

The future form, sustainable urban design and the effect of urban infrastructures: a case study of the Region One of Tehran municipality

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Abstract. Sustainable development is integrated and unfolds with respect to different aspects. Therefore, the concept of sustainability in cities could be analyzed from a variety of facets. It is necessary to study the impact of urban infrastructures on urban sustainability since there is a significant relationship between urban infrastructures and urban development. Urban infrastructures and facilities account for economic, social and environmental improvements. The aim of this study is to analyze the impact of urban infrastructures on urban sustainability based on the indicators of sustainable urban development. It also seeks to provide novel guidelines and procedures for an optimum use of urban infrastructures with the purpose of helping urban sustainability. The results show that the efficient use of urban infrastructures leads us to urban sustainability.

Key Words: sustainable development, Tehran municipality Region One, urban sustainability, urban infrastructures.

Introduction. Urban sustainability and sustainable urban development are similar in meaning and are often used interchangeably. To distinguish between these two terms, we need to know that sustainable urban development shows a process that leads to sustainability while sustainability is a collection of conditions that are stable through time (Leghayi & Mohammad Zadeh Titkanlu 1999).

The basic assumption of sustainable city is this commonly held agreement that what we know today as city may cause environmental tensions. Cities with social layers are expensive to control. City management is not economically convenient (Frey 1999). To recognize a sustainable city, a clear understanding of what it denotes should be obtained. In other words, we have to know what it is, how it functions, and how it changes through time (Williams et al 2010).

The concept of sustainable city was introduced by Maclaren (1996). She distinguishes it from sustainable urban development by considering sustainability as the indicator of a desirable conditions that are stable through time. From her point of view, some key features of urban sustainability that are often referred to in the relevant literature and documents are as follows: the equality between different generations, equality in the protection of natural resources (living based on environmental capacities), minimum use of non-renewable resources, economic feasibility and variety, self-sufficiency and overcoming basic needs of society members (Rahnama & Abbaszadeh 2009).

In defining a sustainable city, there is a necessity of searching cities and rural areas where the needs of civilians can be fulfilled without the imposition of unstable demands upon natural, local or universal resources (Marsoosi & Peyravi 2007).

During the recent decades, sustainable urban development has turned into a novel paradigm in current theoretical and practical ideas on urban planning and development. Although this paradigm is interpreted differently, it generally emphasizes the role of the sustainable, consistent and integrated development of economy, society and environment in a country or a city. Sustainable development permits the existing

society members and the generations to come to use natural resources and urban facilities (Golkar 2011).

Sustainable development is integrated and unfolds with respect to different aspects. Therefore, the concept of sustainability in cities could be analyzed from a variety of facets. It is necessary to study the impact of urban infrastructures on urban sustainability since there is a significant relationship between urban infrastructures and urban development. Urban infrastructures and facilities account for economic, social and environmental improvements. Also infrastructure projects represent major investment and construction initiatives with attendant environmental, economic and societal impacts across multiple scales (Pincetl 2012). The aim of this study is to analyze the impact of urban infrastructures on urban sustainability in Region One of Tehran municipality, based on the indicators of sustainable urban development. It also seeks to provide novel guidelines and procedures for an optimum use of urban infrastructures with the purpose of helping urban sustainability.

Method. This is an applied research using a descriptive-analytical method. The data were gathered through library sources such as different universities, organizations, institutes, research centers, and Iranian and international databases and networks. This was a case study of Kerman town located in the southeast of Iran. The basic theory used in this research is sustainable development theory.

Sustainable development is one of the most inclusive concepts in every time and place. This concept forms the major elements of the 21st procedure which was a part of a 40-chapter document that was agreed upon by world leaders in Rio in 1992 (United Nations Conference on Environment and Development 1992). The goals of sustainable development (i.e. fulfillment of basic needs, improving life quality for everyone, maintaining and managing the ecosystems) are perused on every level of space (i.e. local, national, regional and universal levels). Sustainable development in general involves the aspects from Figure 1.

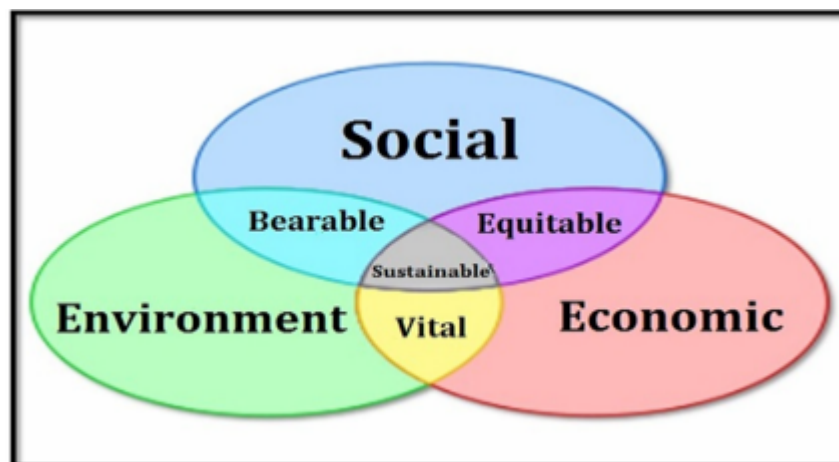


Figure 1. The aspects of sustainable development (Adams 2006).

Sustainable urban development is the result of merging numerous discussions by environmentalists on environmental issues especially urban environment into the theory of sustainable development. Urban sustainable development aimed at protecting natural resources and it was developed and extended to the World in a conference called Habitat in 1996 (unhabitat.org).

According to Hall & Pfeiffer (2000), the following definition for urban sustainable development was put forth: sustainable urban development means improving the life quality of citizens in a city with respect to ecological, cultural, political, organizational, social and economic factors without causing problems for the future generations. These problems might be due to the lack of natural resources and too much local debt. Our goal is make balance between materials, energy, financial/natural sources and the needs of

citizens. This balance should enjoy a central role in defining future decisions on developing urban areas.

The location of the study. Region one of Tehran was included in this study; it is located in Tehran's heights and with an area of approximately 210 square kilometers containing more than 433,500 thousand people according to statistical data. Region 1 is adjacent to region 2 from west, region 3 from south, region 4 from east. From north, this region is connected to the southern slopes of Alborz Ranges with an altitude of 1800 meters. Shahid Chamran Highway is located in the south near the crossroads of Azadi Hotel and Moddares Highway and Ayatollah Sadr Bridge. From west, the region is connected to the lands of Darake River, and from east, it is limited to Artesh Highway, Asphalt factory and Tehran northeast oil station. Region 1 includes 10 districts and 51 neighborhoods (Tehran Region One Municipality 2015) (Figures 2 and 3).

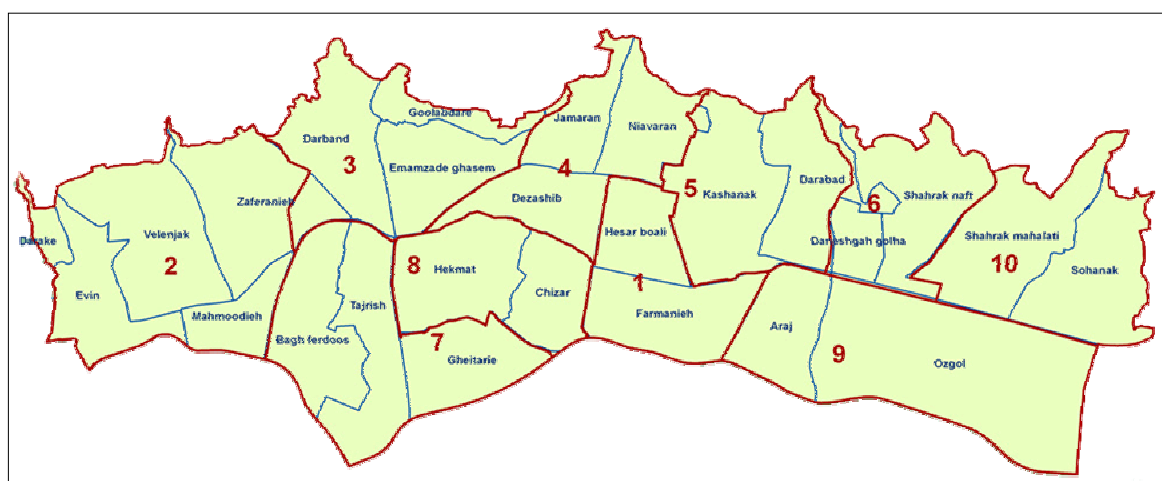


Figure 2. The districts of Region One of Tehran Municipality (Tehran Municipality map 2015).

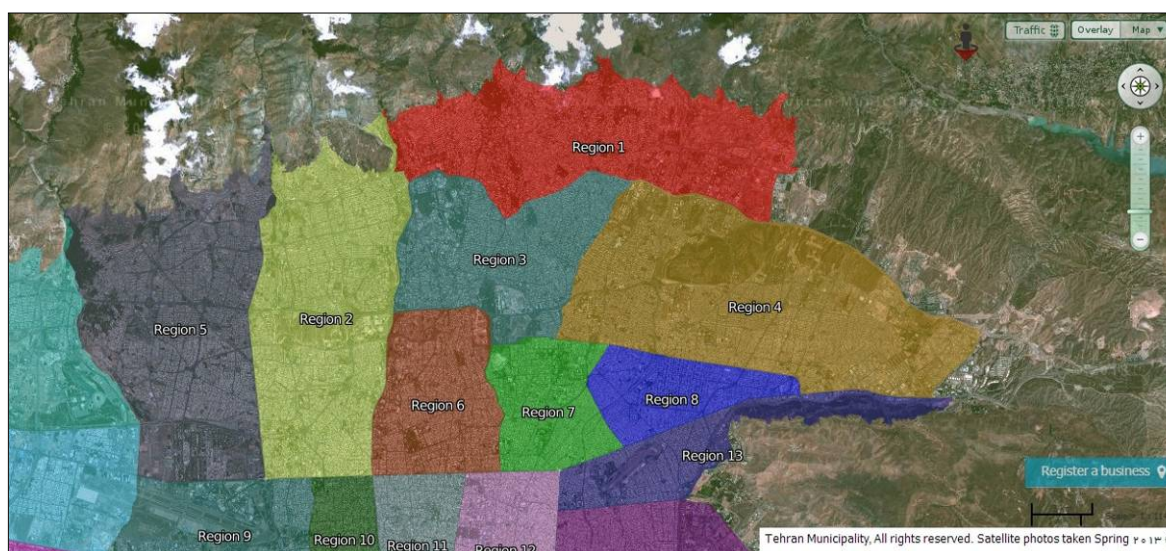


Figure 3. The location of Region 1, Tehran (Tehran Municipality map 2015).

Results and Discussion. Infrastructures form the major section of urban facilities. Factors, elements and process embedded in urban facilities ease the life of citizens. Facilities could be divided into groups including infrastructures and superstructures. Infrastructures are often made of the following elements which are in the form of network: water supply network, waste water disposal network, fuel supply and energy distribution such as gas delivery networks, telecommunications networks, medical waste

disposal, distribution and storage of food, environment protection networks. There are also some elements that form superstructures, which are mostly places and venues and include the following: educational centers, sport complexes, parks, and open spaces, medical and health centers, cultural and religious centers, business and private sections, industrial and production sites, organizations and administrations, military bases and police stations, cemeteries, mortuaries and other places that are in the vicinity of cities. Figure 4 shows the location of infrastructural elements in urban sustainability (Behzadfar 2009).

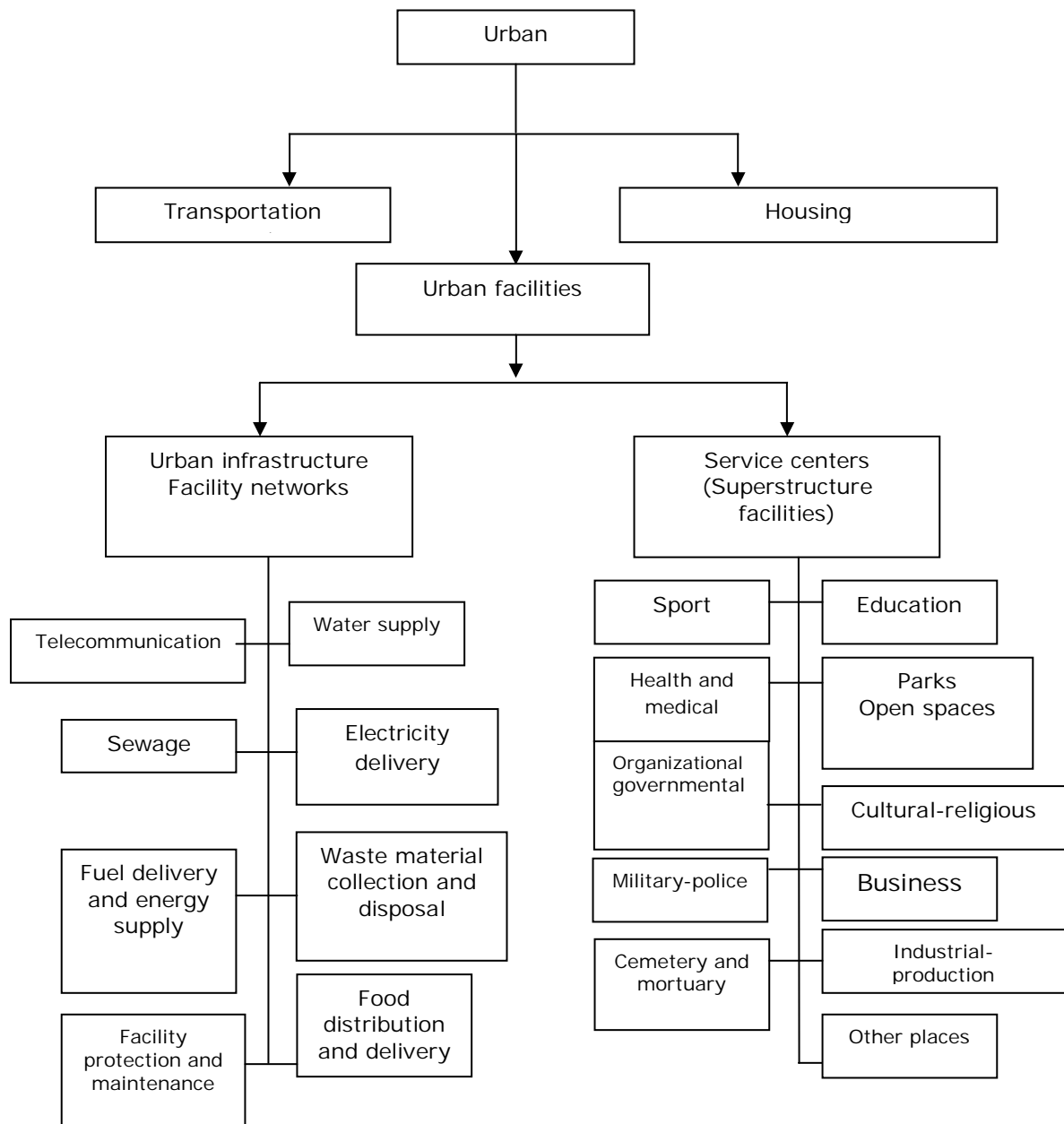


Figure 4. The location of infrastructural elements in urban sustainability (after Behzadfar 2009).

Those characteristics that separate the infrastructure networks from other public facilities are as follows:

- elements forming the infrastructure often penetrate the physical body of cities, and on most of occasions are manifested in the form of underground continuous networks which are lower than surface roads in terms of altitude;

- services are often continuously provided for users that are separated from the network;
- some of these infrastructures provide service beyond their geographical limits;
- infrastructures are not only needed for fulfilling the daily needs of people, but they can also solve the other needs. They need more investment than other facilities. On one hand, they fulfill daily needs and other demands, and on the other hand, their implementation is on the basis of economic and industrial activities which result in urban sustainability of cities;
- the life of infrastructures is in a significant relationship with the life of societies;
- compared with superstructures, urban infrastructures are fundamental to the sustainability and maintenance of social life in cities (Behzadfar 2009).

The application of superstructures may be extended beyond the limits of the physical space of a city, but infrastructures only operate within a city's physical space. Services such as the collection and disposal of surface water could account for a city's health as well as its sustainability. In its basic role, the collection of surface water helps to the protection of citizens against floods, polluted water; it carries wastewater out of city to proper locations. In our age of industrialism, it can be observed that intense raining, oil materials, pesticides, animal wastes, park waste materials, waste materials of streets and pedestrian walk and chemical pollution of air may enter rivers and surface water. Surface water network should be so strong that enough measures be taken before any pollution can make its way into rivers and underground water. One of the most troublesome aspects of future generations will be water supply. Consequently, surface water collection networks can play a key role in gathering and storing the current water especially seasonal streams and then using them for watering parks and green spaces.

In this article, our scope is limited to urban sustainability. The process of urban sustainability consists of a number of elements among which three groups are very important. Infrastructures creation, implementation and maintenance are the three mentioned categories. The continuity of these elements in the process of sustainability program can result in the precise and timely executive plan. Urban sustainability is in an urgent need for the change of our thinking while encountering the aspects of sustainable development (Habibi et al 2011). Figure 5 shows three basic principles of this new way of thinking.

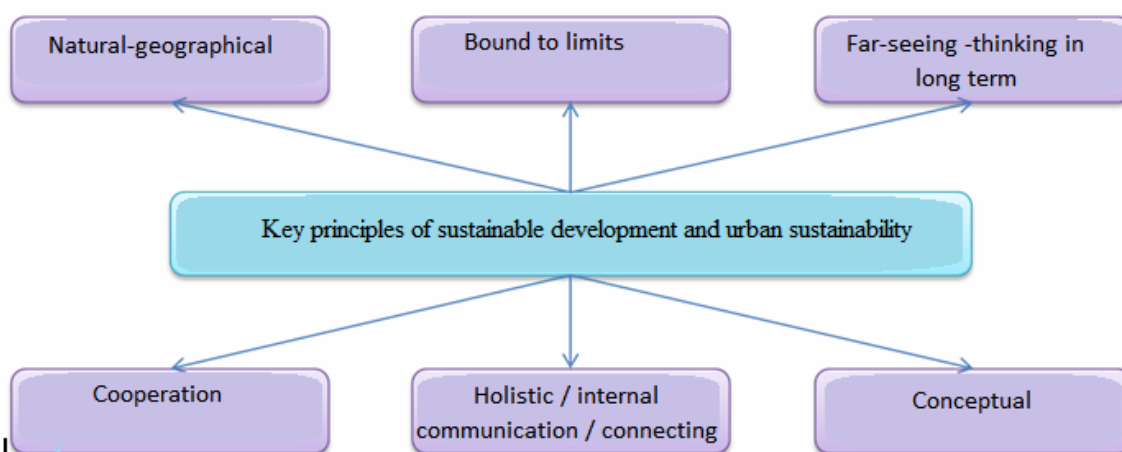


Figure 5. Key principles of sustainable development and urban sustainability
(Source: Krizek & Power 1996).

The relationship between urban infrastructures and the key principles of urban sustainability. The role of far-sightedness in using and maintaining urban infrastructures with the goal of obtaining urban sustainability is that sustainability needs both planning now and in future. In other words, plans on sustainability should include both our and future generation. Any attempt for sustainability should include patience and far-sightedness. Therefore, principles and plans for sustainability should be clear enough so that we be able to evaluate the periodic performance of the officials.

Infrastructures provide service for cities and are useful for their industrial and economic growth. Therefore, we should think long terms while we are to implement and create infrastructures, which will enable us to fulfill the demands of the present and future generations. For example, transportation network and road system is an infrastructure that is effective in the growth of sustainability of any society. Telecommunication network plays the same role. Water supply network is also a vital infrastructure which demands the utmost care in the stage of implementation. We need to be cautious of the future generations so that they do not suffer from the lack water sources. Other infrastructures such as sewage, which disposes surface water, are the result of using water and caring about people's health in urban life (Marlow et al 2013; Habibi et al 2011).

Limitations for the maintenance of urban infrastructures with the goal of reaching urban sustainability. A sustainable society believes that the potentials of a human society is rather limited to certain constraints and conditions. The development and implementation of infrastructures should be done in the light knowing the existing natural limitation (Rees 1996).

Sustainable development planning has borrowed its conceptual structure from the idea of existing capacity. In other words, theorists in sustainable development tend to rely on the limited natural and human-made sources to fulfill a range of different demands. This is a reference to the limitations of a system. The changes that are beyond the system's threshold of tolerable capacity make it unstable and cause destructive impact on it, and they cause irreparable losses (Godschalk & Parker 1975).

Creating a sustainable city includes major changes in urban management and policies. These policies might be related to future investments of the city. Such changes require the implementation of newer plans with respect to recycling and reducing waste material, the convenient use of gas and electricity, using clean energies such as sun, saving water and making pricing policies that include the true environmental prices. The changes may also address those policies that focus on the reduction of waste material and the encouragement of using sustainable goods. The use of water that is recycled from sewage in watering parks and green spaces is an important factor in the sustainability and freshness of the cities that suffer from different forms of pollution (Ziari et al 2009).

Paying attention to geography and nature in protecting infrastructures and attaining urban sustainability. Evaluating the environmental condition and knowing the geography instead of politics is a prerequisite for urban sustainability. A sustainable city should decrease environmental negative impacts and the use of natural resources to a minimum.

Conceptual and integrated vision. Sustainable development peruses transportation, waste and surface water disposal, fuel delivery, energy supply, waste material collection and disposal, food delivery and maintenance, water supply facilities, electricity delivery and economic development not as a goal but as a means of reaching urban sustainability. For example, the improvement of exciting transportation means (e.g. cycling and walking) could be beneficial. One advantage of these modes of transportation is the reduction of noise and weather pollution. Seemingly, the decrease in use of cars does not bear an evident important advantage, but the reduction of car ownership can help people to fulfill their other necessary needs (e. g. house). The reduction of traffic can also protect our children against accidents. Scheduled walking along narrower streets and parking may lead society members to more social interactions, and consequently decreases the toxic materials in underground and surface waters. One smart approach that can prevent the possible problems is to look at issues from multi-dimensional and conceptual viewpoint instead of adopting a limited, one-dimensional scope (Ahern et al 2014).

Holism and the internal relation between the infrastructures with the objective of reaching urban sustainability. Sustainable development is an integrated approach which does not follow an individual pattern. To solve problems, concepts should be seen

holistically in a way that the internal dependency of urban infrastructure could be observed clearly. Environmental engineering, water supply, electricity supply, electrical installations, mechanical installations, gas delivery, road construction, transportation and traffic are those criteria of infrastructures that require team work. Some of these criteria are less visible, but their absence will cause damage to the urban life. For example, attention to water supply cannot be merely a substitute for other infrastructures. Without other system such as surface water disposal networks, flood blockages, waste material collection networks, grain depots, social life encounter numerous irreparable crises. However, the lack of sport centers, educational centers, business organizations, administrations etc. will not endanger the existence of urban life (Behzadfar 2009).

Cooperation for obtaining urban sustainability. Ideally, sustainability aims at people benefits. Therefore, providing efficient infrastructures and installations is a fundamental element in fulfilling the demands of a society with the goal of maintaining urban sustainability.

Considering the basic principles of sustainability, some strategies are proposed for an efficient use of urban infrastructures. Urban sustainability includes space, economic, social and environmental aspects. To reach space sustainability, the distribution of services and facilities should be just without discriminating against anyone. To reach economic sustainability, we need to adopt an efficiency standard for the proper distribution of spaces and activities. Social sustainability is also attainable through the standards of vivaciousness, cooperation and identity. The last principle is environmental sustainability which is analyzed by the environmental quality standard (Figure 6).

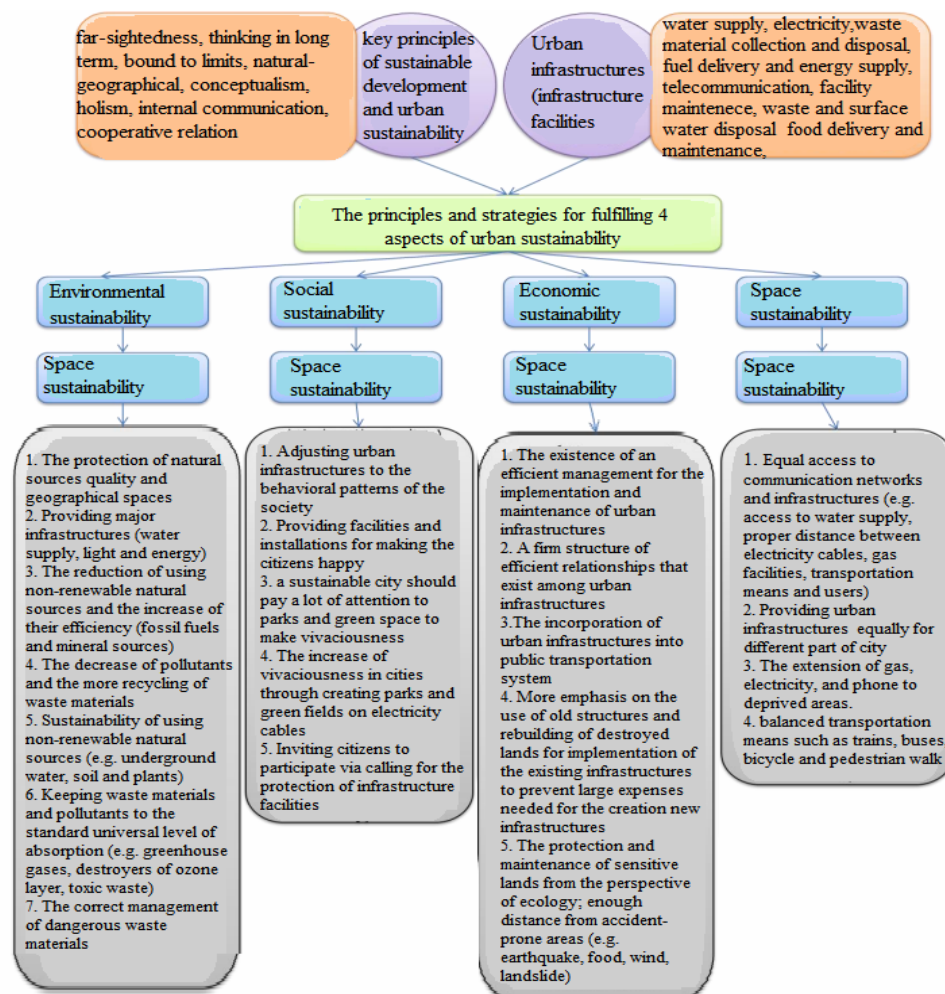


Figure 6. The combination of urban infrastructures and urban sustainability principles with the goal of attaining urban sustainability (original figure).

For the purpose of space sustainability and using the standard of justice, equal access to communication networks (Figure 7) and infrastructure facilities (Figure 8) were analyzed.

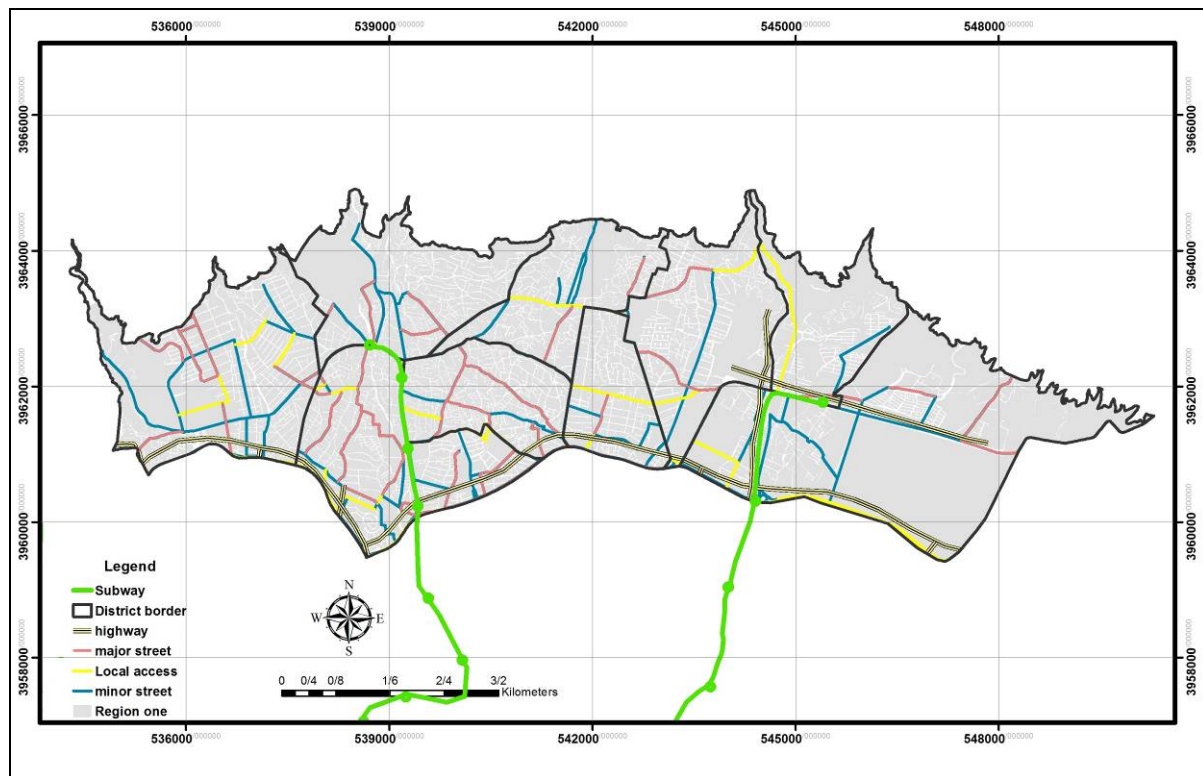


Figure 7. Passages of region one and the location of subway (Tehran Municipality map 2015).

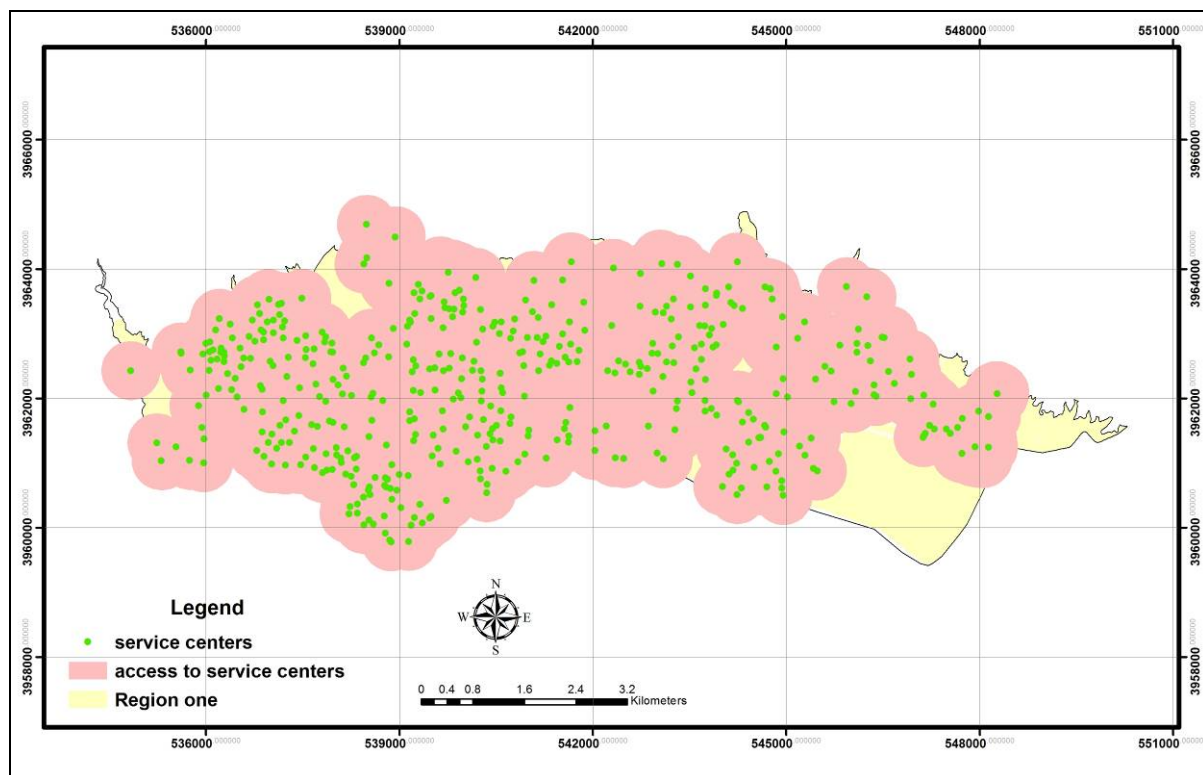


Figure 8. Infrastructure facilities and their access to region one (Tehran Municipality map 2015).

As could be observed from Figure 7, region one is weak with respect to transportation network such as subway. Its access to the main streets of region one is rather limited

which indicates the improper distribution and lack of access to services and transportation means.

Economic sustainability is sought by using efficiency standard, creating a proper space organization, well-structured infrastructure and the appropriate combining of infrastructures with transportation system. Here, the major emphasis is on the optimum use of urban lands, old buildings and destroyed structures for a more efficient use of the existing infrastructures with the incentive of preventing extra expenses for building new infrastructures. In regard to this, sensitive lands from the perspective of ecology such as parks and green fields should be protected, and enough distance from accident-prone areas should be taken into account (e.g. earthquake, flood, wind and landslide).

In overall, 6284425 m² of waste land exists in region one, most of which is located in the north and northeast of the region (Figure 9). These lands could be used optimally considering the infrastructures of region one.

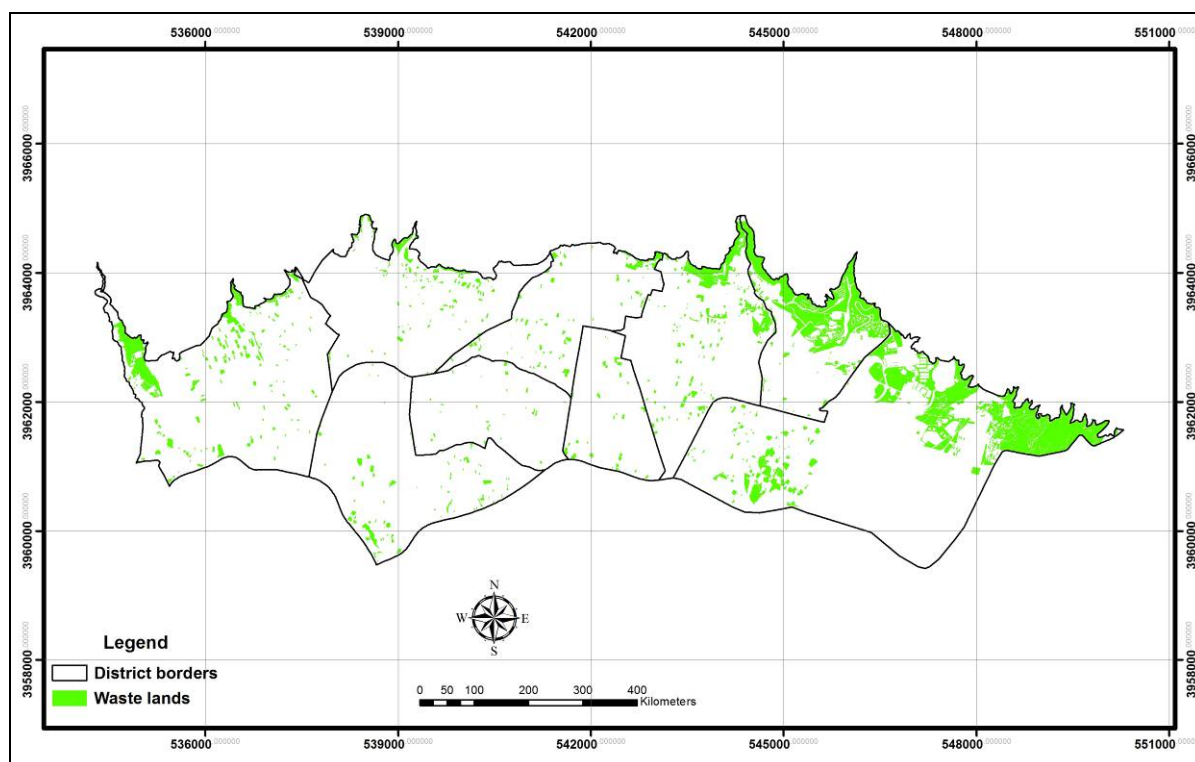


Figure 9. Waste lands of region one (Tehran Municipality map 2015).

There are 234439 m² of historical land in region one (Figure 10). There is a growing need for the protection of these sites.

There are 4926066 m² of worn and weak land abounding in region one in Tehran, which is in urgent need of rehabilitation (Figure 11). Renovating these lands could provide suitable grounds for the more efficient use of existing infrastructures. It also prevents extravagant measures for building new infrastructures. This is in line with attaining sustainability with an emphasis on urban infrastructures.

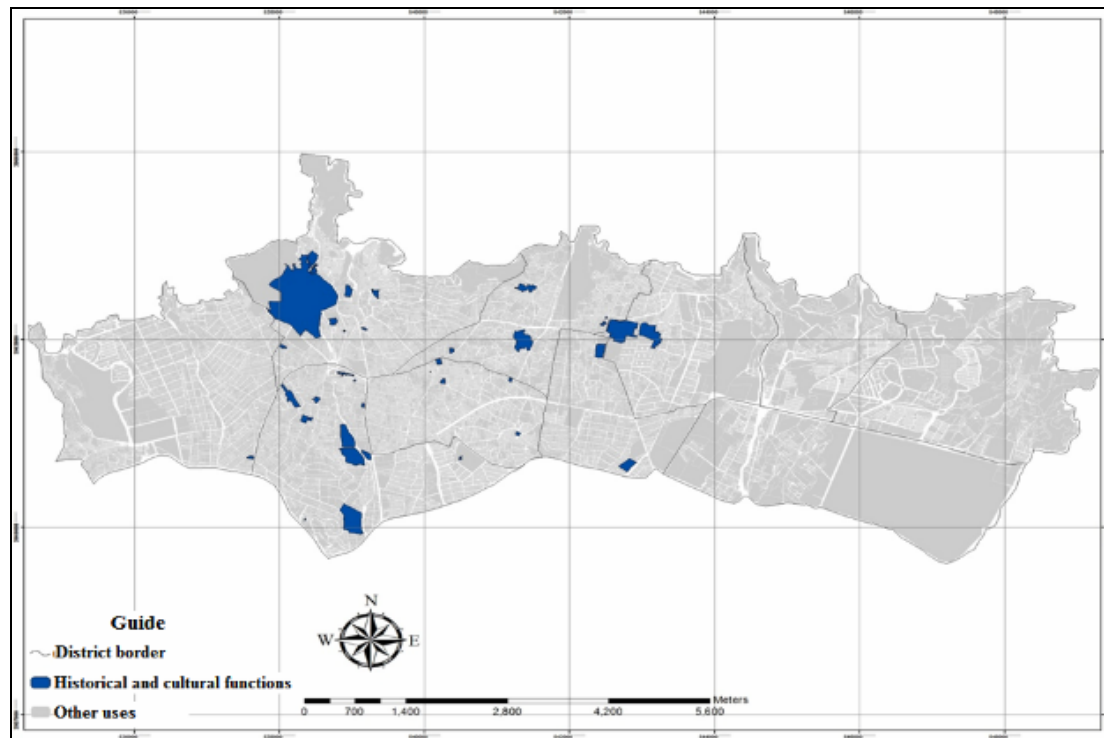


Figure 10. Historical lands of region 1 (Tehran Municipality map 2015).

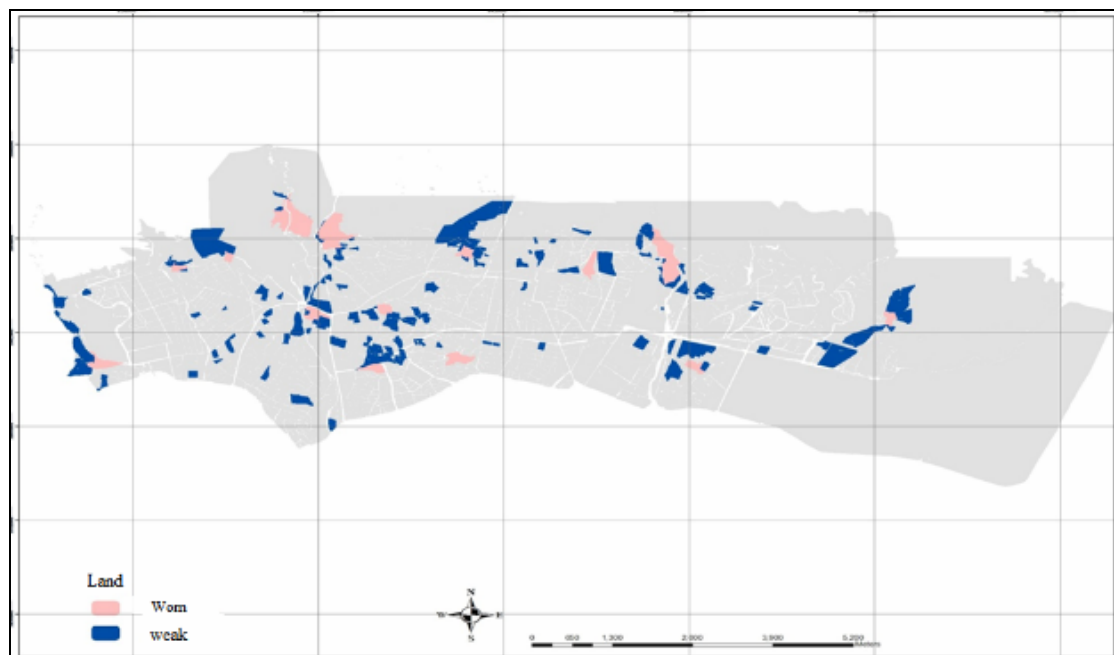


Figure 11. Worn and weak lands of region one (Tehran Municipality map 2015).

There are 1301232 m² of green land in region one (Figure 12). Enough attention should be paid to the maintenance and protection of these lands which are ecologically sensitive areas.

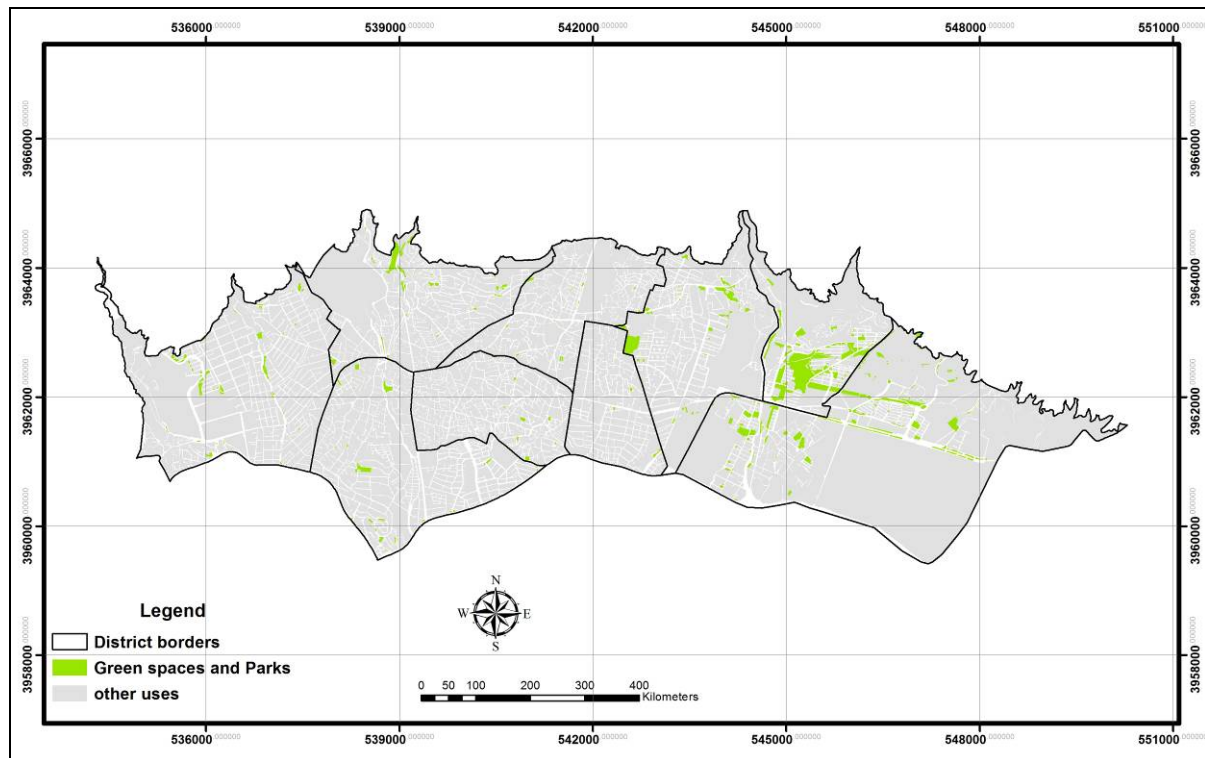


Figure 12. Green spaces of region one (Tehran Municipality map 2015).

In Figure 13, river limits of region one could be observed. In order to be aware of accident-prone zones, officials need to pay enough attention to these areas to reduce the risk of damage in natural disasters.

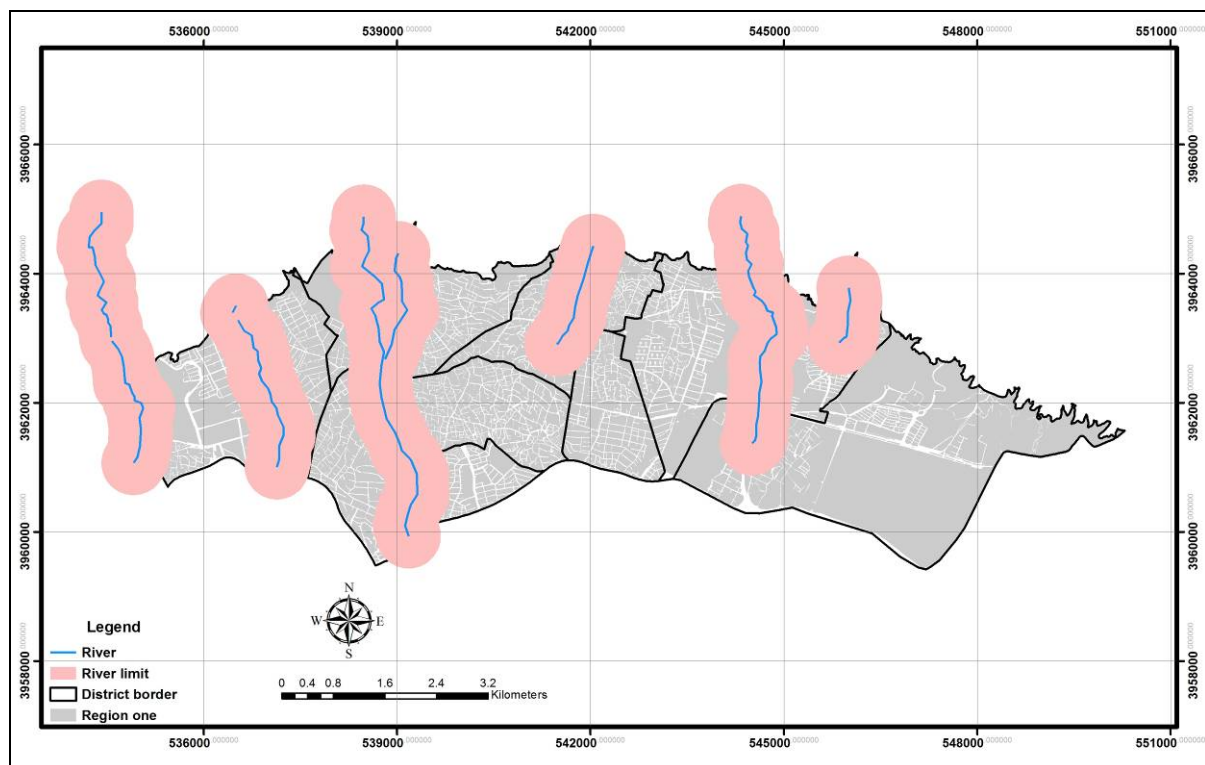


Figure 13. River limits in region one (Tehran Municipality map 2015).

Social sustainability is also analyzed through the use of vivaciousness, cooperation and identity. In social sustainability, the emphasis is on city designing based on trees, green

spaces and parks. Interconnection of open spaces and green spaces plays a pivotal role in this aspect of sustainability.

There are 547132 m² of open spaces located in region one, which can be used to design the urban sustainability of the region (Figure 14).

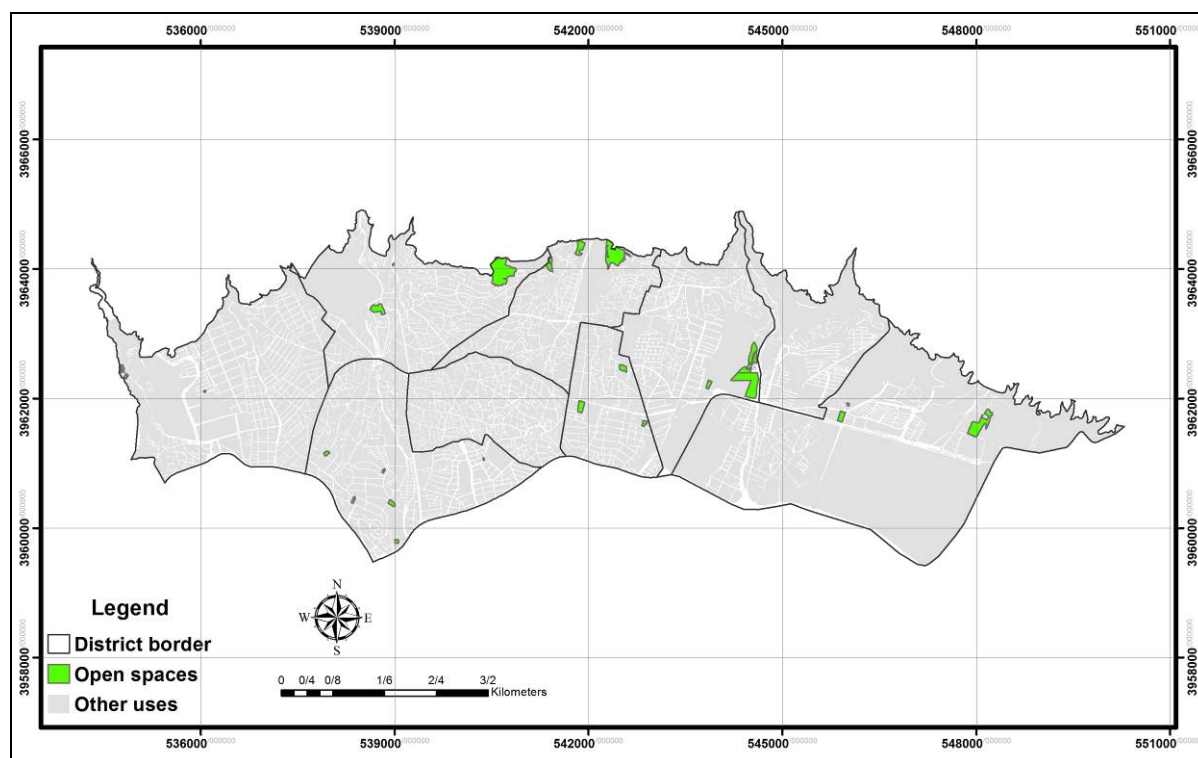


Figure 14. Open spaces in region one (Tehran Municipality map 2015).

Finally, our analysis will address environmental sustainability with the standard of environmental quality. Natural sources' quality maintenance, the protection of landscapes, providing basic urban infrastructures (e.g. water, sewage, light and electricity), the reduction of the use of non-renewable natural sources, the decrease of pollutants, the increase of waste material recycling, sustaining the use of non-renewable natural sources and the correct management of dangerous waste material is of prime importance in this regard.

As can be observed, region one is weak with respect to access to transportation means such as subway. Its access to the main streets is limited, which indicates the improper distribution and lack of access to services and transportation means.

To reach economic sustainability using efficiency standard the following factors were extremely useful: efficient management of urban infrastructures, creating a proper space organization, well-structured infrastructure and the appropriate combining of infrastructures with transportation system, more emphasis on the optimum use of urban lands, old buildings and destroyed structures for a more efficient use of the existing infrastructures with the objective of preventing extra expenses for building new infrastructures, the protection of ecologically sensitive lands such as parks and green fields, assigning enough distance from accident-prone areas. Waste lands of region one have the potential of being used optimally with respect to the existence of urban infrastructures. There is an urgent need for the protection of historical places. Weak and worn lands need to be rehabilitated. Renovating these lands could provide a more efficient use of the existing infrastructures, which also prevents expenses for building new infrastructures. Enough attention should be paid to the maintenance and protection of green lands which are ecologically sensitive areas. City planners should be aware of accident-prone zones such as river limits to reduce the risk of damage in natural disasters.

Social sustainability was attained through the standards of vivaciousness, cooperation and identity. The following factors were considered useful adjusting urban infrastructures to the behavioral patterns of the society, providing facilities and installations for making the citizens happy, paying a lot of attention to parks and green space to make vivaciousness, increasing vivaciousness in cities through creating parks and green fields on electricity cables and inviting citizens to participate via calling for the protection of infrastructure facilities. The open spaces of region one could be used in designing the sustainability of region one in Tehran.

The final criterion for sustainability was environmental sustainability, which was analyzed by the standard of environmental quality. The important factors in this aspect of sustainability were natural sources' quality maintenance, the protection of landscapes, providing basic urban infrastructures (e.g. water, sewage, light and electricity), the reduction of using non-renewable natural sources and the increase of their efficiency (fossil fuels and mineral sources), the decrease of pollutants and the more recycling of waste materials, sustainability of using non-renewable natural sources (e.g. underground water, soil and plants), keeping waste materials and pollutants to the standard universal level of absorption (e.g. greenhouse gases, destroyers of ozone layer, toxic waste), the correct management of dangerous waste materials.

Conclusions. Sustainable design is a kind of design which aims to meet the needs of today without damaging the resources of future generations. In sustainable design, the economic and social sustainability should be regarded as well as the energy consumption and the environmental impact of buildings and cities. Thus, the environment is a convenient and pleasant framework for the social cohesion, personal welfare and the personal independence of basic necessities. The purpose of the present study was to examine the effect of urban infrastructures on urban sustainable design. In this regard, the infrastructures affecting the sustainable design were identified and their distribution was evaluated at District 1 of Tehran and the design sustainability was raised according to four dimensions of physical, economic, social and environmental.

In the dimension of physical sustainability, supplying the equal and fair access to communication networks and infrastructure, providing a variety of urban infrastructures fairly for people and residents in various parts of the city, developing and creating a balanced and comprehensive public transport network should be considered by using the criterion of justice.

The economic dimension of design sustainability can be achieved by using the criterion of performance which means the creation of a spatial organization and appropriate performance in the location of activities.

In the social sustainability dimension, the criteria of vitality, participation and identification should be considered in which adjusting the urban space infrastructures based on the behavioral pattern of the society, providing the infrastructure equipments and facilities for the happiness and satisfaction of urban residents, sustainable city for creating the vitality in cities emphasize the green urban spaces, the design based on green spaces and urban parks, and the interconnected network of urban green and open spaces.

In the environmental sustainability dimension, the criterion of environmental quality is suggested in which the quality of natural resources and the perspective of geographical space, providing the urban infrastructures (water, sewage, lighting and power), reducing the consumption of non-renewable natural resources and use them more efficiently, reducing the production of pollutants and recycling more wastes, sustainable consumption of renewable natural resources (e.g., groundwater, soil and plants) and the proper management of hazardous wastes are considered.

The study results showed that maintaining the urban infrastructures, a coherent structure of efficient and reliable relationships between urban infrastructures, with more emphasis on the efficient use of lands within the city, using the old buildings, restoring degraded lands for the efficient use of existing urban infrastructures and avoiding the high costs to create new infrastructures in new urban developments, threaten the

conservation and maintenance of ecologically sensitive lands and the distance from the areas where there is the risk of natural disasters.

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