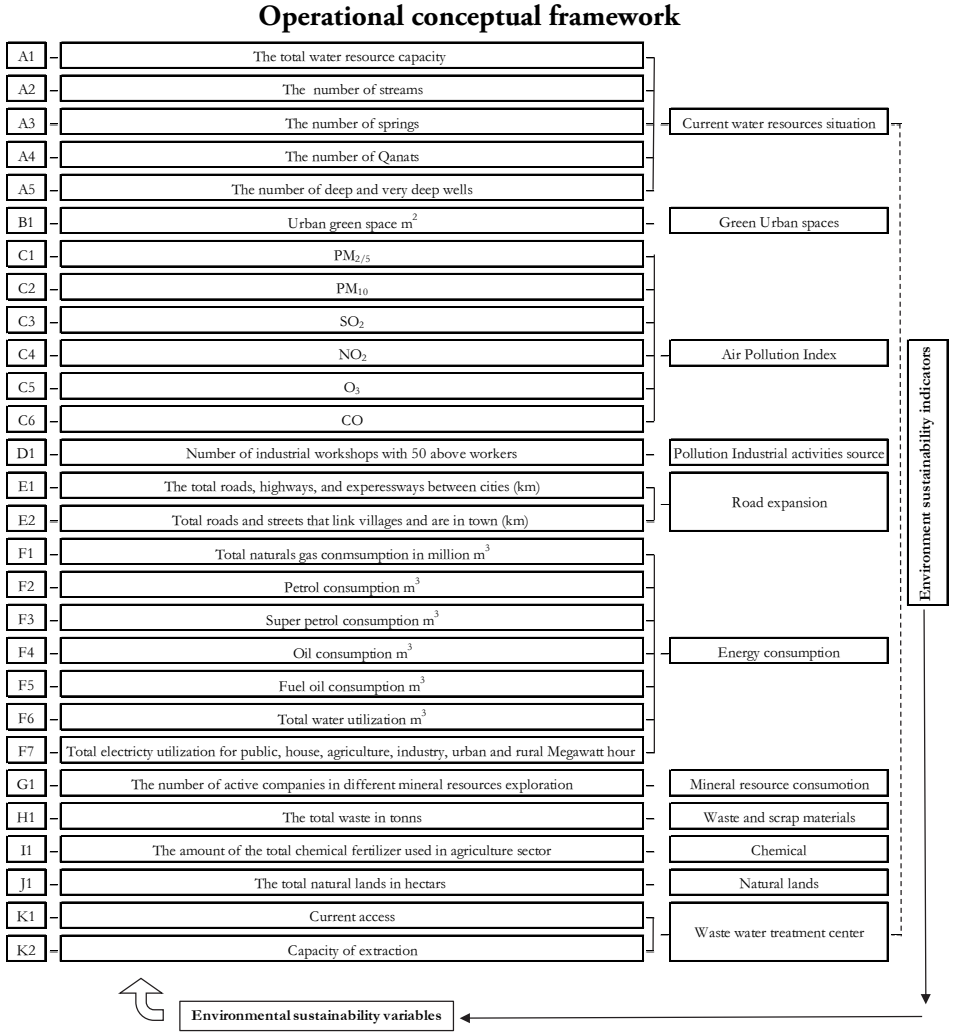


In this study, the selection of indicators and environmental sustainability variables was performed based on theoretical foundations and the availability of data for analysis. Finally, 11 indicators and 28 variables were selected (Figures 3–4). Indicators and selected variables indicate the amount of exploitation and utilization of environmental resources, including energy resources, water resources, and mineral resources (indicators of the status of water supply sources, utilization of energy resources, the amount of waste generated and waste materials, the use of fertilizers, the amount of air pollutants, road and highway development[2] the industrial activities of the pollutants, the wastewater treatment plants, and the extent

[2] Road development made life easier, while we have made more roads the pollutants increased.

of urban green spaces), and the amount of interference in nature (the index of the extent of the natural and pristine lands).

Figure 4



Tehran city is located in the center of Tehran province, with an area of about 12,981 square kilometers, between 34 to 36.5 degrees the north latitude and 50 to 53 degrees the east longitude. This province is limited to the north of Mazandaran province, south to Qom province, the southwest to Markazi province, the west to Alborz province, and the east to Semnan province. According to the 2017 census, the population of this province was 13,267,637 people, of which 12,568,823 people are in urban areas and 698,814 people live in rural areas. The center of this province is Tehran (http://www.ostan-th.ir/). According to the latest country divisions provided by the

Statistical Centre of Iran in 2018, the province of Tehran consists of 16 counties including Tehran, Shahriar, Shemiranat, Malard, Varamin, Ray, Qods, Islamshahr, Damavand, Firuzkuh, Qarchak, Baharestan, Pishawa, Pakdasht, Pardis, and Robat Karim. The city of Tehran alone has over eight million population; needless to say, that such a population of millions will have more pressure and environmental impact.

Figure 5

Tehran province situation among the other counties, 2018

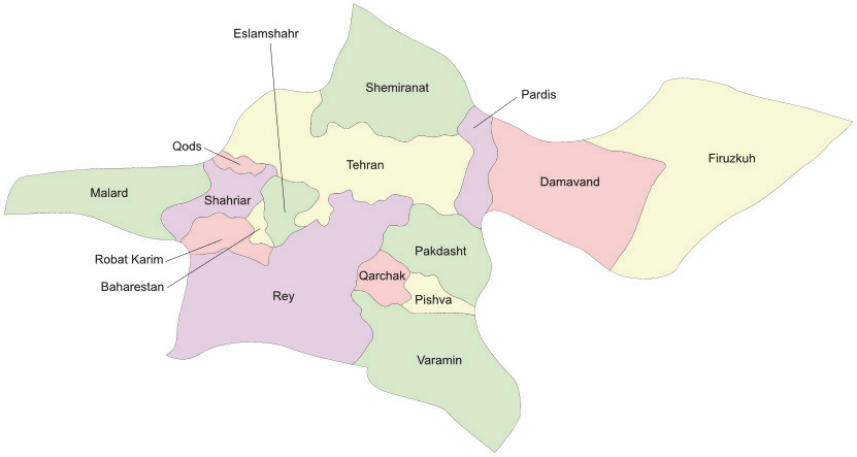
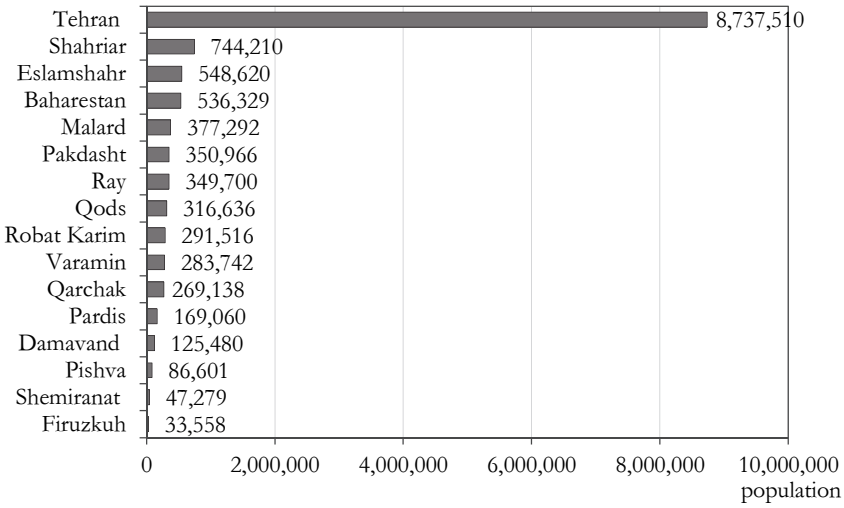


Figure 6

Tehran province and Tehran counties population, 2017



Materials and methods

To run the TOPSIS model, it is first necessary to create a matrix of data that is set according to the m option and n index, as shown below:

$$A_{ij}= \begin{vmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ . & & & . \\ . & & & . \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{vmatrix}$$

Then the normalization should be done. For this purpose, Norm Normalization can be used as follows.

Normalization method using Norm

In this type of revaluation using the function (1), each element of the decision matrix is divided into the sum of squares of the elements of each column (Purtaheri 2016)

$$n_{ij} = \frac{a_{ij}}{\sqrt{\sum_{i=1}^{m} a_{ij}^2}} \quad (1)$$

In this equation, the nij is unscaled option i, in terms of j index. Subsequently, using the Shannon Entropy Method, we can calculate the weight of the indices.

Shannon Entropy Weighting Method

This method calculates the weights associated with each index based on the distribution of the values of the indices. Entropy has the capability to receive it, and adjust the weights based on the model if the decision-makers have an initial assessment of the importance of the indicators. Therefore, when the data of a decision matrix are fully specified, the entropy method can be used to evaluate the weights. The greater the dispersion in the values of one indicator is, the more important it is. In fact, entropy can be considered as a measure of uncertainty, which is shown by the probability distribution Pi. As stated, uncertainty measurements or (Ei) can be expressed as (2) (ibid.: 88–91):

$$E_i = S(P_1, P_2,\dots,P_n) = -K \sum_{i=1}^{n} [P_i - lnP_i] \quad (2)$$

K is a constant and is calculated using the function (3):

$$K = \frac{1}{\ln(m)} \quad (3)$$

where (m) is the number of alternatives.

(E) is also the probability distribution Pi, and its value, if Pi is equal to Pi, = 1/n, is the maximum value that can be calculated as the function (4):

$$-K\sum_{i=1}^{n} P_i - lnP_i = -K\left\{\frac{1}{n}\ln\frac{1}{n} + \frac{1}{n}ln\frac{1}{n} + \dots + \frac{1}{n}ln\frac{1}{n}\right\} = -K \times ln\frac{1}{n} \quad (4)$$

The decision matrix in the entropy method consists of n options and m index, in which, using the formed matrix, Pij can be obtained from equation (5):

$$P_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}}; \forall_j \quad (5)$$

And the entropy of the index j (Ej) is also calculated as the function (6):

$$E_j = -\mathrm{K}\sum_{i=}^{m}[P_{ij}\ lnP_{ij}\ ];\forall_j \quad (6)$$

The degree of uncertainty or degree of deviation (dj) is also obtained from function (7):

$$E_j = 1 - E_j;\forall_j \quad (7)$$

Then, as stated, we can obtain the weight of the indices using the function (8):

$$\mathrm{W}_j = \frac{d_j}{\sum_{j=1}^{n} d_j};\forall_j \quad (8)$$

Then you must determine the most suitable (V_j ^ +) and the most inappropriate (V_j ^ –) values. Then, we must calculate the distance between the option and the positive and negative ideals using functions (9) and (10):

$$d_i^+ = \sqrt{\sum_{j=1}^{n}(V_{ij} - V_j^+)^2}\ .\mathrm{i} = 1.2.\ldots.\mathrm{m} \quad (9)$$

$$d_i^- = \sqrt{\sum_{j=1}^{n}(V_{ij} - V_j^-)^2}\ .\mathrm{i} = 1.2.\ldots.\mathrm{m} \quad (10)$$

Finally, we must calculate the closeness coefficients CL * according to (11):

$$CL_i^* = \frac{d_i^-}{d_i^- + d_i^+} \quad (11)$$

Any options that CL has larger ones would be better to have a range between zero and one. Provide findings and analysis.

Analysis and findings

There is a huge literature on sustainability studies in Tehran province at the neighborhood level (Shokohi–Hosseini 2017), urban regions (Fanei–Saremei 2014), and urban neighborhoods (Sasanpour et al. 2015). These studies have never gone over the metropolitan areas. Furthermore, less attention has been paid to the interaction between Tehran province and other neighborhoods. The findings of this study are very important and more practical for policymakers and decision-makers because the criteria of this study were identified through international works on sustainability, and we selected those effective criteria to increase the accuracy of our assessment. As mentioned above, the previous studies just looked at certain areas, and they have been more in particular issues in sustainable planning and the whole of Tehran and its interaction with other provinces have been neglected.

In this section, the collected data are firstly explained in terms of their indicators and their variables. Then, the environmental sustainability of the cities is done using the Topsis model:

Table 1

General data from Tehran Province, 2017

Country	Industrial workshops above 50 workers	CO_2	O_3	NO_2	SO_2	PM_{10}	$PM_{2/5}$[a)]	Green spaces area	Deep and very deep wells	Qanats	Springs	Streams	Total water resource, m^3
Eslamshahr	20	–	–	–	–	–	–	2,850,731	350	5	0	2	49,410,482
Baharestan	–	0	12	27	38	0	152	19,391,148	60	3	0	0	49,062,290
Pakdasht	69	0	35	24	17	52	32	2,814,000	187	7	0	1	27,015,176
Pardis	–	30	22	44	0	0	29	10,851,122	62	1	4	3	12,664,237
Pishva	–	–	–	–	–	–	–	650,000	169	4	0	0	5,773,253
Tehran	405	40	15	69	25	51	83	139,951,772	544	191	70	1	1,040,107,415
Damavand	8	–	–	–	–	–	–	2,756,348	488	98	182	0	13,921,529
Robat Karim	54	0	0	38	21	62	0	2,615,404	83	6	1	0	28,188,657
Ray	87	–	–	–	–	–	–	2,139,237	487	80	1	2	15,125,633
Shemiranat	–	–	–	–	–	–	–	207,689	143	72	650	13	3,375,943
Shahriar	100	0	0	54	0	0	119	9,287,792	490	11	0	1	68,606,548
Firuzkuh	9	–	–	–	–	–	–	352,159	190	17	305	3	2,621,115
Qods	12	–	–	–	–	–	–	2,464,581	52	0	0	3	28,790,071
Qarchak	–	–	–	–	–	–	–	3,539,123	43	3	0	1	21,273,003
Malard	–	45	12	0	32	79	121	11,258,428	430	49	0	1	30,598,595
Varamin	22	0	28	24	27	50	98	2,239,139	344	10	0	1	19,676,053
Total	786	115	124	280	160	294	634	213,368,673	4,122	557	1,213	32	1,416,210,000

a) Data collected in 1/2018.

Source: Statistical Center of Iran 2017a, pp. 127, 2017b, pp. 75., 2017c, pp: 552, 2017h, pp. 17, 2017f, pp. 237., https://aqms.doe.ir/Home/AQI;

Table 2

Used data in project, 2017

County	Electricity consumption (domestic, public, agricultural, industrial, commercial and free use, street lighting) in terms of megawatt hours	Total roads in county and between cities (freeway, highway, main road), kilometer	Total roads in county and between cities (roads between urban and rural), kilometer	Total natural gas consumption, million m^3	Total petrol consumption, m^3	Total premium gas consumption, m^3	Total kerosene consumption, m^3	Total mazut consumption, m^3	Total water consumption, m^3
Eslamshahr	1,297,968	127.7	95.5	514	210,083	11,390	1,340	224	38,660,314
Baharestan	670,193	23.9	11.3	294	0	0	0	0	38,863,962
Pakdasht	1,145,698	189.7	140.3	3,145	92,611	2,363	1,970	9,106	20,788,630
Pardis	573,413	95.0	28.3	231	0	0	0	0	10,973,486
Pishva	241,961	98.8	79.0	123	0	0	0	0	4,499,606
Tehran	21,152,524	149.9	82.9	10,873	3,292,720	370,713	9,743	70,709	797,648,663
Damavand	381,746	391.7	259.0	215	99,001	2,248	4,101	974	10,274,699
Robat Karim	761,001	99.8	49.8	2,028	214,741	14,067	1,019	3,150	20,386,801
Ray	2,786,073	363.4	144.0	1,688	505,912	33,600	4,532	5,696	11,996,843
Shemiranat	181,967	171.5	115.5	1,153	0	0	0	0	2,363,160
Shahriar	1,421,201	167.6	117.0	659	422,308	22,045	2,884	1,334	53,999,967
Firuzkuh	270,225	395.3	299.0	205	23,988	0	3,093	13,976	1,832,866
Qods	810,122	22.4	7.0	285	0	0	0	0	22,869,540
Qarchak	408,516	350.0	9.0	221	0	0	0	0	16,581,154
Malard	709,590	263.0	213.0	328	0	0	0	0	24,193,779
Varamin	668,264	350.0	9.0	292	127,855	2,139	711	175	15,332,432
Total	33,480,462	3,259.7	1,659.6	22,254	4,989,219	458,565	29,393	105,344	1,091,265,902

Source: Statistical Center of Iran 2017d, pp: 341–340. 2017e pp: 214–211., 2017g, pp: 127.

Table 3

Descaling by normalization, 2017

County	Initial nominal capacity	Number of active mines in extracting different minerals	Produced waste (ton)	Total chemical fertilizer for agriculture (ton)	Total natural land and moorland area
Eslamshahr	22,000	0	272	2,212	0
Baharestan	–	0	320	721	0
Pakdasht	–	7	216	3,955	21,609
Pardis	85,000	2	200	0	8,280
Pishva	11,145	1	60	3,153	3,068
Tehran	786,808	182	7,544	1,572	91,290
Damavand	–	26	205	1,152	153,226
Robat Karim	29,000	0	115	528	6,000
Ray	3,400	6	150	8,915	156,047
Shemiranat	3,000	10	35	63	113,560
Shahriar	40,000	4	565	1,139	7,002
Firuzkuh	–	15	55	459	211,168
Qods	28,650	10	275	313	0
Qarchak	–	0	160	459	0
Malard	12,000	0	250	2,270	85,901
Varamin	–	6	–	5,742	91,533
Total	1,021,003	269	10,422	32,653	948,684

Source: Statistical Center of Iran, Tehran Province-Mine Division, 2017: 203; Statistical Center of Iran, Statistical Yearbook of Tehran- Urban Civil Division, 2017: 550–551; and Tehran Waste Management Organization, Information Section Statistics: https://pasmand.tehran.ir; Statistical Center of Iran, Statistical Yearbook of Tehran Province - Agriculture, Forestry and Fisheries, 2017: 168; Statistical Center of Iran, Statistical Yearbook of Tehran Province – Land and Climate, 2017: 28–34; Based on the data of Tehran-Agricultural statistics, water, and electricity, 2017: 130.

Normalizing the data using the Norm

To normalize the data using the norm, the data were first obtained at power 2, and then its sum was calculated for each index and the sum of the roots was also calculated. Finally, each variable in variables were divided into totals.

Table 4

Application of Shannon Entropy for weighting, 2017

County	A1	A2	A3	A4	A5	B1	C1	C2	C3	C4	C5	C6	D1
Eslamshahr	0.05	0.14	0.00	0.02	0.28	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Baharestan	0.05	0.00	0.00	0.01	0.05	0.01	0.57	0.00	0.56	0.24	0.22	0.00	0.00
Pakdasht	0.03	0.07	0.00	0.03	0.15	0.02	0.12	0.39	0.25	0.21	0.64	0.00	0.16
Pardis	0.01	0.21	0.01	0.00	0.05	0.01	0.11	0.00	0.00	0.39	0.40	0.45	0.00
Pishva	0.01	0.00	0.00	0.02	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tehran	0.99	0.07	0.09	0.78	0.43	0.99	0.31	0.38	0.37	0.61	0.27	0.59	0.93
Damavand	0.01	0.00	0.24	0.40	0.39	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Robat Karim	0.03	0.00	0.00	0.02	0.07	0.02	0.00	0.46	0.31	0.33	0.00	0.00	0.12
Ray	0.01	0.14	0.00	0.32	0.39	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.20
Shemiranat	0.00	0.90	0.87	0.29	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Shahriar	0.07	0.07	0.00	0.04	0.39	0.07	0.45	0.00	0.00	0.47	0.00	0.00	0.23
Firuzkuh	0.00	0.21	0.41	0.07	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Qods	0.03	0.21	0.00	0.00	0.04	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Qarchak	0.02	0.07	0.00	0.01	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Malard	0.03	0.07	0.00	0.20	0.34	0.08	0.46	0.59	0.47	0.00	0.22	0.67	0.00
Varamin	0.02	0.07	0.00	0.04	0.27	0.02	0.37	0.37	0.40	0.21	0.51	0.00	0.05
County	E2	F1	F2	F3	F4	F5	F6	F7	G1	H1	I1	J1	K1
Eslamshahr	0.18	0.04	0.06	0.03	0.11	0.00	0.05	0.06	0.00	0.04	0.18	0.00	0.03
Baharestan	0.02	0.03	0.00	0.00	0.00	0.00	0.05	0.03	0.00	0.04	0.06	0.00	0.00
Pakdasht	0.26	0.27	0.03	0.01	0.16	0.12	0.03	0.05	0.04	0.03	0.32	0.06	0.00
Pardis	0.05	0.02	0.00	0.00	0.00	0.00	0.01	0.03	0.01	0.03	0.00	0.02	0.11
Pishva	0.15	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.25	0.01	0.01
Tehran	0.15	0.93	0.98	0.99	0.78	0.97	0.99	0.98	0.98	0.99	0.13	0.25	0.99
Damavand	0.48	0.02	0.03	0.01	0.33	0.01	0.01	0.02	0.14	0.03	0.09	0.42	0.00
Robat Karim	0.09	0.17	0.06	0.04	0.08	0.04	0.03	0.04	0.00	0.02	0.04	0.02	0.04
Ray	0.27	0.14	0.15	0.09	0.36	0.08	0.01	0.03	0.03	0.02	0.72	0.43	0.00
Shemiranat	0.21	0.10	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.00	0.01	0.31	0.00
Shahriar	0.22	0.06	0.13	0.06	0.23	0.02	0.07	0.07	0.02	0.07	0.09	0.02	0.05
Firuzkuh	0.55	0.02	0.01	0.00	0.25	0.19	0.00	0.01	0.08	0.01	0.04	0.59	0.00
Qods	0.01	0.02	0.00	0.00	0.00	0.00	0.03	0.04	0.05	0.04	0.03	0.00	0.04
Qarchak	0.02	0.02	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.02	0.04	0.00	0.00
Malard	0.39	0.03	0.00	0.00	0.00	0.00	0.03	0.03	0.00	0.03	0.18	0.24	0.02
Varamin	0.02	0.02	0.04	0.01	0.06	0.07	0.02	0.03	0.03	0.00	0.46	0.25	0.00

Note: All of these values in the Excel software environment are rounded up to two digits, and only two digits of numbers are displayed here.

Weighting with Shannon Entropy

For weighting with Shannon entropy, the sum of data for each variable was first computed and then the digits of each data were divided into its total. The K scale was calculated from the split of 1 to 16ln (number of options = 16) equal to –36.11. In the next step, the confidence values were obtained in such a way that the amount of ln for the data in Table 5 was calculated and multiplied, then the sum of each

column was obtained and the K value was divided. Uncertainty values were also ensured by dividing digit 1 into values, and then the sum of uncertainty amounts was calculated and equal to 16.41. In the final stage, the final weights resulted from the uncertainty of 40.16, which is equal to 1.

Table 5

Weighting with Shannon Entropy, 2017

County	A1	A2	A3	A4	A5	B1	C1	C2	C3	C4	C5	C6	D1
Eslamshahr	0.03	0.06	0.00	0.01	0.08	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Baharestan	0.03	0.00	0.00	0.01	0.01	0.01	0.24	0.00	0.24	0.01	0.01	0.00	0.00
Pakdasht	0.02	0.03	0.00	0.01	0.05	0.02	0.05	0.18	0.11	0.09	0.28	0.00	0.09
Pardis	0.01	0.09	0.00	0.00	0.02	0.01	0.05	0.00	0.00	0.16	0.18	0.26	0.00
Pishva	0.00	0.00	0.00	0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tehran	0.73	0.03	0.06	0.34	0.13	0.75	0.13	0.17	0.16	0.25	0.12	0.35	0.25
Damavand	0.01	0.00	0.15	0.18	0.12	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Robat Karim	0.02	0.00	0.00	0.01	0.02	0.01	0.00	0.12	0.13	0.14	0.00	0.00	0.07
Ray	0.01	0.06	0.00	0.14	0.12	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.11
Shemiranat	0.00	0.41	0.54	0.13	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Shahriar	0.05	0.03	0.00	0.02	0.12	0.05	0.19	0.00	0.00	0.19	0.00	0.00	0.13
Firuzkuh	0.00	0.09	0.25	0.03	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Qods	0.02	0.09	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Qarchak	0.02	0.03	0.00	0.01	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Malard	0.02	0.03	0.00	0.09	0.10	0.06	0.19	0.27	0.02	0.00	0.01	0.39	0.00
Varamin	0.01	0.03	0.00	0.02	0.08	0.01	0.15	0.17	0.17	0.09	0.23	0.00	0.03
County	E2	F1	F2	F3	F4	F5	F6	F7	G1	H1	I1	J1	K1
Eslamshahr	0.06	0.02	0.04	0.02	0.05	0.00	0.04	0.04	0.00	0.03	0.07	0.00	0.02
Baharestan	0.01	0.01	0.00	0.00	0.00	0.00	0.04	0.02	0.00	0.03	0.02	0.00	0.00
Pakdasht	0.08	0.14	0.02	0.01	0.07	0.08	0.02	0.03	0.03	0.02	0.12	0.02	0.00
Pardis	0.02	0.01	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.02	0.00	0.00	0.08
Pishva	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.00
Tehran	0.05	0.49	0.66	0.18	0.33	0.64	0.73	0.63	0.68	0.27	0.05	0.01	0.77
Damavand	0.16	0.01	0.02	0.00	0.14	0.01	0.01	0.01	0.01	0.02	0.04	0.16	0.00
Robat Karim	0.03	0.09	0.04	0.03	0.03	0.03	0.02	0.02	0.00	0.01	0.02	0.01	0.03
Ray	0.09	0.08	0.01	0.07	0.15	0.05	0.01	0.08	0.02	0.01	0.27	0.16	0.00
Shemiranat	0.07	0.05	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.00	0.00	0.12	0.00
Shahriar	0.07	0.03	0.08	0.05	0.01	0.01	0.05	0.04	0.01	0.05	0.03	0.01	0.04
Firuzkuh	0.18	0.01	0.00	0.00	0.11	0.13	0.00	0.01	0.06	0.01	0.01	0.22	0.00
Qods	0.00	0.01	0.00	0.00	0.00	0.00	0.02	0.02	0.04	0.03	0.01	0.00	0.03
Qarchak	0.01	0.01	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.02	0.01	0.00	0.00
Malard	0.13	0.01	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.02	0.07	0.09	0.01
Varamin	0.01	0.01	0.03	0.00	0.02	0.05	0.01	0.02	0.02	0.00	0.18	0.01	0.00

Note: All of these values in the Excel software environment are rounded up to two digits, and only two digits of numbers are displayed here.

Table 6

Confidence and uncertainty amount with the last with the finalized Shannon Entropy weight K is equal to –0.361, 2017

Variables	A1	A2	A3	A4	A5	B1	C1	C2	C3	C4	C5	C6	D1
Confidence amount	0.44	0.73	0.30	0.70	0.91	0.41	0.66	0.47	0.63	0.67	0.62	0.39	0.58
Uncertainty amount	0.56	0.27	0.70	0.30	0.09	0.59	0.34	0.53	0.37	0.33	0.38	0.61	0.42
Shannon Entropy final weight	0.03	0.02	0.04	0.02	0.01	0.04	0.02	0.03	0.02	0.02	0.02	0.04	0.03
Variables	E2	F1	F2	F3	F4	F5	F6	F7	G1	H1	I1	J1	K1
Confidence amount	0.87	0.66	0.45	0.28	0.69	0.45	0.45	0.56	0.46	0.46	0.69	0.74	0.34
Uncertainty amount	0.13	0.34	0.55	0.72	0.31	0.55	0.55	0.44	0.54	0.54	0.31	0.26	0.66
Shannon Entropy final weight	0.01	0.02	0.03	0.04	0.02	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.04

Note: The numbers have rounded in this table, also the last Entropy sums are equal to one.

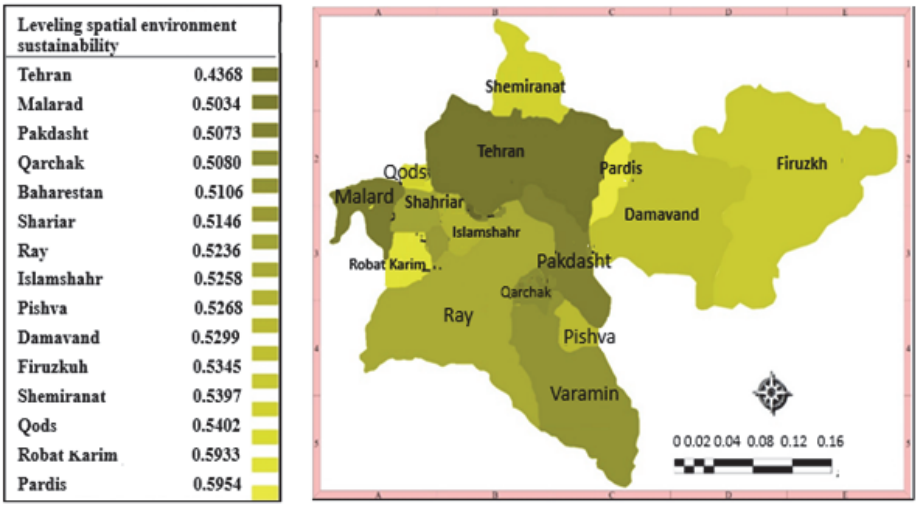
Topsis finalization level for environmental sustainability of counties and their spatial representation

For leveling with the Topsis model, we set the stochastic data in the weight of each variable, and then determine the most appropriate and most inappropriate quantities in terms of the variable nature. In the next step, the difference between each of the data obtained in the previous step is obtained from the most appropriate figure and the result is brought to power 2, then the sum of its rows and roots of the sum of the rows are calculated. It is also necessary to calculate the difference between the normal data weighted by the weight of each variable from the most inferior to the second, and then calculate the power of 2, and then calculate the sum of its rows and roots of the sum of the rows. In the end, the cultivars related to the total number of rows of the most inappropriate and the most appropriate are combined, and then the roots of the total number of rows of inappropriate ones are divided. We will process this process for each option, and the digits that will be obtained will be between 0 and 1, and the larger one will be more appropriate.

According to Figure 5, environmental sustainability ratings indicate that Tehran is the lowest ranking and the city of Pardis has the highest rank. Of course, this leveling does not mean that the city of Pardis is quite desirable in comparison to other cities; in other words, the only county is compared here. Tehran < Malard <Pakdasht <Qarchak <Varamin <Baharestan <Shahriar <Ray <Islamshahr <Pishva <Damavand <Firuzkuh <Shemiranat <Qods <Robat Karim <Pardis.

Figure 7

Leveling spatial environmental sustainability in Tehran province (Application of Topsis model), 2017



General status of environmental sustainability in Tehran province and its spatial development

Using the T-test, a one-sample test showed that with a significance level below 0.05 and a 99% confidence level, the overall status of environmental sustainability in Tehran province with an average of 157 from the standard average, ie 165, was lower.

Because the T single sample test showed the overall status of environmental sustainability in Tehran province below the standard average; in Figure 8 its environmental sustainability was divided into two very weak and weak categories. According to Figure 7 a large part of the city of Tehran, south to the center of Shemiranat, parts of north and south of Varamin, the capital city of Baharestan and Shahriar, west of Malard, north and Pakdasht, the whole city of Qarchak, northeastern Ray are very weak and in other cities it is weak.

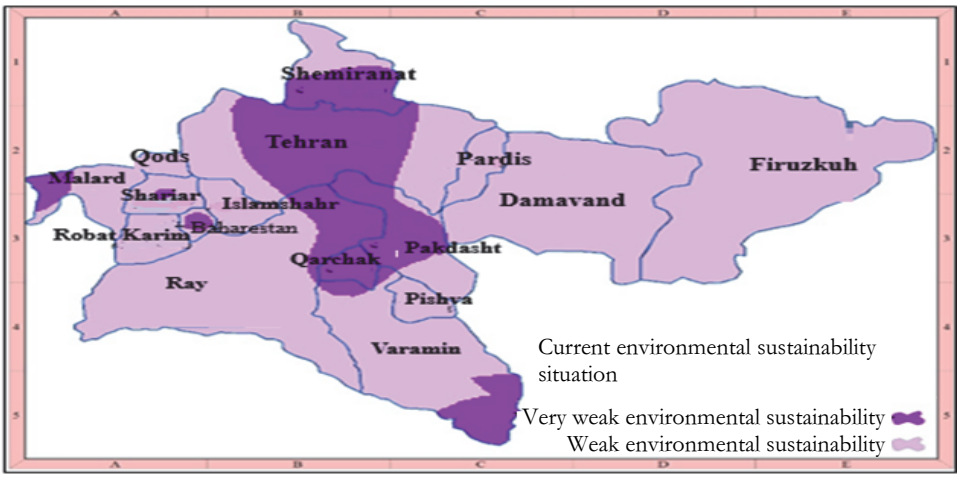
Table 7

T-test single sample, 2017

Standard deviation	Sig. t	Confidence level	Mean result	T-test
165	0.000	99%	157	–0.167
Deviation	Degree of freedom	Upper level	Lower limit	The last environmental sustainability condition
–8.11	15	135	–151	Less than mean deviation standards

Figure 8

Tehran current spatial environmental sustainability situation, 2017



Influence of indicators on the environmental sustainability of the cities of Tehran province

Using the Friedman test, the average of the impact of the indicators on the environmental sustainability of the cities of Tehran province was obtained in SPSS software. Accordingly, the utilization of energy sources with an average of 11, and the status of water supply sources with an average of 10 have the most impact on the environmental sustainability of cities (Table 8).

Table 8

Friedman Test, 2017

County	Options	Degree of freedom	Significant level	K Squared	Mean
Green urban spaces					3.94
Industrial pollutant activities					4.09
Mineral resources consumption					4.19
Amount of waste and scrap					4.53
Chemical fertilizer					6.09
Natural lands	16	10	0.000	92.192	4.69
Water resources condition					10.00
Air pollution index					5.34
Road development					7.81
Energy resource use					11.00
Sewage treatment plant					4.31

Conclusions

Tehran has been at the lowest level in the level of environmental sustainability among other counties; this means that the environmental issues in Tehran are more significant than in other counties. However, data collection due to touch such sensitive issues under the current government in Iran was so difficult and they do not want to expose their incompetences and weaknesses on sustainable planning and policy issues. Tehran is so populated, and the population growth of this city, which is several times larger than in other counties, and the high consumption of energy resources and high contamination has reduced the quality of the environment in Tehran. The geographical location of Tehran and the variety of ecosystem services made Tehran rich in water resources by the unique oro-hydrographic situation in the north and qanats, but rapid urban expansion and population growth have polluted all these natural ecological provisioning systems and limiting environmental resources by pollutants, sewage treatment plants, but its environmental issues are much higher and the following can be mentioned: 1) The highest amount of NO_2 emissions; 2) The largest number of industrial pollutants; 3) The most consumed natural gas, gasoline, super petrol, kerosene, petrol, water and electricity (household, general, agriculture, industrial, commercial), and free consumption, street lighting); 4) the largest number of minerals active in minerals; 5) the largest amount of waste and waste generation; 6) the largest population (with a population of several million; among the cities in the province of Tehran, after the city of Tehran, the population of the city of Shahriar is the highest and is equal to 744,210 people, which does not reach one million); the highest number of deep and semi-deep qanats. NO_2 pollutants or nitrogen dioxide cause disturbances, diseases, and pulmonary infections, burning wood, combustion caused by vehicles, and industrial activities. Therefore, it endangers human health. On the other hand, the use of energy and mineral resources, deep and semi-deep wells indicates the high utilization rate of the natural environment.

In addition, high waste and waste production would mean the risk of falling environmental health. This city indeed has the highest amount of water resources, but its total water resource is 1,040,107,415, cubic meters, 797,648,663 cubic meters are in the consumption cycle as wastewater become out of reach. In the end, the surplus will be 242,458,752 cubic meters. Therefore, the amount of consumption is much higher than the amount of water storage. Tehran's population and concentration is another important factor that negatively affects its environmental sustainability. The comparison of its population with other counties indicates an imbalance in the spatial distribution of the population. The population of over 8 million is more concentrated in a limited area of the region, which is considered to be a potential hazard to the quality of natural resources.

Furthermore, the overall status of environmental sustainability in Tehran province with an average of 157 is below the average of the standard of 165, which means the unsuitable environmental sustainability situation in the entire Tehran province, and its spatial manifestation showed that in areas of the Tehran, Shemiranat, Varamin, Baharestan, Shahriar, Malard, Pakdasht, Qarchak, and, Ray; the environmental sustainability is weak and in other counties is very weak. On the other hand, the most effective indicators on the environmental sustainability of the counties of Tehran province are the exploitation of energy resources and water supply resources. This indicates that among the 11 indicators used in the research, consumption of energy types and water consumption in Tehran is significant and contributes to the increasing environmental instability. Tehran's population attraction made the other counties so populated as well so much pressure on Tehran city-region resources has made the current quality of environmental sustainability so low. Therefore, the environmental capacity for future sustainable development is too weak. Right now lack of appropriate waste management systems due to inadequate waste management sites, lack of understanding of waste management by local governments reduced environmental quality in the southern part of Tehran. Also, the local governments are not aware of what and how mitigation policies and adaptation for better application of energy systems in cities can help with the quality of the environment. Furthermore, many social problems and issues in Tehran province have accumulated due to unplanned regional policies and Urban Sprawl.

Recommendations

• Special attention on population distribution and natural resources capacity in each county.
• Balance in natural resources utilization such as energy and mineral resources with less ecological impact and destruction of natural resources.
• Install appropriate recycling systems to prevent its entry and accumulation in the natural environment. For instance, waste generated during the recycling process and increase the capacity of the wastewater treatment plants, renewable energies,
• Provide facilities and technologies for urban and industrial use of clean energy to reduce the amount of pollutants into the air.
• Increase awareness of environmental issues among citizens and citizens of each county through direct contacts (e.g. Social media).

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