Urbanization and Sustainable Land Use Planning Challenges in the Mazandaran Metropolitan Area, the Case of Sari City

A Dissertation Submitted to the Faculty of Spatial Planning

at Technical University of Dortmund

In accordance with the requirements for the degree of Doctor of Engineering

(Dr.-Ing.)

by

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Dortmund, Germany

February 2023

Dissertation, Fakultät Raumplanung, TU Dortmund, Dortmund.

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Date of Disputation: 18.08.2022

Declaration

With this, the author declares that all information in this academic work (Ph.D. thesis) has been independently and originally written and completed to fulfill the requirement for a Doctor of Engineering (Dr.-Ing.) degree. Also, as required by these rules and conduct, the author has fully cited and referenced all materials and results that are not original to this work.

Ahmad Sahraei Juybari

February 2023

Abstract

After the industrial revolution in the late eighteenth century, massive changes in the social and economic sectors occurred, particularly in cities. These changes have accelerated urban growth by providing more financial resources and opportunities for urban areas than rural areas. As a result, cities have become larger, more populated than rural areas, and urban issues have become more complex and serious.

The city of Sari, since the last decades, has been facing massive migration, uncontrolled land-use change, non-sustainable consumption of farmlands, and sprawling growth. Simultaneously growing the city, the city's issues became more challenging. Methodologically, this thesis benefits from methodological pluralism and seeks to analyze the city of Sari with attention to the defined objectives and questions in chapter one. Methodological pluralism involves employing multiple methods to obtain a value. Therefore, this thesis applied several mathematical models and softwares considering the types of data. Parts of the data were collected from the published data and reports by Iran’s national and regional organizations. Moreover, some of the data that were not available were collected through field works, surveys, and interviews with experts and managers. The results show that the current centralized political structure has made urban management ineffective and reduced public participation in the planning and executing processes. The results of the models for analyzing the urban system in the Mazandaran metropolitan area have shown agglomeration of the population in the urban areas, especially in the big cities, particularly in Sari. The urban system is centralized, and there is an imbalance between the size and rank of cities, especially in big cities. Also, the results of land-use change modeling and working with satellite images have shown that the city of Sari has been faced with massive sprawling growth, particularly during the last decades. And finally, the results of land-use changes analysis using GIS and aerial images have shown progressed unplanned land-use changes, particularly near the official border of Sari city.

Keywords: Planning system; Urban development; Land use changes; Land consumption; Urban sprawl growth; The Mazandaran metropolitan area; Sari city

Acknowledgments

It gives the author a great pleasure in expressing his most profound gratitude, especially to his supervisor, **Prof. Dipl.-Ing. Christa Reicher**, for her constant guidance, support, motivation, and untiring help. The author is very much obliged to her for her insightful comments and constructive criticisms at different stages.

Also, the author is grateful to his other supervisor, **Prof. Dr.-Ing. Frank Othengrafen**, for his patience and detailed guidance and suggestions during the completion of this dissertation.

The author also thanks **Prof. Dr. Sophie Schramm** for her support and acceptance as the chairperson of this dissertation.

The following thanks goes to the Faculty of Spatial Planning, Dortmund Catholic Student Community, AStA TU Dortmund, Prof. Sigrun Dechêne, Mitra Haghnegad and her family, Eva-Maria Stein Hoffer, and Horst Wessel "chef of the Moskito GIS Company."

The author wants to extend his heartfelt respect and deep appreciation to his dear caring parents, his precious and lovely one Eva-Carolin aCampo (Superheldin) and her caring parents, his dear sister Mobina, and his dear brothers Mohammad and Ali for their love and tremendous support throughout the whole process.

Also, this is a valuable opportunity for the author to thank all people who have supported him during his life to be in this stage of success, especially while writing this thesis.

Ahmad Sahraei Juybari

February 2023

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ABBREVIATIONS

MAXLIKE	Maximum Likelihood
LCM	Land Change Modeler
MLP	multilayer perceptron
TPM	Transition Potential Modeling
CA_MARKOV	Automaton Markov Mod
GLP	Global Land Project
LULC	Land Use and Land- Cover
IGBP	International Geosphere-Biosphere Project
IHDP	International Human Dimension Project
UCP	Urban Comprehensive Plans
USDA	Urban Sustainable Development Agendas
USGS	United States Geological Survey
GIS	Geographic Information System
GDP	Gross Domestic Product
IMF	International Monetary Fund
UN	United Nations
SCP	Sustainable Cities Program
HDI	Human Development Index
WCED	World Commission on Environment and Development
UNESCAP	The United Nations Economic and Social Commission for Asia and the Pacific
CIAM	Congrès Internationaux d’Architecture Moderne or International Congresses of Modern Architecture
UNECE	United Nations Economic Commission for Europe
Y_u	the annual growth rate of urban population
LQ	Location Quotient
TNi	the number of employments in i sector locally
TNa	Overall employment locally
CNi	the number of employments in i sector regionally or nationally
CNa	Overall employment regionally or nationally
Pi	Frequency
LnPi	frequency of the natural logarithm
TNC	Total number cities
NGOs	Non-Governmental Organizations

A	Small urban area
B1	Medium-sized cities (small-class)
B2	Medium-sized cities (big-class)
C1	Big cities (Medium-class)
C2	Big and very big Cities

Chapter One

Urbanization and Sustainable Land Use Planning Challenges in the Mazandaran Metropolitan Area,

the Case of Sari City

1.1. Introduction

Mazandaran metropolitan area is located in the north of Iran (4047964.32 m N, 684691.47 m E) and has 60 cities with about 1,943,378 urban population (Statistical Center of Iran, 2016). In this region, from the south, we have mountains with Caspian Hyrcanian mixed forests ecoregion, and from the north, is close to the Caspian Sea. Mazandaran also has valuable potentials, including temperate climate, tourism attractions, extensive agricultural activities, livestock, industries, services, commercial and marine activities, and is near to Tehran[1]. Most of the cities in this metropolitan area have placed in the coastal area and near the rivers and just some towns are placed in the plains and mountains (Figure 3) (Mazandtarh, 2009). This thesis believes that, all the above factors have increased land use changes and consumptions in this metropole. Since the last decades, the urban system in this metropole has been faced with centralization, and there is an imbalance between the distribution of population and the size of cities. As a result, the big-sized cities became overpopulated.

[1] the capital of Iran

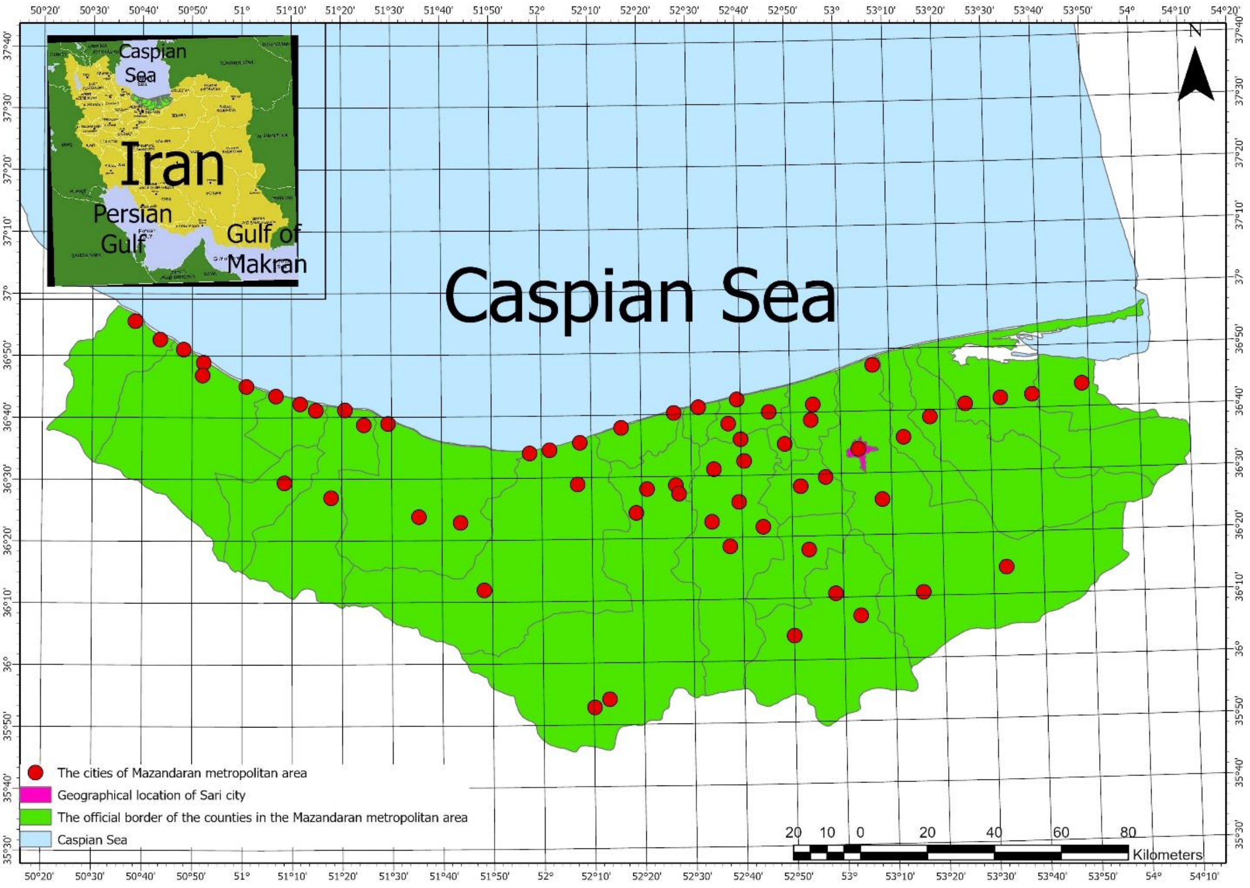


Figure 1 The geographical locations of counties and cities in the Mazandaran metropolitan area, (by the author)

Table 1 Population categorization in the Mazandaran metropolitan area (Statistical Center of Iran, 2016)

Groups of cities	Number of cities	Population size	Percent
C1	2	597619	30,75
B2	2	442481	22,77
B1	5	336289	17,3
A	51	566989	29,18
Sum	60	1943378	100

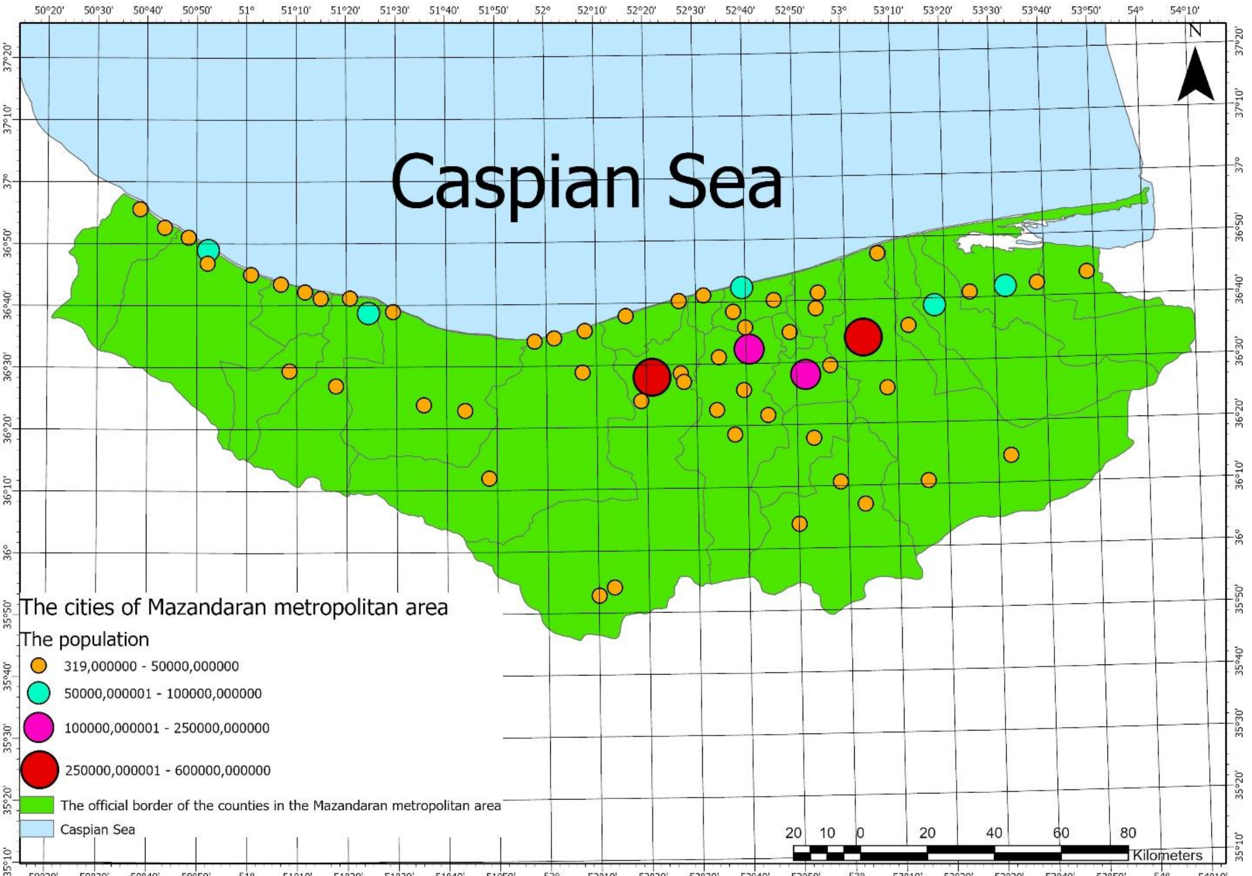


Figure 2 Classification of cities in the Mazandaran metropolitan area considering population (by the author)

Table 2 Calcification of Iran's urban areas based on the population (by the author)

classes	Urban Groups	Population
A	Small cities	less than 50000
B1	Medium-sized cities (small-class)	50000 to 99999
B2	Medium-sized cities (big-class)	100000 to 249999
C1	Big cities (Medium-class)	250000 to499999
C2	Big and very big Cities	500000 to 2000000

Urban sprawling growth, land use changes and building without permits are the most critical issue and challenge in this metropole, especially in Sari city.

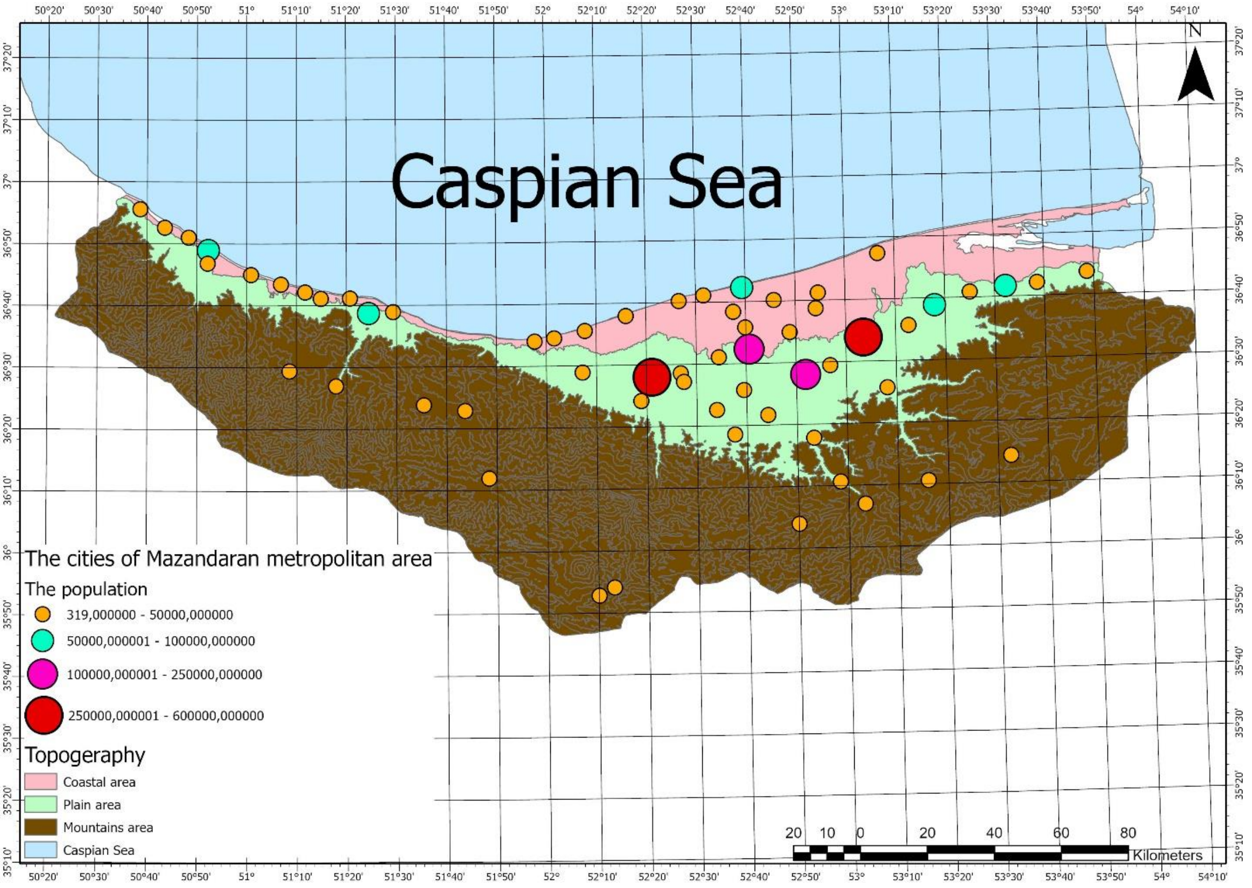


Figure 3 Topography of the Mazandaran metropolitan area and location of cities (by the author)

A city's functions and spheres of influence will change by changes in the economic, agricultural, industrial, servicing, and political forces. And any change in the mentioned sectors leads to new changes in urban land uses and land consumption. As a result, any significant change in urban land uses and activities will affect a city's functions and spheres of influence.

Table 3 The total population of the Mazandaran metropolitan area. Source: Analysed and classified by the author, 2021, and raw data from the (Statistical Center of Iran, 1956-2017).

Decades	1956	1966	1976	1986	1996	2006	2016
The total population	973964	1247102	1596565	2274862	2602008	2922432	3283582
Cities	156329	301729	511787	897667	1223326	1554143	1936662
Villages	817635	945373	1084778	1377195	1378682	1368289	1346920

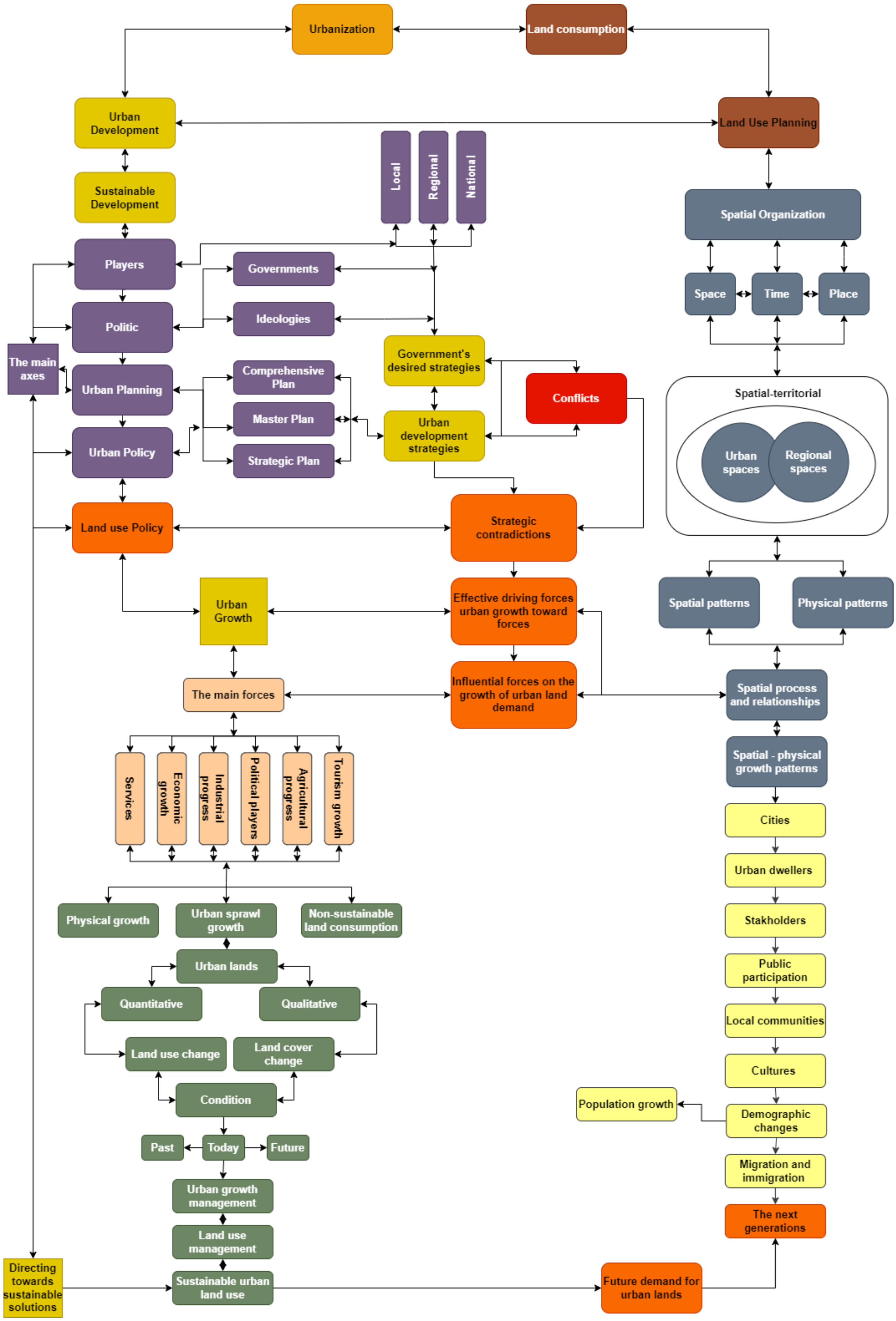


Figure 4 Conceptual model of this thesis (by the author)

Regarding this thesis, studying these forces such as economic, agricultural, industrial, political, tourism, and servicing is required to provide new and reliable findings on the land-use changes in Sari city.

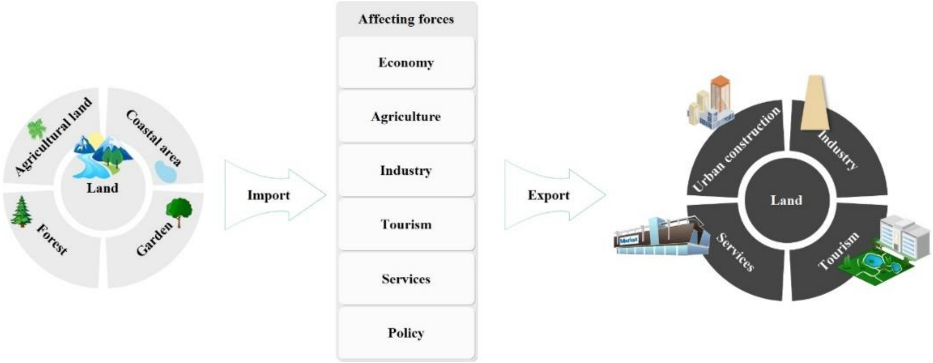


Figure 5 The main forces of land use change (by the author)

1.2. The city of Sari

Sari is located on the east side of the Mazandaran metropolitan area and is the capital of this metropole. The area of the city is about 5013.37 hectares. About 347402 people live in the official border of the city, and considering the peripheral area the city has about 504298 population. Sari has two different physical tissues, old and young. The old tissue is located in the core of the city, and the rest are young tissue that has been developed generally since 1935 by today.

Table 4 The changes of urban-rural population growth at the Sari city and district levels. Source: Analysed and classified by the author, 2021, and raw data from the (Statistical Center of Iran, 1956-2017)

Decades	1956	1966	1976	1986	1996	2006	2016
Total Population of Sari District	129168	204982	262877	370515	422461	490830	504298
The Population of Sari City	27037	44547	70753	141020	195882	259413	347402

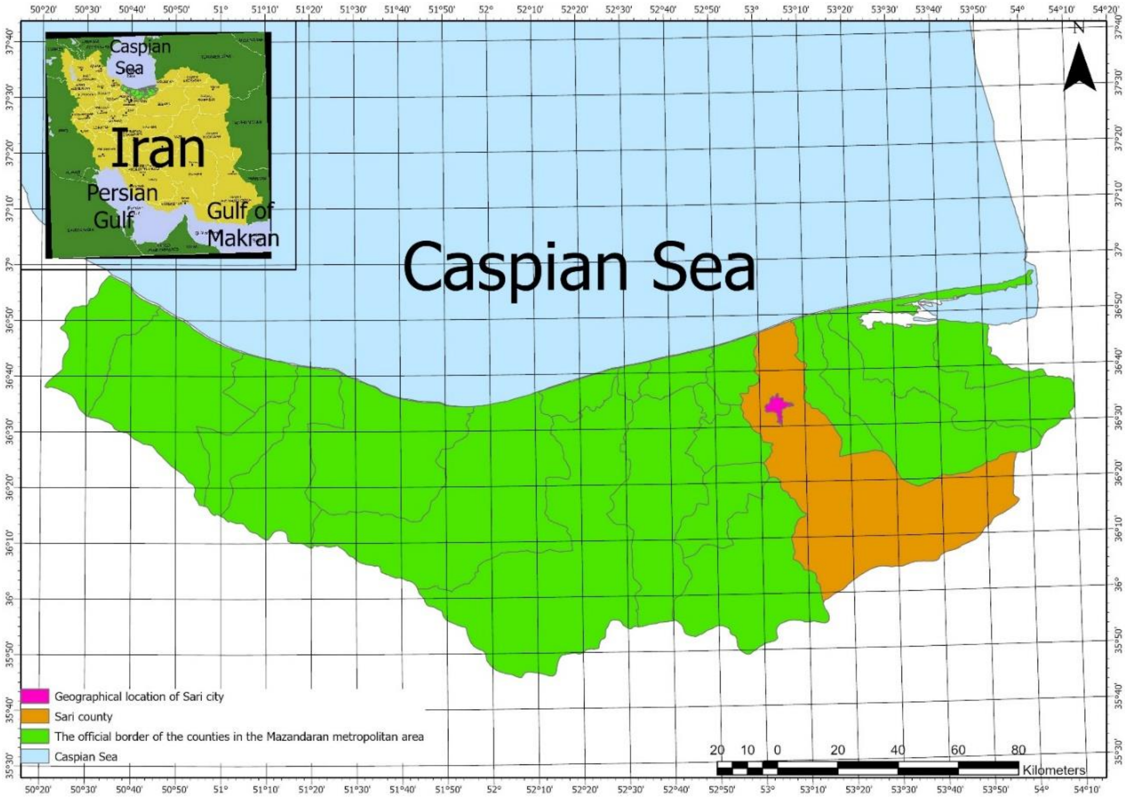


Figure 6 The geographical position of Sari county and Sari city (by the author)

Despite implementing several development plans to control urban growth and prevent land use changes in Sari, the city still could not control this trend. The city has grown non-sustainable and uncontrolled on valuable farmlands, particularly in recent decades.

Lack of clear and effective development policies have faced manage of cities and control of land resources with many difficulties locally and regionally. The current inefficient planning frameworks and ineffective administration performances made planning acts in Iran complex and most of development plans could not be implemented successfully.

This thesis believes that identifying and studying the major factors of land-use changes of Sari city can help understand better the causes of this problem and propose effective solutions.

1.3. Research questions

This research is issue-oriented and seeks to find the relationships among the mentioned forces that have increased and-use change and non-sustainable consumption of the farmlands. Accordingly, the questions are sorted into two groups. The main question is solution-oriented and seeks to solve the current issue. And the subsidiary questions are issue-oriented and seek a cause-and-effect relationship that has emerged from the problems mentioned above.

1.3.1. The main question

How can drive the uneven and destructive spatial pattern of urban development and intense land-use changes of Sari city toward a balanced and sustainable path? (Solution-oriented and directed question)

1.3.2. The subsidiary questions

- How is the pattern of urban development in the Mazandaran metropolitan area considering the population distributions in the cities and the place of Sari city in this region? (Correlational and directed question)

- What development forces have intensified land use change and consumption in this city, and how? (Relational-analytical question)

- What are the causes of instability and increasing land-use changes in Sari, and what factors play a role in exacerbating it? (Relational-analytical question)

1.4. Research propositions

- Centralization and inefficient planning system have progressed a ploralized form of regional development and intensified unequal distribution of opportunities, infrastructures, and facilities not only between urban and rural areas.

- Sectoral development has unbalanced urban hierarchies in the Mazandaran metropolitan area and intensified urban-rural migration.

- Centralization has affected the management of cities, and processes of planning and executing urban development plans negatively.

- Centralization, and sectoral development policies have intensified the urban sprawl growth, land-use change, and non-sustainable consumption of valuable agricultural lands.

1.5. Research objectives

1.5.1. General objective

One of the main goals of this thesis is to identify the most influential forces of the non-sustainable urban development in this metropolitan area, particularly in Sari. And providing solutions for promoting a sustainable form of urban development, land-use planning, and land consumption in this metropolitan area, and particularly for the city of Sari?

1.5.2. Specific objectives

- Studying the nature and structure of the urban system and the spatial development of cities in the Mazandaran metropolitan area (with an emphasis on Sari).

- Identifying the main forces that have intensified unequal urban-spatial development in this region and its effects on the instability of urban lands.

- Review and assess the effects of the agricultural, industrial, political, services, and economic factors on the development pattern of cities, spatial-physical elements, and determine the impact of these factors on the sprawling growth, land use change, and land consumption.

1.6. Methodology

Methodologically, this thesis benefits from a commitment to methodological pluralism and seeks to alaysis the sity of Sari considering the defined objectives and questions. This thesis has studied the city of Sari and its relations at the regional and national levels. Several research methods were used in this study considering the aims and types of data.

1.6.1. Methods and tools for data collection

For the documentary studies this thesis has used books and scientific papers.

The quantitative and statistical data were collected from the following organizations and platforms: The Ministry of Housing, Roads and Urban Development; Statistics Center of Iran; National Budget and Planning Organization; Consulting firms as the provider of urban development plans, USGS, and Google earth.

- The other part of the data that weren’t available collected through fieldwork and survey.

1.6.2. Data analysis

The following models were applied for analyzing the collected data,: Modified Exponential Model, Linear Regression Model, (LQ) Location Quotient – Lorenz Curve – The Rank – Size Rule –Zipf’s law, Entropy Index – The Gini coefficient, Isard's Longitudinal and Transverse Model – Location Coefficient- Land Change Modeler (LCM)- MAXLIKE, MARKOV, Cellular Automaton Markov Model (CA_MARKOV)

The Excel software is used for running the above mentioned mathematical models and analyzing the data.

For remote sensing and land use change modeling this thesis has used the software IDRISI Selva to analyze the physical growth of Sari city, land use changes and sprawl growth. Also, for mapping and generating thematic maps this thesis used the ArcGIS, GIS-Pro and Google Earth.

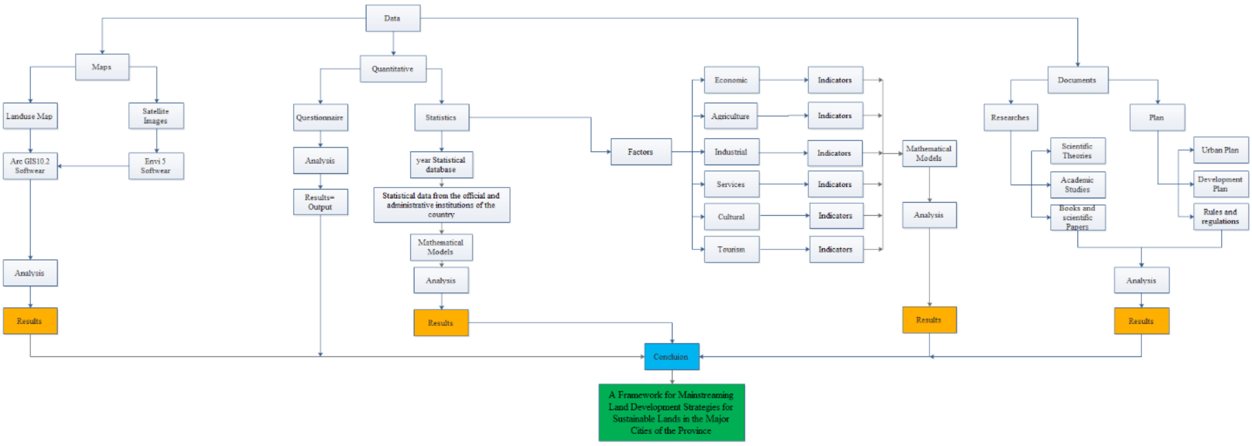


Figure 7 Conceptual model of this Ph.D. thesis considering methodology and data analysis processing (by the author)

1.7. Innovation

In order to provide reliable results, this thesis has studied these main economic forces, including agricultural, industrial, servicing, and political factors in this thesis. It has helped to understand better Iran’s urbanization considering the planning and political system, urban development policies, and urban development plans. Additionally, it was helpful to find the reasons of inefficient urban planning in Iran, and the forces of non-sustainable land use changes and land consumption. Accordingly, this thesis has studied all national development plans, official reports, and all implemented urban development policies and strategies since 1908 by 2020.

1.8. Limitations

Knowing about the limitations of this thesis can help to prevent any possible problems that can make the results invalid and unreliable.

1.8.1. Personal limitations

The thesis aims to obtain significant results through the correct data and provide solutions concerning the research questions and objectives. Therefore, this study is responsible or being neutral in all steps of this thesis.

1.8.2. Research limitations

Data limitations and collecting correct data are one of the main challenges of this thesis. Some types of data that were available, were collected from the published data and reports by Iran’s national and regional organizations. But, for the group of data that were not available, the author collected them through field works, surveys, and also interviews with experts and managers.

Chapter Two

Urbanization, forces, changes, and challenges

2.1. Anthropogenic urbanization

Urbanization is the implication of changes in the human lifestyle. Changing and developing the human lifestyle from a caveman to a nomadic lifestyle helped emerge of tribes and small communities. Humans learned how to save themselves against natural threats and control and manage the natural environment. And later, they learned how to construct shelters, big towers, and castles with more security and defense systems. These places were the first sample cores of civilization and the small size of today's cities with hundreds or thousands of inhabitants. But later, civilization and more security helped humans to construct new settlements in open spaces, which finally led to the emergence of the first generation of today's cities and towns. From thousands of years ago, cities' type and form have been changed and developed depending on local conditions. This thesis regarded cities as an anthropogenic phenomenon, and their structure and forms have become more complicated considering humans' mind complexity and progressity.

In continue this thesis has provided some definitions of "urbanization."

Urbanization is one of the significant global trends that have been growing in most countries since the 1880s, concerning the agglomeration of population and socio-economic changes (C. Weber, A. Puissant, 2003), (Antrop, 2004).

Urbanization is a social development with growth in the size of population and area of cities (T.V. Ramachandra, H. A. Bharath, M. V. Sowmyashree , 2013) (Yasuhiro Sato a, Kazuhiro Yamamoto, 2005).

Urbanization is the result of complex and dynamic economic growth that happens at multiple scales of space and time (Thomas Elmqvist, Michail Fragkias, Julie Goodness, Burak Güneralp, Peter J.Marcotullio, Robert I. McDonald, Susan Parnell, 2013), (Tim Dyson, 2011).

2.2. The major aspects of the contemporary urbanization

During the last decades, the non-sustainable urban growth has been faced the world with global issues. And depending on the local conditions, the intensity of its negative effects was different. Most of today’s urban issues are air pollution, urban disease, climate change, crime, overcrowdingn, and non-sustsinable land use changes (Gotham K. , 2012). Urbanization after the industrial revolution was very different from before. From the viewpoint of this thesis, the following aspects are the aspects that distinguish contemporary urbanization from the time before the industrial revolution: (1) scale, (2) rate, and (3) size.

2.2.1. The scale of urbanization

The scale of urbanization relates to population size, activities, economic growth, geographical location, and environmental limitation. Today's cities are very bigger and more agglomerated than the cities from before the 1880s. For example, today, there are about 36 megacities in the world that are massively agglomerated with more than ten million populations. For instance, the metropole Tokyo-Yokohama has more than 38 million populations in an area of 13,500 km2, which is bigger than Jamaica with 11,000 km2 Figure 8.

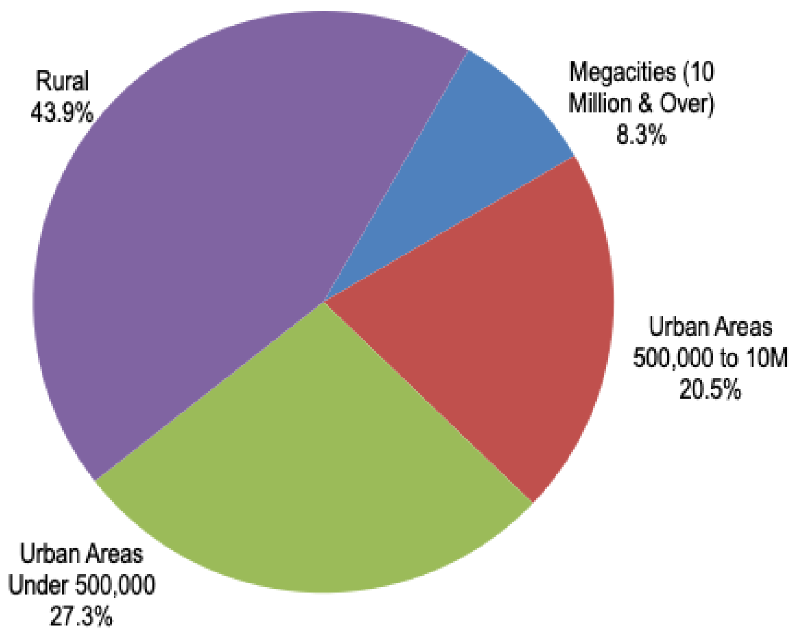


Figure 8 The distribution of the world population (Cox, 2021)

As presented in the above graph, the most populous urban areas are the 36 megacities, each with more than 10 million residents. Megacities receive outsized attention due to their influence in media, finance, and tourism, but they have only 14.8% of the urban population and 8.3% of the world population. The other urban areas in Demographia World Urban Areas (between 500,000 and 10 million) account for 20.5% of the world population, while smaller urban areas have 27.3% and the rural regions 43.9%.

2.2.2. The rate of urbanization

The high rate of urban growth is the other considerable aspect of contemporary urbanization. According to the statistical data, the rate of urban population has been growing globally particularly since the 1950s (Figure 9) (Adesoji David JIBOYE, 2011) (Giovana Mira de Espindola a, 2017). United Nations in the year 2010 published the "World Urbanization Prospects" report and predicted that the urban population between 2010 – 2030 will grow by about 1.4 billion globally. Which accounts for about 60% of the world's population (Shen, Z., 2012). However, in 2020, more than 56.12% of the world's population lived in urban areas (See Figure 10) (UN, 2011). Therefore, this thesis predicts that the world's urban population will be more than 60% by 2030.

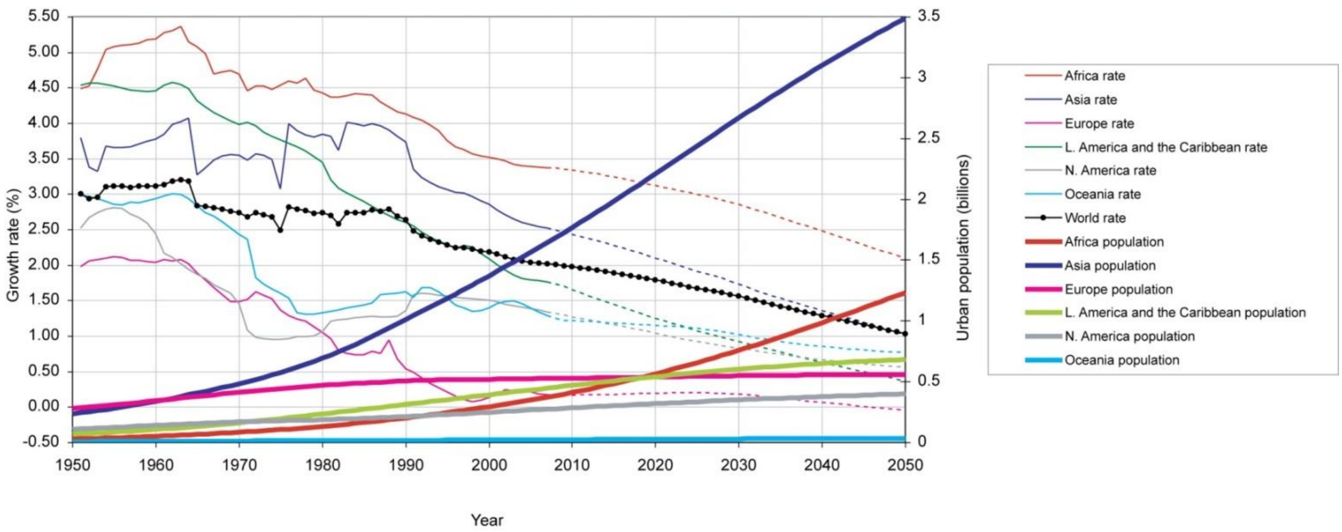


Figure 9 The world's urban population growth by region (Karen C. Seto, Roberto Sanchez-Rodrıguez, Michail Fragkias, 2010)

As presented in the above graph, the thin lines denote rates of change; the thick lines represent magnitudes. The dashed lines represent United Nations projections.

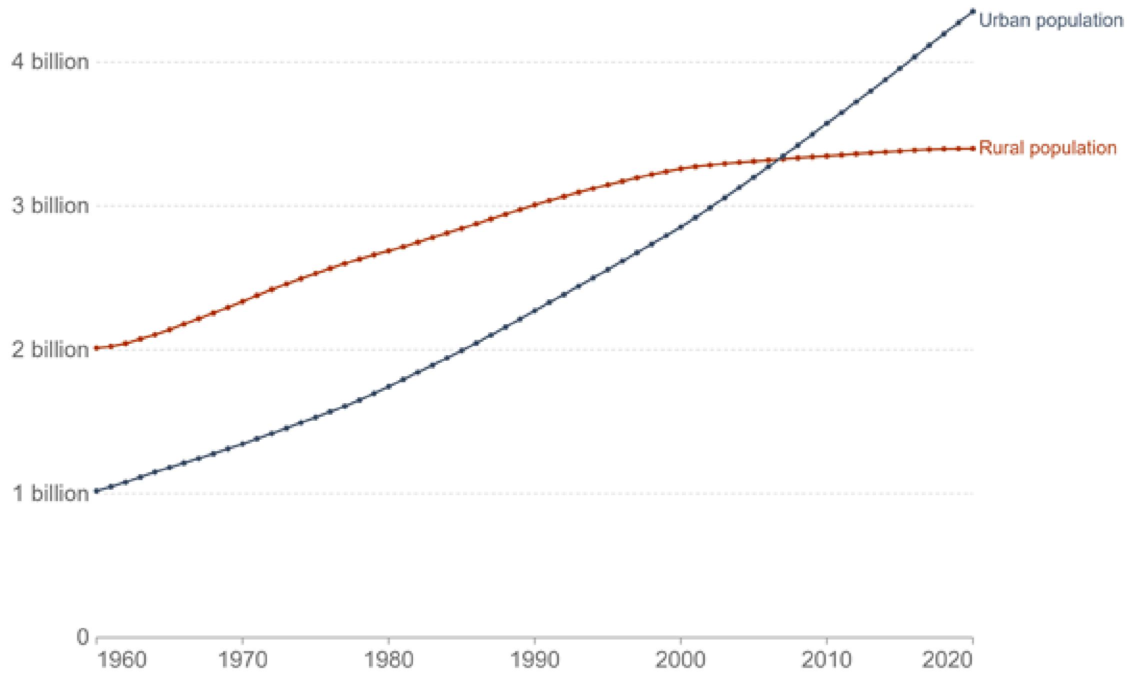


Figure 10 Number of people living in urban and rural areas globally , 1960 to 2020 (ourworldindata, 2021)

2.2.3. Urbanization and size of cities

Since the 1950s, researchers have identified some major changes in urban areas that have intensified global issues, including changes in urban interactions, health, nonstop urban-rural migration, increase in urban population, and non-sustainable urban growth (Karen C. Seto, Roberto Sanchez-Rodrıguez, Michail Fragkias, 2010).

According to the studies, the most rapid-urbanized regions are located respectively in Asia, Africa, Europe, and South America. But, it should be noted that the Western European countries and North America, because of industrialization and economic development, have experienced urban development some decades earlier than the other countries (Anett Hofmann, Guanghua Wan, 2013). For example, the demographic changes of the following cities from 1 million to 8 million has taken about 130 years for London, 45 years for Bangkok, 37 years for Dhaka, and 25 years for Seoul. In the 1970s, the numbers of megacities with 10 million populations or more were not more than three cities. But today, we have about 38 megacities, which will increase to 41 cities by 2030. Also, up to the 1970s, just about 15b"large cities" were in the world, but today we have 43 big cities, which are projected to be about 63 cities by 2030. Additionally, medium – and small-sized cities have also grown simultaneously (see Figure 11) (Thomas Elmqvist, Michail Fragkias, Julie Goodness, Burak Güneralp, Peter J.Marcotullio, Robert I. McDonald, Susan Parnell, 2013).

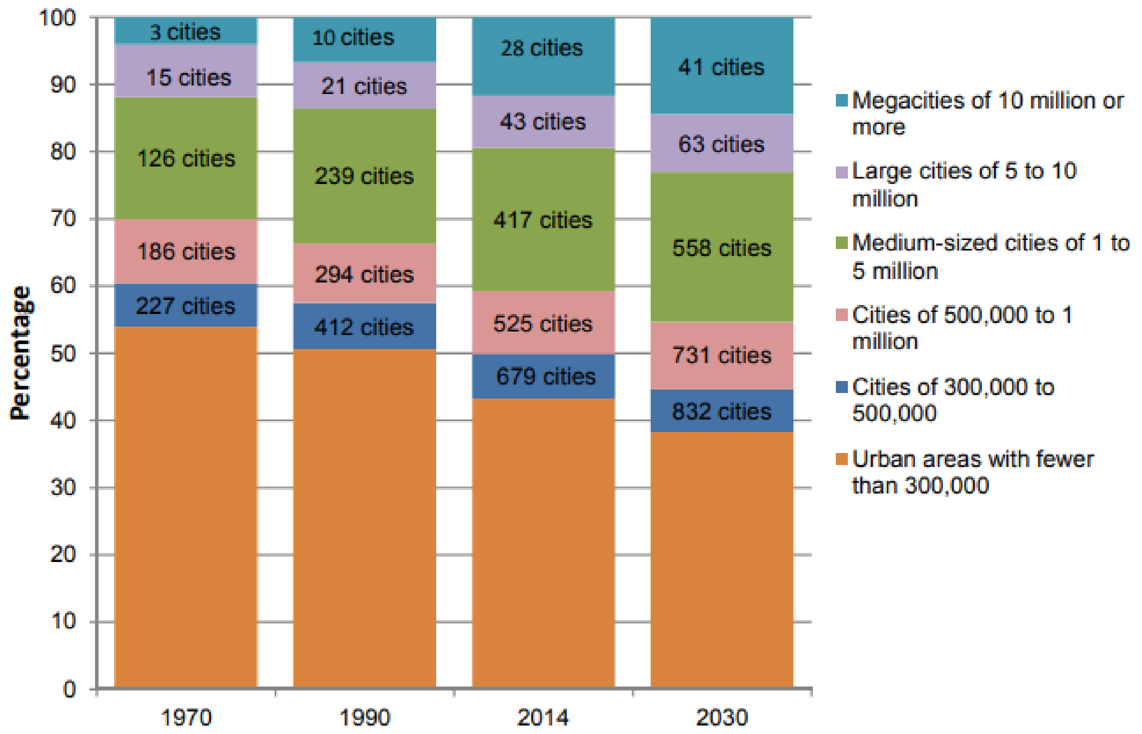


Figure 11 Classification of the urban population considering size and number of cities globally, between1970 to 2030 (United Nations, 2014).

2.3. Drivers of urbanization

Analyzing socioeconomic changes help to identify some significant drivers of urbanization and also understand this process better. Usually, the reason for the migration of people from rural to urban refers to their needs and goals. For this group of people, migration can be an option to reach their goals or meet their needs better and easier than where they live. The advantages of a destination encourage people to migrate, or some disadvantages of where they live have forced them to migrate.

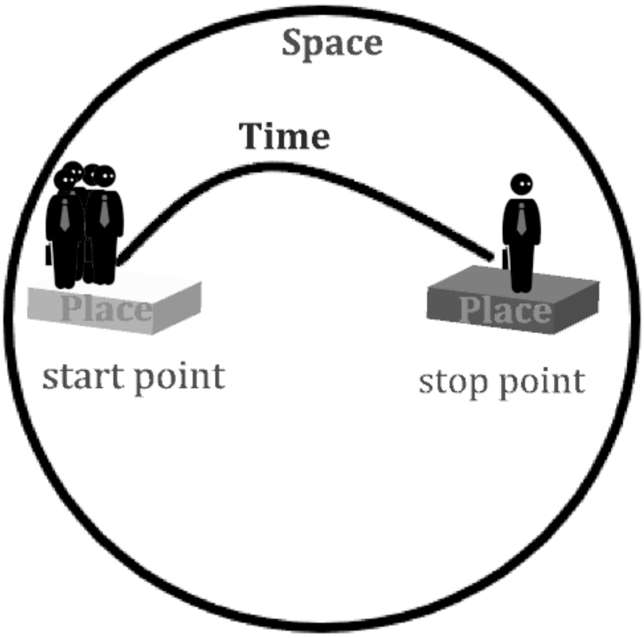


Figure 12 Conceptual model of migrations between places within space and time (by the author)

Hence, this thesis studies these issues considering the factors of time and place. As represented in the above conceptual model of the migration (Figure 12), there are two places: 1- The start point and 2- The stop point. The start point is where persons want to move from one place to another, which can be an urban or rural area. And the Stop point refers to a destination. It should be noted that considering the factor of time, migrations can be temporary or permanent. And space contains all of them, including people, places, mobility, and time.

Of course, needs and how people meet their needs will affect their decisions and places to migrate. And a need can change by change in the social-economic sectors.

And most of the changes in the social-economic sectors occur under development policies, which are generally made by policymakers.

These elements have two different types of connections as follow: 1- Internal connections and 2- External connections

1- The internal connections refer to a **linear relation and interaction between the elements** in a one-dimensional space Figure 13.

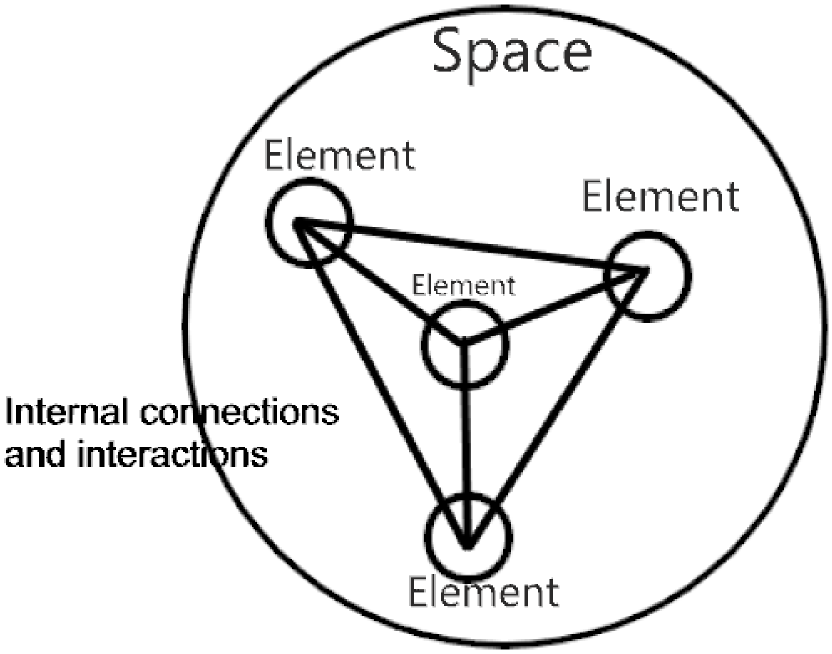


Figure 13 Internal connections and interactions among elements in an one-dimensional space (by the author)

1. The external connections refer to the relations and interactions between elements and spaces in multiple-dimensional spaces. Here, the elements are the junctions that provide a possibility for connecting and linking many spaces together. They establish multi connections between elements for "effecting on" or "to be affected from" (Figure 14). As a result, they provide multi circular flows and interactions between spaces to create multiple spaces. Multiple spaces can be grouped and classified. And each group can

include many spaces but may belong to other groups or another bigger group.

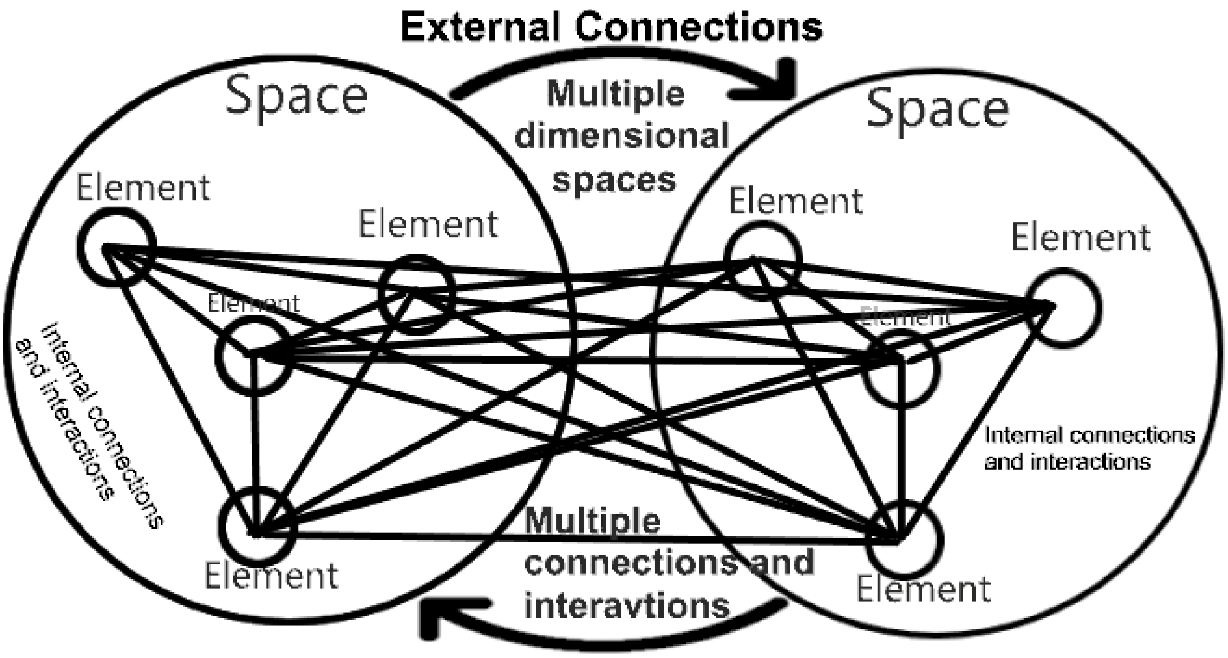


Figure 14 In- External connections and interactions between spaces and elements in multiple dimensional spaces (by the author)

For example, implementing an ineffective urban development policy in a place can negatively affect other places' development of a region. It means implementing an ineffective development policy can, through the junctions, affect spaces and even change them. In this regard, this thesis believes that, increasing urban-rural migration follows the above rule. Implementing non-sustainable development policies, unequal distribution of resources, and attention to cities more than villages have increased inequality, urban-rural migration, and created different landscapes of development. Furthermore, this study has provided some statistical data that helps understand better the drivers of urbanization and how the proportion of the urban-rural population has ended in the benefit of the cities.

Considering the report of the United Nations, rural areas had about 442.45 million people, and urban areas had about 18.92 million population before 1500 BC[2]. In other words, about % 95.9 of the world's population lived in rural areas and %4.1 in urban areas.

Between 1500 – 1600, rural areas had about 525.15 million population, and in urban regions with a %1.1 increase had about 28.82 million people.

Between 1600 – 1700, rural areas had about 527.41 million people and urban areas with a %0.1 increase had about 30.75 million population.

Between 1700 – 1800, rural areas had about 917.56 million population and urban areas about 72.26 million people.

Between 1800-1900, rural areas had about 1.38 Milliard people and urban areas about 270.6 million.

Between 1900 – 2000, about 3.28 milliard people lived in rural and about 2.87 milliard people in urban areas. The world was faced with an extreme decrease in the rural population, and a remarkable increase in the urban population (Figure 15)**.** It is projected that, about 3.09 milliard people will be settled in rural areas by the 2050s, and 6.68 milliards in urban zones.

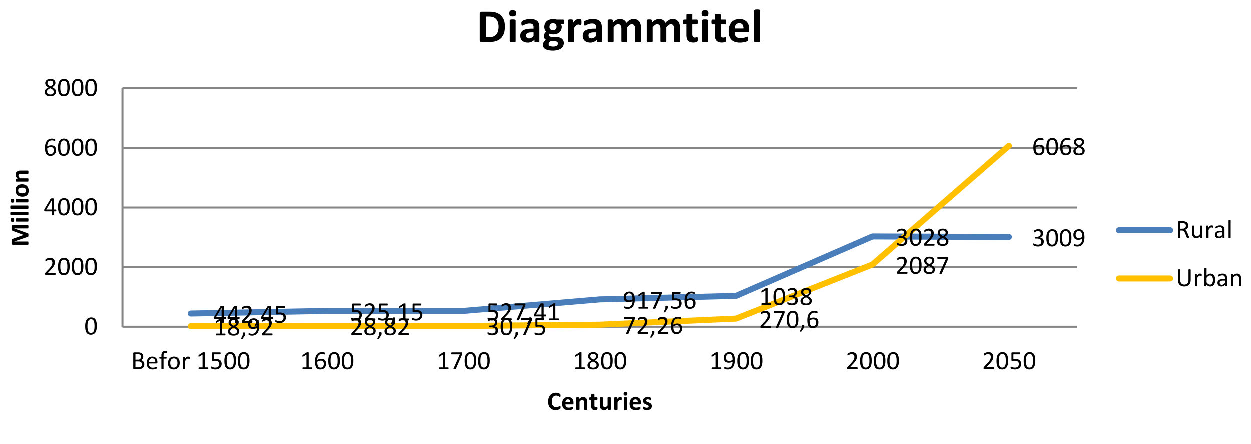


Figure 15 Urban and rural demographic changes over centuries (ourworldindata, 2021)

2 before Christ

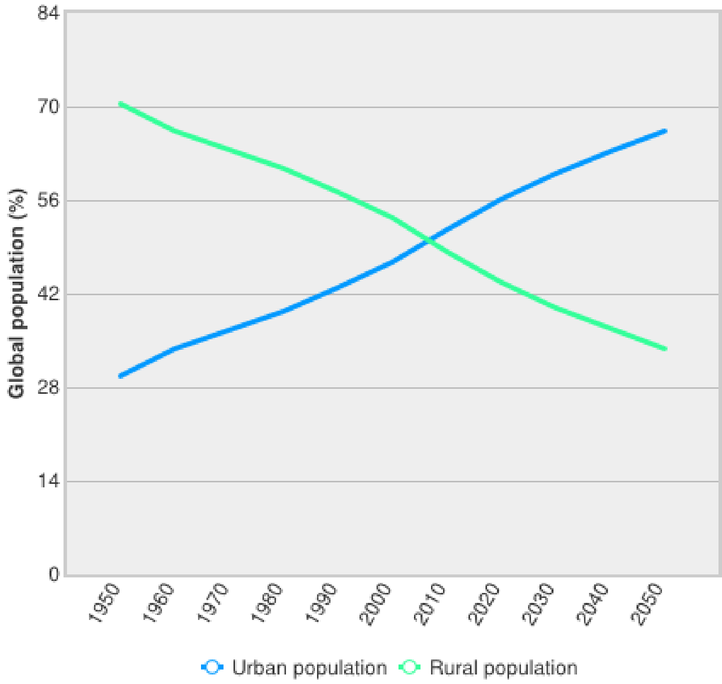


Figure 16 Percentage of the global population living in urban areas from 1950 to 2050 (World Health Organization, 2018)

Between the 1500th and early the1700th, in general political factors, military power, geographical location, trade and environmental potentials had played considerable roles in the emergence and development of cities. About more than 90 percent of people worked on farmlands, which has escalated the population of rural areas. The population change between these centuries was very low Figure 15.

Since the middle of the 1700th occurred, the first significant growth change in the rate of the urban population. Particularly after the beginning of the industrial revolution Figure 15. The Industrial Revolution has progressed urbanization by providing new job opportunities but led to the massive migration of people from rural to urban areas. Also, the emergence of philosophers and economic theoreticians like Karl Marx with new ideas for reforming political structures and economic systems were the other primary drivers of urbanization, particularly in western countries. Capitalism and moving toward economic prosperity through the construction of heavy, semi-heavy, and light industries, massive production, and promotion of consumerism were the other forces that have accelerated urbanization. On the one hand, constructing thousands of factories around urban areas had increased the need for new workers. And on the other hand, these had increased the needs to new educational, health, transportation, and entertainment infrastructures and new buildings for settling new migrants. So, these factors have developed urbanization and expanded urban growth. But, rural areas became just a place for producing agricultural goods to provide the needed daily foods of cities.

Technological development is the other driver of urban growth that has progressed urbanization remarkably. The development of new transportation systems has provided comfortable, faster, and secure vehicles, which have decreased the time of trips and increased the transport of people. Also has enabled people to have jobs in other places far from where they live. It also has developed the interactions between cities at the regional or national and global levels, and reformed international economic and political systems.

It should be noted that, the revolutionary effects of technological development are not limited to transportation systems. Technological development has changed today’s lifestyle, communications, and created new social and cultural values. For example, new generations of smartphones, social media, and online marketing have changed or even, in some cases, reformed daily trip patterns, mobility, and human behaviors. Technological development has provided the basis for the emerg of today’s smart cities, which will be a dominant form of tomorrow's cities. In tomorrow's cities, robots will be one of the main drivers of urbanization, with revolutionary effects on urban transportation systems and providing other services.

2.4. Cycles of urbanization and counterurbanization

American geographers have defined the concept of counterurbanization for the first time. Considering capitalism, they have conceptualized this theory to study the general socioeconomic aspects of urbanization at the regional and national levels (Vartiainen, 1989). Counterurbanization means the deconcentration of the population from agglomerated urban zones towards urban peripheries or rural areas (Dematteis, 1986). In her study on "Making Sense of Counterurbanization," Clare Mitchell defined Counterurbanization as a contemporary phenomenon resulting from changes in social-physical preferences between space and place (T.G. Nefedova, N.E. Pokrovskii, A.I. Treivish, 2016).

In general, counterurbanization has four phases as follows (Figure 17).

1- Urbanization 2, suburbanization 3, Counterurbanization 4, reurbanization

The first phase is "**urbanization**," which is defined as a concentration of population in the city centers. In this phase, the direction of the population is from urban fringes or non-urbanized zones into the official borders of cities (Marc Antrop, 2004).

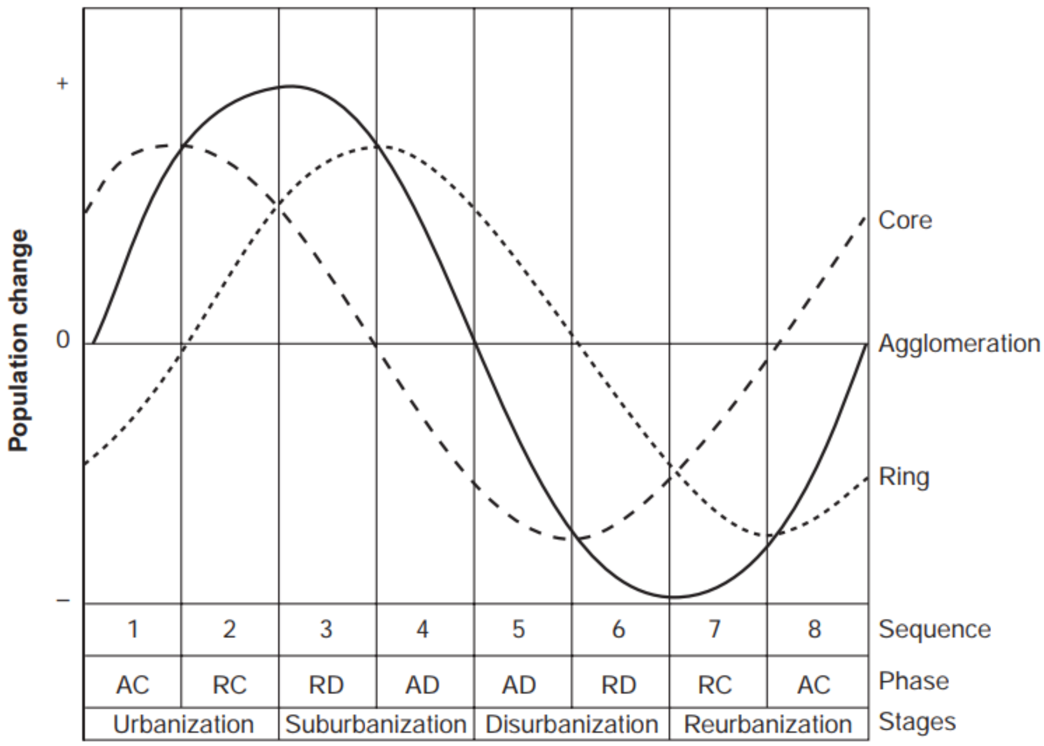


Figure 17 Modelling the phases of urban development. Meaning of the abbreviations: – A, absolute; R, relative; C, centralization; D, decentralization (Paddison, 2001)

The second phase is "**suburbanization**," and in this phase, cities will face rapid population growth due to the overflow of the migration from the inside of cities' official borders towards urban edges and, finally, emerge of suburbans. Today's urban inner-zone issues are the main reasons that have forced people to live in the suburbs. The development of urban infrastructures and transportation systems has facilitated suburbans' accessibility to travel to other urban zones easier and faster (Matthiessen, 2013).

The third phase is "**Counterurbanization**," and cities will face a decrease in the size of population and people will move from the inside of cities toward non-urbanized areas (Antrop, 2004). Actually, it implies demographical and social-economic deconcentration (Corey, 2013). This phase has two main aspects as follow: (a) physical expansion of suburban zones, (b) moving from urban to rural areas because of change of human needs and finding new places to meet their needs (T.G. Nefedova, N.E. Pokrovskii, A.I. Treivish, 2016).

Given researchers, in general, counterurbanization happened in regions that have experienced suburbanization (Antrop, 2004), (Vittorio Gargiulo Morelli, Kostas Rontos, Luca Salvati, 2014). These processes of urbanization, suburbanization, and counterurbanization have a cyclical process, which semas to be as a form of differential urbanization (Tiit Tammaru, Hill Kulu, Inga Kask, 2013). But regarding this thesis, based on the report of the United Nations (see Figure 16), today more than 50% of the world's population is living in urban areas, which will be more in the following decades.

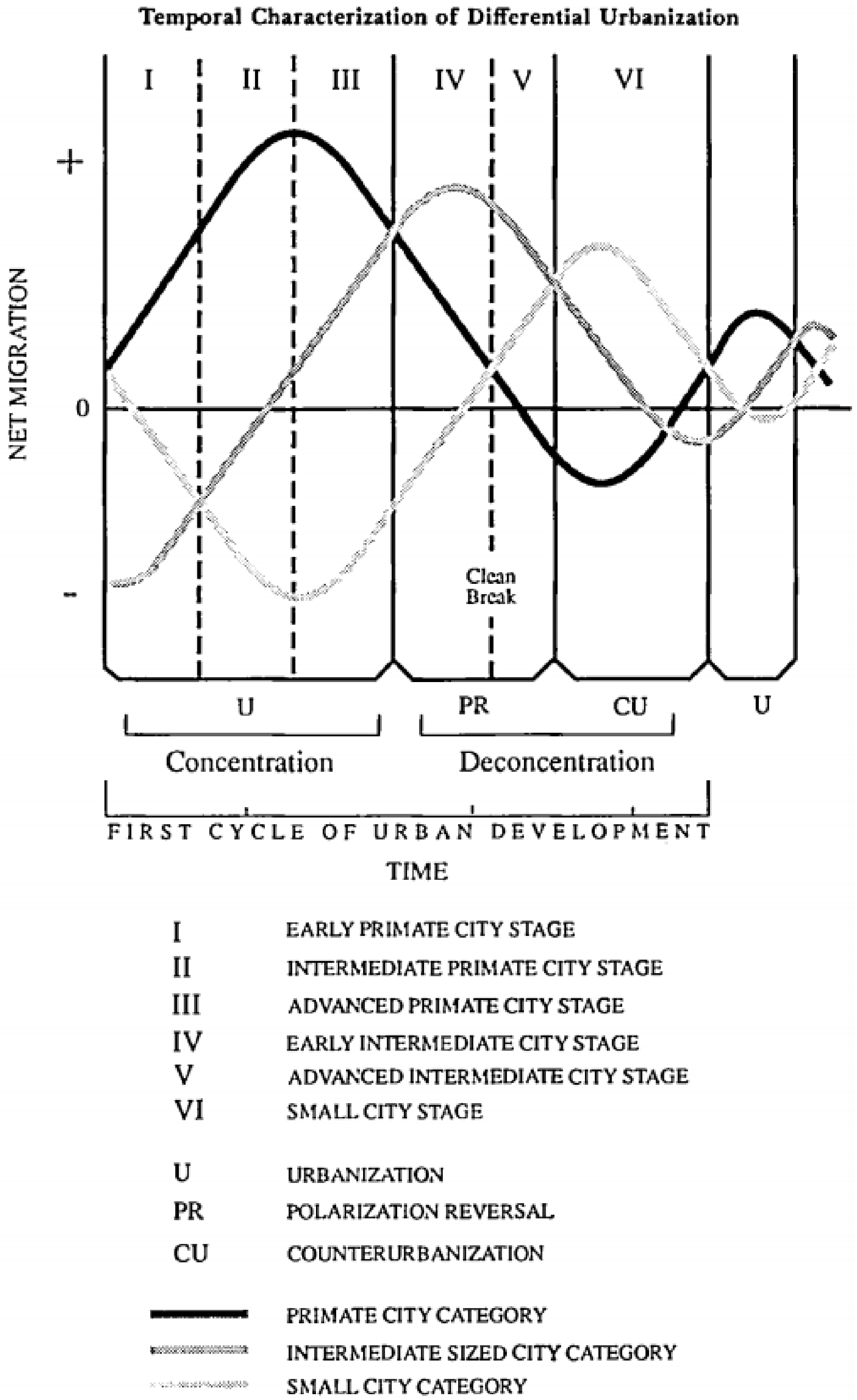


Figure 18 Temporal Characterization of Differential Urbanization (Hermanus S. Geyer, Thomas Kontuly, 1993).

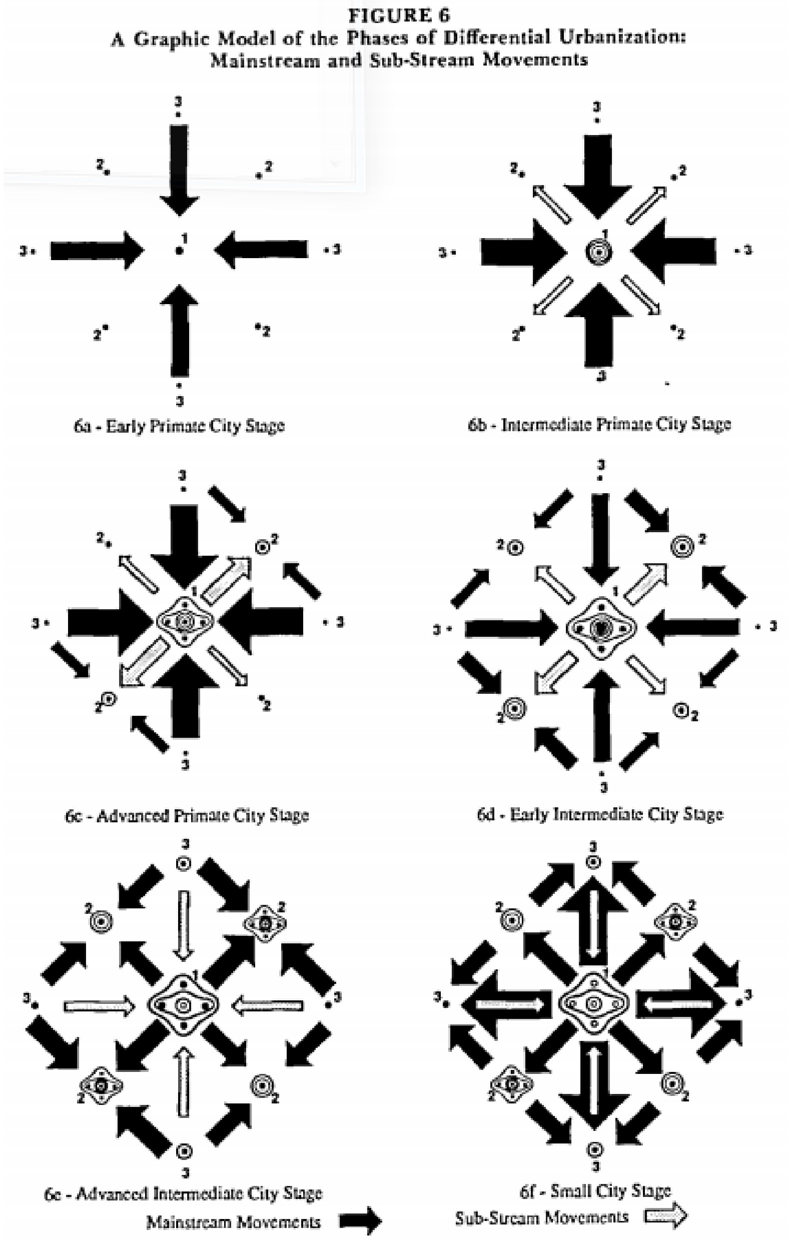


Figure 19 The conceptual model of the Phases of Differential Urbanization: Mainstream and Sub-stream Movements (Hermanus S. Geyer, Thomas Kontuly, 1993).

Coclirane and Vining (1988) in their study have argued that in the counterurbanization phase, according to the acceleration of changes between the core and periphery areas, the time to mobilize everything to face reurbanization is short (Hermanus S. Geyer, Thomas Kontuly, 1993). Also, the results of Klaassen and Van den Berg's study on European cities development have shown that each phase of cities' development is specified by a particular spatial pattern of shrinkage in cities' core or growth in other rings, including suburban. Also, they have argued, suburbanization happened between the decades 1950-1960, while in some European countries, happened counterurbanization between the 1970s and 1980s (Manisha Jain, Stefan Siedentop, Hannes Taubenböck, Sridharan Namperumal, 2013). Moreover, Dematteis, in 1986, argued that the following main factors have accelerated counterurbanization in Italy: 1) socio-cultural and historical backgrounds 2) housing market, 3) developing industrial activities in urban peripheries and deindustrializing urban zones with many factories that were placed inside of cities' official borders. He argued that the new spatial structures are the results of the counterurbanization and conflicts between dominated forms and forces (Giuseppe Dematteis, 1986).

The fourth phase is named "**reurbanization**" and in this phase, the direction of the population is from the outside towards the inside of cities' official borders (Antrop, 2004).

2.5. Continental urbanization

Implementation, Experiences, and Outcomes

2.5.1. Urbanization in Europa

Historically, pillars of today's urbanization in Europe were founded in Southeast Europe in 700 B.C. and slowly has been developed throughout this continent (Marc Antrop, 2004). Urbanization is closely related to political structures, economic development, and industrial progress in this continent. About two hundred years ago, happened industrialization in West Europe, and consequently pushed millions of people from rural to cities and triggered rapid urbanization (Michael Wegener, Klaus R. Kunzmann, 1993). Industrialization has accelerated the construction of new industries and transportation facilities. This economic transition caused significant changes in social structures and spatial forms and urban growth (Gotham K. , 2012).

2.5.2. Urbanization in North America

Between 1880 and 1929, the industrialization has progressed urban growth in the United States Figure 20. During this time, cities‘ buildings became bigger and higher (Gotham K. F., 2012), because of the agglomeration of capital, population, proximity, nearest accessibility to the resources, and economic growth (Rees, 2016).

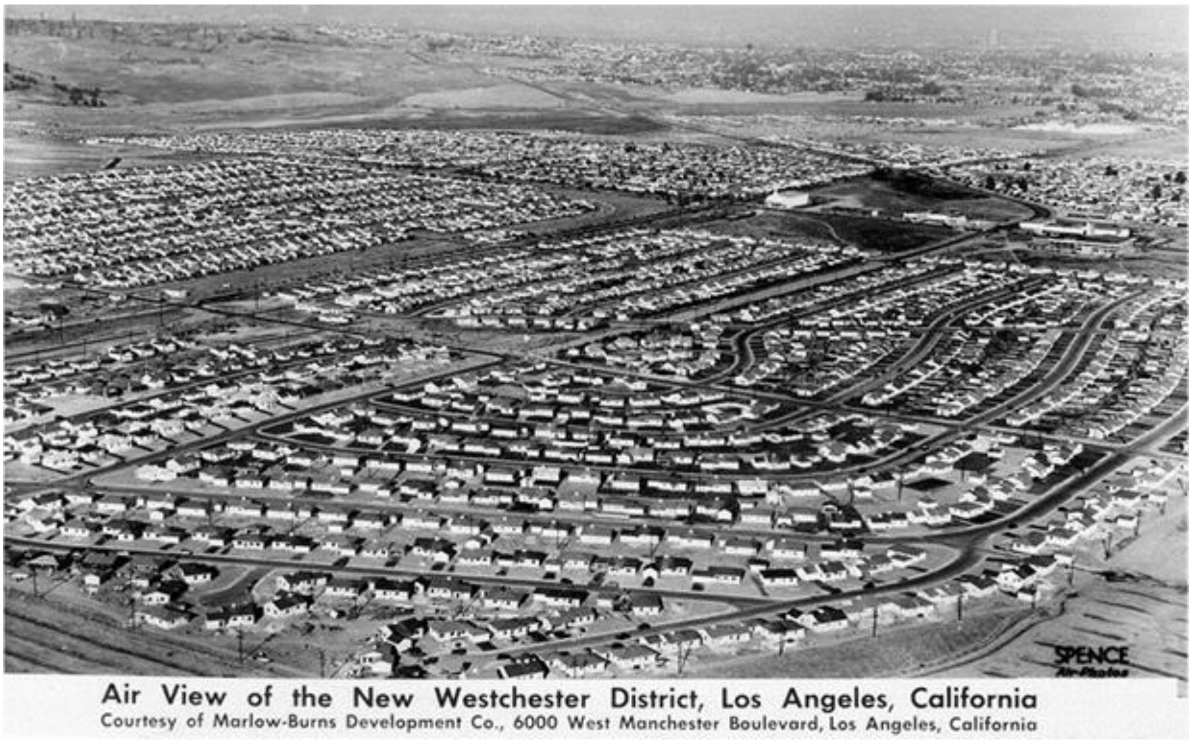


Figure 20 Pioneer mass-builder Fritz Burns developed Westchester in the late 1930s, devising many of the mass-production techniques adopted by postwar suburban builders through the United States (Becky Nicolaides, Andrew Wiese, 2017).

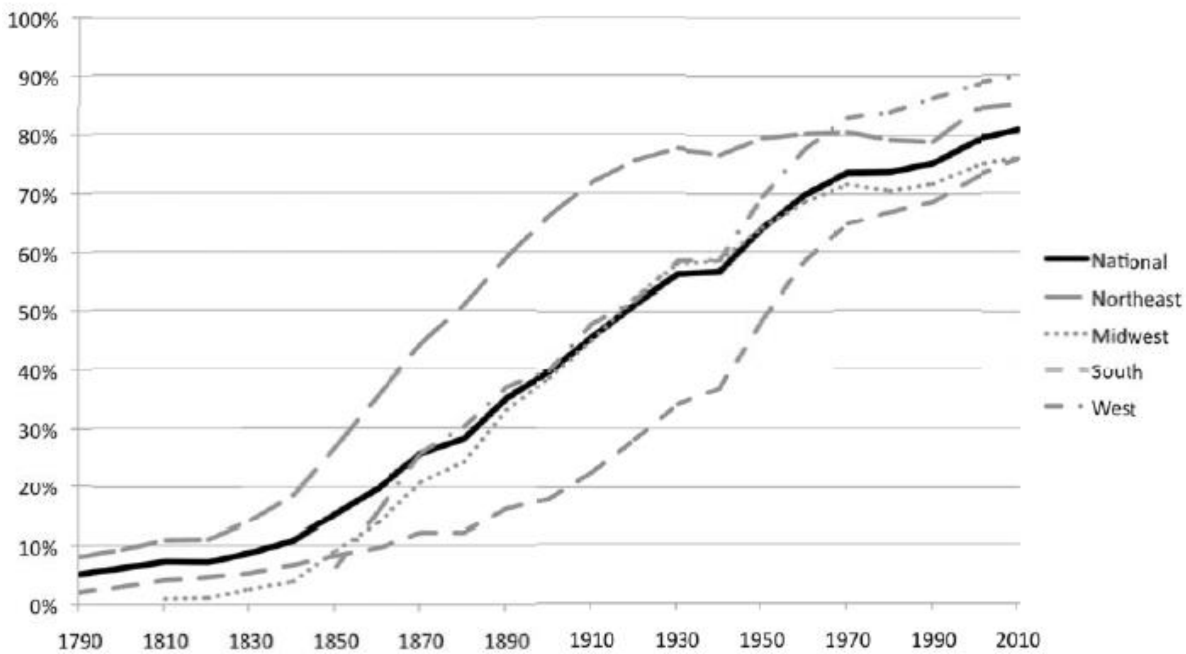


Figure 21 The population of urban areas in the United States, 1790-2021 (Leah Platt Boustan, Devin Bunten, Owen Hearey, 2013).

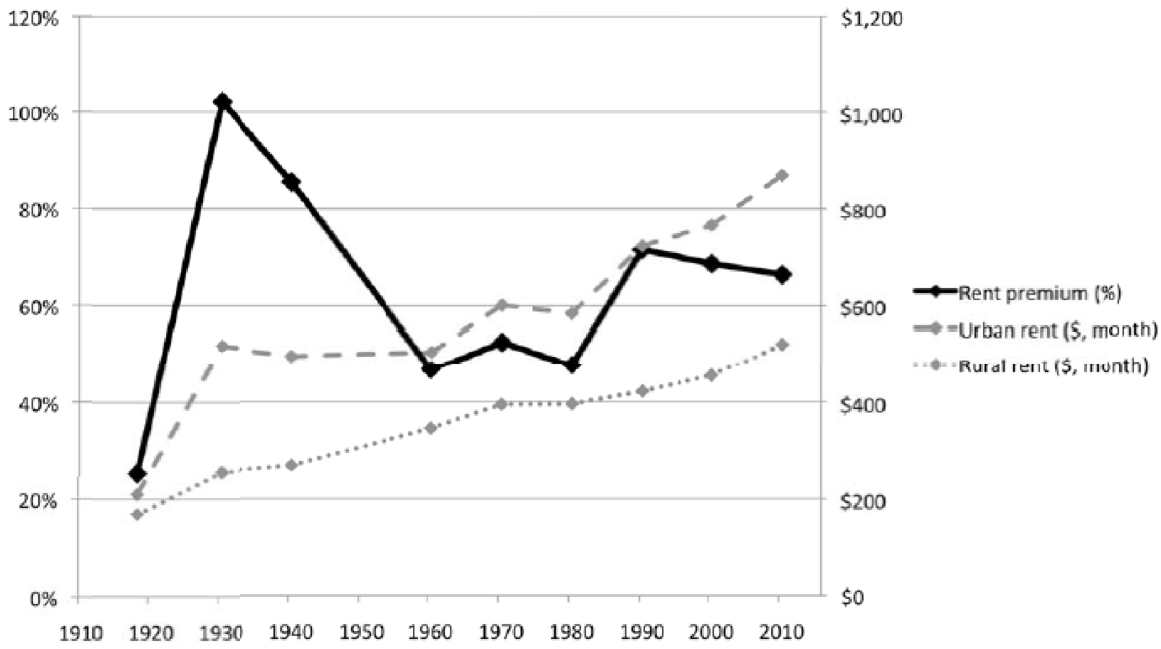


Figure 22 U.S. urban rent premium, 1918-2010. It represents the premium nationally for households of industrial workers living in cities (Leah Platt Boustan, Devin Bunten, Owen Hearey, 2013).

In the United States, the rapid urbanization happened during the early period of industrial development (Gotham K. , 2012). Between the decades 1929-1941, the economic downturn in addition to the first and second world wars forced many Americans out of work. And these issues negatively affected welfare, income, economic activities, and urban development (see Figure 22) (Lesh, 2000). But later, growth in the economic activities had progressed cities' economic activites, and finally resulted to urban growth. This fact shows a significant relationship between economic growth and urban growth. Also it should be noted that, the growth of industrial activities, particularly in the car industries has promoted suburbanization. Because it enabled people to use private cars for daily transport especially after the 1960s (see Figure 23) (Leah Platt Boustan, Devin Bunten, and Owen Hearey, 2013).

Figure 23 Irvine, California, exemplified the massive scale of suburban developments after 1960 and their multiple functions including suburban housing, offices, retail, and industry. Irvine housed more than 60,000 people by 1980 and 212,000 by 2010 (Becky Nicolaides, Andrew Wiese, 2017).

2.5.3. In the Latin American countries

As was explained before, the industrial revolution and its role in the economic growth and developing cities is one of the main reasons of the rapid urbanization in the industrialized countries. But this process was not the same for cities in Latin America. The form, design, infrastructures, social and economic condition of this continent is very different from other continents, and most of the considerable social-economic changes have occurred since 1950 Figure 24.

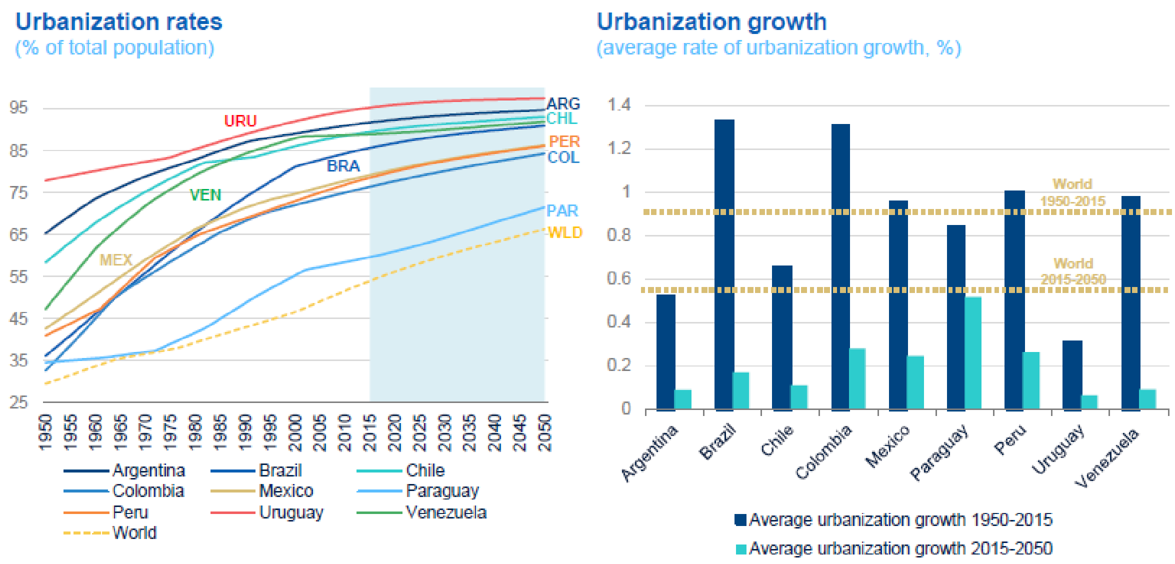


Figure 24 Urbanization in the Latin American countries (BBVA, 2017)

The historical backgrounds of political and economic conditions and structures, natural resources and environmental limitations, and even socio-cultural are the main factors that have created different urban landscapes and growth in any country. As shown in the graphs (see Figure 24 and Figure 25), there is a significant relationship between urbanization and economic growth.

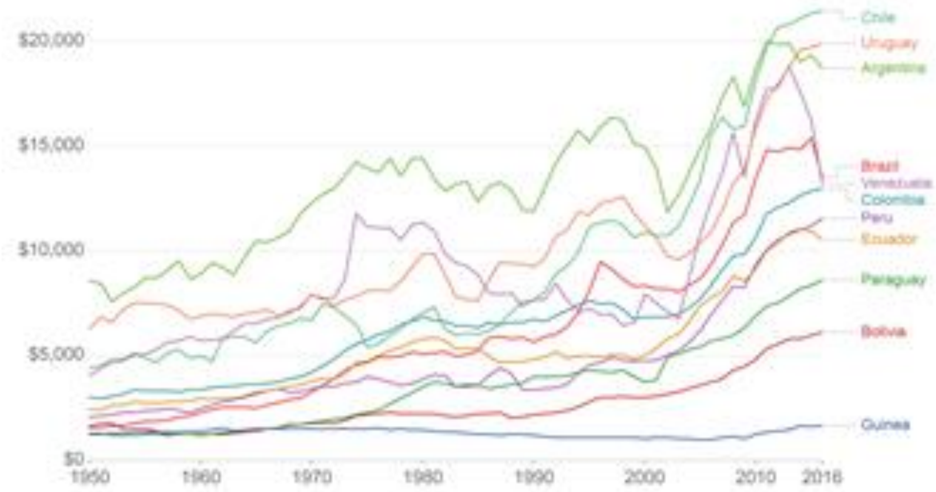


Figure 25 GDP of South American countries per capita, from 1950 to 2016 (United Nations, World Urbanization Prospects: The 2018 Revision, 2018)

In the industrialized countries of Western Europe, the rate of employment in the manufacturing and the services sectors is more than Latin America countries (Julia J. Henderson, 1957). In Latin America, urban population growth resulted from expanding services and not industrial development (Harley L. Browning, 1958). Also urban-rural migration is one of the main factors. For example, in the capital of Venezuela, about 47.8 percent of the urban population was born outside the city, about 44.1in the Federal District of Mexico, and about 51.4 percent in Peru (Kingsley Davis, Ana Casis, 1946).

2.5.4. Urbanization in Africa

The process of urbanization was in each continent different also in Africa, but not in the population changes. The urban-rural migration and increasing urban population were the same changes that happened in all continents. According to the statistical data, about 43,8% of Africa's population live in urban areas. In the next two decades, Africa's urban population will increase "annually" by 3.1 percent, while the rate of world average annual growth is 1.7 percent (Nations, 2021) (Daniel Hoornweg, Mila Freire, 2013). Africa's urban population has been grown from 32 million in 1950 to over 587 million in 2021 (Nations, 2021). Moreover, expected it will be double in the next two decades and will be more than 1.3 billion in 2050. If these predictions become true, it will be one of the fastest urbanization growth that the world will be experienced (Turok, 2016).

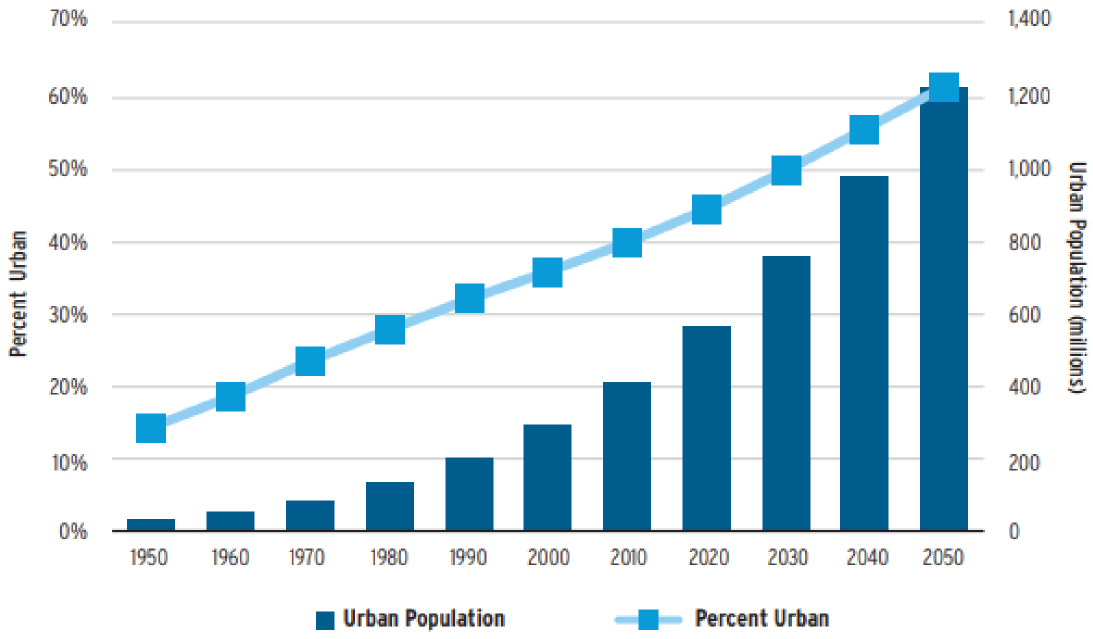


Figure 26 Urbanization in African (1950-2050) (Daniel Hoornweg, Mila Freire, 2013).

The African cities in the south of the Sahara and Western Nigeria have been constructed during the last decades and have new distinctive tissues than other areas (Tingwei, 1988). Also, most Europeans live in these areas, so considerable ownership differences exist between Africans and the non-African population (Daniel Hoornweg, Mila Freire, 2013). The population size in these cities is often unstable because male workers work there for limited periods and then return to their tribes (Julia J. Henderson, 1957).

In Africa, the migration of low-income families has accelerated the rapid urbanization (Alexandra Hill, Christian Lindne, 2010). By 2030, about 350 million people will live in African cities (Adesoji David JIBOYE, 2011). Uncontrolled population growth has faced cities with many challenges in managing and controlling transportation systems, water and wastewater, solid waste, and energy (Daniel Hoornweg, Mila Freire, 2013) (Turok, 2016).

2.5.5. Urbanization in Asia

Over the last few decades, happened some enormous demographic changes in Asia. In 1990 the Asia-Pacific had an urban population of just over 1 billion. But two decades later the population had grown to 1.76 billion, and it is projected to increase to 2.6 billion by 2030 (Mary Jane Ortega, Stephani Widorini, 2018) (UN, 2011). This global trend led to the growth of megacities, which have more than 10 million populations. But, it should be noted that, half of htem are in Asia (UN Habitat, 2012).

Uncontrolled urban-rural migration is one of the main reasons for rapid urbanization in Asia (Julia J. Henderson, 1957) (Hoselitz, 1957). But this process became faster by political forces. A high degree of the concentration of political centers and organizations in cities, has accelerated the social-economic development of cities than rural.

More than 40 percent of Asia's urban dwellers live in low-quality houses and poverty is defined by the following considerations:

- Shortages in providing essential services
- Difficulties in access to adequate and secure shelter resulting in health and environmental issues.
- Increased environmental vulnerabilities and natural disasters (UN Habitat, 2012).

According to the studies, globalization has also accelerated the economic growth of some Asian cities and provided a large market and opportunities (Tinker, 2006). The combination of global markets with cheap labor in Asia has accelerated urban-rural migration and these cities have become the 'factory of the world.' Producing high-value-added goods and has developed Asian cities’ economic growth and domestic markets (Sheppard, 2014).

2.6. Sustainable urbanization

The concept of sustainability or sustainable development was employed for the first time at the Stockholm conference. The principles of urban sustainability are like supportive guidelines for developing cities considering environmental limitations and natural potential. Sustainable urban development policies should be developed concerning the following aspects:

- Improving life quality
- Increasing participation between stakeholders and people
- Providing long-term solutions
- Reducing pressures on the environment (Raffaele Lafortezza, Giovanni Sanesi, 2019), (J. Jorge Ochoa and Yongtao Tan and Queena K. Qian and Liyin Shen and Eduardo López Moreno, 2018).

Attention to the above mentioned aspects helps to provide a multi-dimensional framework for developing sustainable urban development policies (in-hai Lu, Shan-gan Ke, 2018). But for this aim, political and institutional support are needed locally and globally. Without political supports, there is no way to solve today's global crises such as climate change, air pollution, traffic, and reducing consumption of fossil fuels (an Zhang, Jiapeng Xu, Yizhu Zhang, Jing Wang, Siyu He, Xiao Zhou, 2020). For example in this regard, United Nations provided the Sustainable Cities Program (SCP). And in this program was paid significant attentions on public participation (United Nations, 2021), to create awareness and mobilize local governments (Roy, 2009).

2.6.1. Toward a sustainable urbanized world

The current non-controlled urban-rural migration has progressed a massive urbanization globally (Ichimura, 2003). Urbanization is not just the result of economic development. So, for developing principles of urban sustainability, should be considered the economic, social, and environmental matters. Because it helps to maximize the advantages of urban growth for social development (United Nations, World Urbanization Prospects: The 2018 Revision, 2018), (Shaheen L. , 2006). Urban sustainability principles help to maintain the ecosystems, control urban-rural migration, reuse or recycle wastes, manage urban growth, optimize land consumption, etc. (Suzanne Vallance, Harvey Perkins, 2010).

Figure 27 Share of the urban population globally (UNCTAD, 2018)

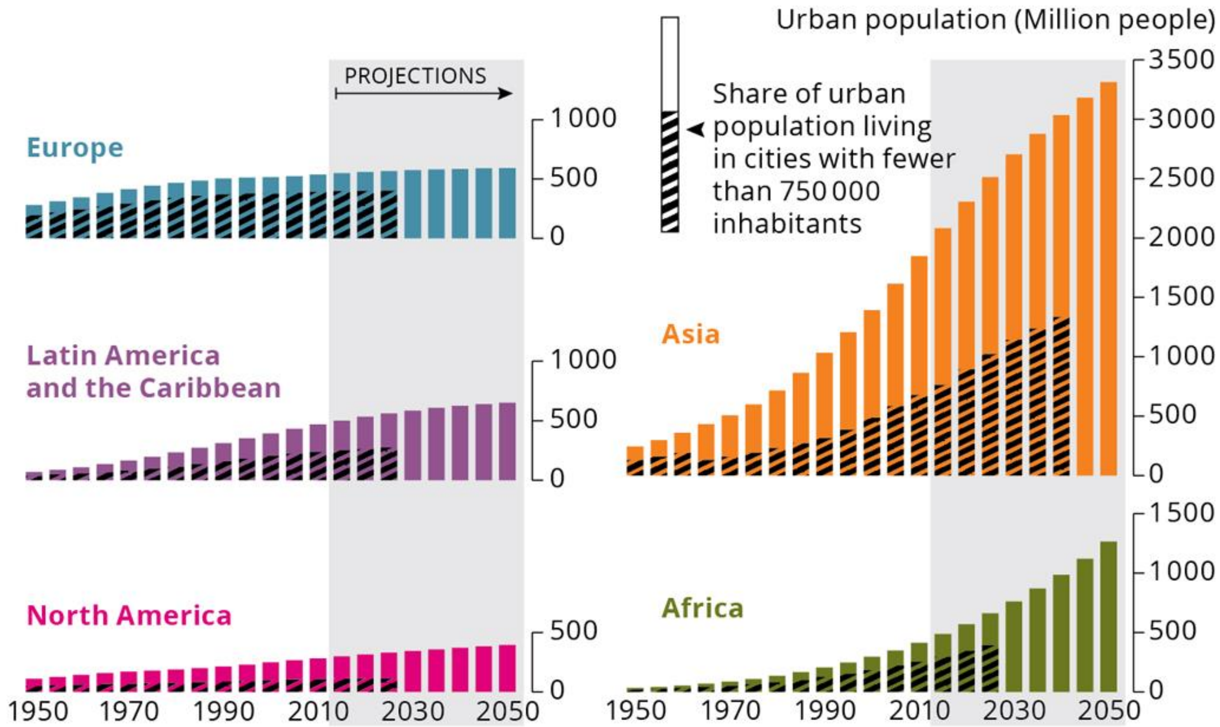


Figure 28 This figure shows the projections of the world's urban population ((EEA), European Environment Agency, 2014)

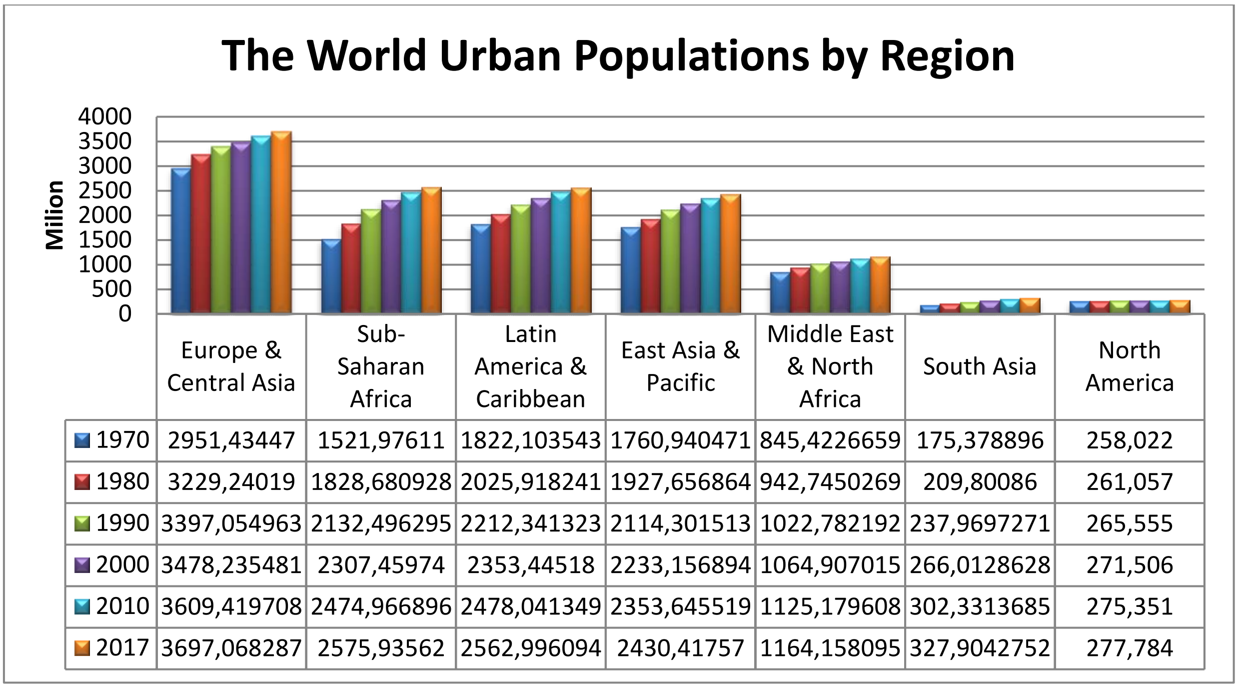


Figure 29 The urban population of the world by region, 1970-2017 (Create by Author) and (Data by (worldbank, 2018))

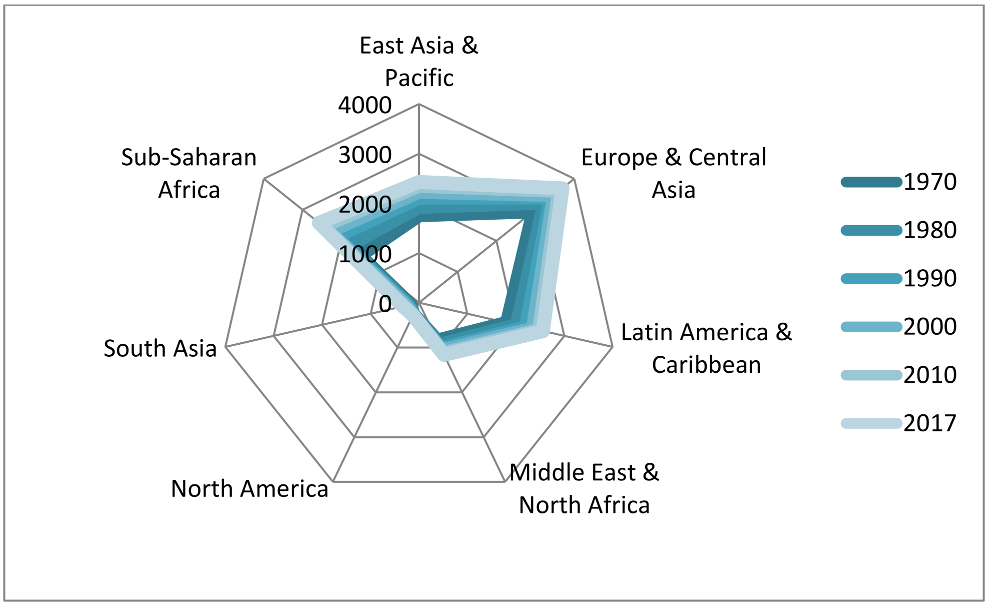


Figure 30 The Radar chart of the urban population of the world by Region (Create by Author) and (Data by (worldbank, 2018))

2.6.2. Urbanization and urban land use sustainability

Generally, today's cities have been grown unsustainably (Weingaertner, 2005), (T.V. Ramachandra, Bharath H. Aithal, 2013); otherwise, the world would not face such global environmental issues. Most part of the designed urban development policies since the 1950s resulted in today's non-sustainable cities and have changed natural landscapes into buildings, streets, and urban infrastructure dramatically. For example, non-sustainable and rapid urban growth policies and paying attention to cities more than rural are the result of uncontrolled urban-rural migration, which has progressed land-use changes (Yuzhe Wu a, Xiaoling Zhang, Liyin Shen, 2011), (Hai Minh Phama, Yasushi Yamaguchi, Thanh Quang Bui, 2011). So, it is necessary to provide new ways to adapt development policies concerning environmental limitations, global issues, and increasing public participation (Chengdong Wang, Yutao Wang, Renqing Wang, Peiming Zheng, 2018), (Yehua Dennis Wei, Xinyue Ye , 2014). Because global commitments and international corporations are needed for solving global issues.

2.6.3. Urbanization and economic development

The link between economic development and urbanization is undeniable (Tie-Ying Liu, Chi Wei Su, Xu-Zhao Jiang , 2015), which has also strongly progressed urbanization particularly since the 1900s (Gordon McGranahan, George Martine, 2012) (Luisito Bertinelli, Duncan Black, 2004). Furthermore, the author believes that economic growth, industrialization, and globalization have been the fundamental driving forces of today's urbanization (Peilei Fan, Zutao Ouyang, Dinh Duong Nguyen, Thi Thuy Hang Nguyen, Hogeun Park, Jiquan Chen, 2019), (Ronald L.Moomaw, Ali M.Shatter, 1996).

Studies have shown that, the relative growth in demand increases the relative importance of the manufacturing and service sectors, particularly in urban areas. Since, in general, for constructing these activities is not needed to hectares of land parcels; thus, these firms and service centers can be constructed in urban areas without remarkable difficulties. For example, you can have just one product in thousand hectares of farmland but more than two hundred activities and thousands of services in just ten hectares. So, if we argue that, rapid urbanization is associated with faster economic growth. Thus, this can not be an exaggeration if we say, the agglomeration of big cities' capital has a close relationship to the population growth of cities.

For example, Megeri and Kengnal, in their research using Human Development Index (HDI), have studied twenty-two states of India, and according to the results economic development has progressed urbanization (M. N. Megeri, Prakash Kengnal, 2016), (Massimiliano Calì, 2008), (Julia J. Henderson, 1957). In their studies, economists like Karl Marx and Friedrich Engels, Max Weber, and Georg Simmel recognized the role of cities in the emergence and growth of capitalism and cities as a center of political and economic power. Max Weber (1958) considered medieval European cities and their institutions as fundamental factors for economic development and capitalism. For Weber, a city represents a concentrated form of formal structures and he emphasizes on harmony, efficiency, and provides possibilities for predicting social relations and activities (Gotham K. F., 2012).

Economists like planners believe that urban growth in developing countries is uncontrolled. Such rapid urbanization results from political forces and sectoral development policies, which have created polarized and non-developed landscapes. Indeed, they describe the situation as urbanization without development. Developing countries today are more urbanized than countries at similar levels of development in the last century (Ronald L.Moomaw, Ali M.Shatter, 1996).

Chapter Three

Sustainable Development

3.1. Sustainable development

Since the last decades, the United Nations held many conferences and international summits in different countries, such as Stockholm, Brundtland, Rio, and Johannesburg, to draw public attention to the main problems that threaten humans and the environment. Today's concept of sustainable development has been developed after a long time of international cooperation and many universal summits because of many local and global environmental and social-economic issues (Murphy, 2012). In the beginning, the concept of sustainable development was employed to draw global attention to environmental issues, global warming, climate changes, mobilizing communities and governments to control this non-sustainable process, improving health services, and reducing poverty (Soltesz, 2008), (Je!rey C. Bridge, A.E. Lulo, 1999), (Drakakis-Smith, 1995). But during the last decades tried to use this concept in many field of science (Ghalam, 2013), and it helped to link the social, environmental, cultural, and economic together for making common sustainable policies for our common future (Dan Cristian Durana, Alin Artenea Luminita Maria Gogana, Vasile Durana, 2015).

3.2. The emergence of sustainable development theory

3.2.1. Stockholm conference [3]

Given the increasing environmental and health issues because of rapid industrial and urban development, the general assembly of the United Nations held an

3 United Nations Conference on the Human Environment (UNCHE)

international conference (1972) on “Human Environment” in Stockholm (Handl, 2012). The main axes of the conference were defined as follows:

1) A declaration and action plan for global health issues in developing and developed countries (ET Sullivan. Ind. L. Rev., 1972)

2) Making some practical solutions and inviting all countries to participate in an international action plan (United Nations, Report of the United Nations Conference on Human Environment, United Nations Conference on the Human Environment (Stockholm Conference), 1972).

In this conference‘s report was emphasized on supporting local governments during the making and implementing local development policies and projects to enhance the quality of life and contribute to a sustainable form of economic growth (Martin W. Holdgate, Mohammed Kassas, Gilbert F. Whithe, 1982), (Kennet, 1972), (Emmelin, 1972).

3.2.2. Brundtland commission [4]

Brundtland World Commission held in 1984 by United Nations on “Environment and Development” and 900 days after the conference, was published a report under the title “our common future” in 1987 (Emas, 2012). This commission had defined the first definition of “Sustainable Development” as follows: It is a new form and path of development that meets the needs of the present generation without depletion of natural resource capacities and abilities (McManus, 2014). Sustainable development is like development with “responsibility” and efficient use of renewable and non-renewable resources concerning social and environmental limitations (Keeble, 1987), (Redclift, 1989).

Another definition provided by the Britannia government on “Sustainable Society,” refers to the places where people decide to be there for living and working (Downing, Andrea S; Chang, Manqi; Kuiper, Jan J; Campenni, Marco; Häyhä, Tiina; et al. , 2020). Indeed living and working are two main keywords in this definition that

4 World Commission on Environment and Development (WCED)

survival of both parts are dependent on human and environment sustainability because human's life and activities are tied to the sustainability of the environment. Sustainable development means rearrangement of technical, practical, environmental capacities with economic and social development policies to realize sustainability.

Also, this commission paid attention to the necessity of education in the development of the social sector to increase social capacities (Muñoz, 2020), and public participation in waste management or recycling (Borowy, 2013), (M.Harris, 2000). For example, people can significantly encourage factories to use recyclable materials for products by declining to buy products packed in non-recyclable material.

But at that time, some people criticized that the defined goals and policies are more general and should be more detailed considering different local conditions (Næss, 2007), (Borowy, The Brundtland Commission:Sustainable development as health issue, 2013) (Pearce, David, and Giles Atkinson, 1998). In contrast, supporters argued that local policies have to be designed by local governments considering their own local conditions (Alpopi C., Manole C.. and Colesca S. E., 2011).

3.2.2.1. The main aspects of Brundtland's report

These aspects were classified into different groups considering type and role as follows:

a) Promoting healthcare
b) Supporting poor and homeless people
c) Increasing the ability of low-income groups to improve living conditions
d) Monitoring and decreasing environmental degradations,
e) Developing new energy resources to decrease the consumption of fossil fuels (ChrisSneddon, Richard B.Howarth,Richard B.Norgaard, 2006), (Burton, 1987).

3.2.2.2. The main dimensions of sustainable development in the Brundtland's report

According to the report, the main dimensions of the Brundtland report are: environmental sustainability, economic sustainability, and social sustainability, physical and political sustainability (Auty, 1997), (Bass, 2007).

3.2.2.2.1. The objectives of environmental sustainability:

- Identifying environmental limitations, potentials, and capacities,
- Identifying and minimizing the adverse effects of artificial phenomena on the environment,
- Management of natural resources efficiently, and avoid depletion of the non-renewable and valuable natural resources just for short-term goals or private interests of some particular groups (Ralf Barkemeyer, 2011).

3.2.2.2.2. The objectives of economic sustainability:

- Progressing sustainable development by identifying new economic potentials
- Promoting principles of sustainable development in all economic development policies
- Promoting sustainable development patterns at the local, national and global levels
- Increasing the efficiency of goods and services
- Maximizing efficient use of mineral resources (David Pearce, 1998).

3.2.2.2.3. The objectives of social sustainability:

- Increasing the quality of life in terms of welfare, social quality, and sharing development costs and benefits equally
- Equal access to healthcare services
- Providing new legal mechanisms for making sustainable development policies (Paul, 2008).

3.2.2.2.4. The objectives of physical and political sustainability:

- Identifying potentials of human and natural resources and capacity building to establish viable settlements to support low-income families (McChesney, 1991).

- Strengthening democracy and increasing participation of people in the decision-making process through the empowerment of the local community (Newman, 2006).

3.2.3. Earth summit

This conference organized by United Nations on "Environment and Development" in 1992, Rio de Janerio, Brazil. The conference followed the former conferences and with the cooperation of most countries to promote sustainable development policies globally. And after the conference, United Nations had published this conference's report with the title "Agenda 21" (Jane A. Leggett, Nicole T. Carter, 2012). This report included commitments, recommendations, guidelines, and providing financial resources to accelerate sustainable development. Agenda 21 was published in four chapters considering the following sectors: 1- social and economic sectors, 2- management of human and natural resources, 3- strengthening communities and NGOs (Panjabi, 1997), (Sitarz, 1993).

The conference promoted making new policies and developing land-use models to reduce non-sustainable land consumption and improve land management for decreasing pressures on urban lands (Jr., 2015), (Davidson, 2006), (Kiernan, 1992). In this report, "land" is defined as an unrenewable and valuable resource (Palmer, 1992), (Grubb, M., Koch, M., Thomson, K., Sullivan, F., & Munson, A, 2019).

3.2.4. Johannesburg summit

Johannesburg Summit was an international conference on "Sustainable Development" and was organized by United Nations with the cooperation of most countries in 2002, in Johannesburg, South Africa. The conference followed the former conferences but thematically had focused particularly on sustainable development (Frantzius, 2004). The final report of the Johannesburg included commitments, responsibilities, and cooperation generally (Speth, 2003). This conference promoted the integration of development policies for the following sectors: "economic development, social development, and environmental development. Also as mentioned in this report, governments, organizations, private sectors, and people are responsible for this process (Gill Seyfang, 2002). Globalization was also another main topic that was discussed at this conference (Nath, 2003). Globalization has provided new opportunities and challenges for trade, investment, and capital trends. Therefore, this conference suggested making new policies to arrange and manage connections and activities among countries and develop regional partnerships via cooperation.

3.3. Urban sustainability

As we know, up to 2030, about 60 percent of the world's population will be settled in urban areas (Song, 2022), (The Role of Cities in Sustainable Development, 2010). Increasing migrations towards cities are one of the main reasons that have accelerated urbanization and urban physical growth (Anne Shepherd, Leonard Ortolano, 1996), (Mostafa Rasoolimanesh, Nurwati Badarulzaman, Mastura Jaafar, 2011). Even this issue, with different negative consequences depending on local conditions, is becoming more complicated in developing countries (Dr. Ayman Nour Afify, 2002). Thus, the ability of cities to implement sustainable development policies considering the spatial-time would be different. For example, most of the urban problems in developed countries are concentrated on reducing the consumption of fossil oil to control climate change and global warming. But in developing countries social and health issues are prior to environmental issues. Researchers believe that, sustainable urban development is related to equality, social justice, fulfilling basic human needs, as well as attention to employment, poverty, health, urban physical environment, and infrastructures (Steven Curwell, Mark Deakin, Mark Deakin, 2005).

Chapter Four

Urban sprawl growth and land use changes

4.1. Urban growth

City growth emerges as spatial and physical changes resulting from the concentration of population in a place because of social-economic or environmental potentials. Generally, urban growth considering geographical and spatial differentiation can be different. The intensity of urban growth and physical expansion will be affected by the factors of time, forces, tempo, and scale of changes in the economic, social, and demographic sectors.

Since the last century, changes in the physical structure and nature of cities were accompanied by changes in urban functions, land use and the emergence of new activities in cities. Changing natural resources like raw lands into numerous buildings with commercial, residential, industrial, and service functions have occurred under the daily growth of a big factory that we have constructed and named "City." As well, today's urban daily life challenges and issues became more complex. Some significant forces such as economic policies, dominated ideologies, planning culture, and local specific conditions and potentials have played substantial roles in accelerating or decelerating peace of urban growth and development and generating new spatial landscapes locally and globally (WÄLTI, 2004). For example, the industrial revolution and free market policies of the industrialized countries have constructed a new spatial organization of the market and escalated environmental problems such as climate change globally. In this regard, according to the Paris climate agreement, one-hundred and eighty-seven countries were committed to reducing environmental emissions. Still, the most producers of emissions are industrialized countries including: China, the USA, European countries, Japan, and also developing countries including Brazil, India, Russia, Canada, Indonesia, South Korea, Mexico, Saudi Arabia, and South Africa (Schreurs, 2016), (MichailFragkias, Christopher GBoone, 2016).

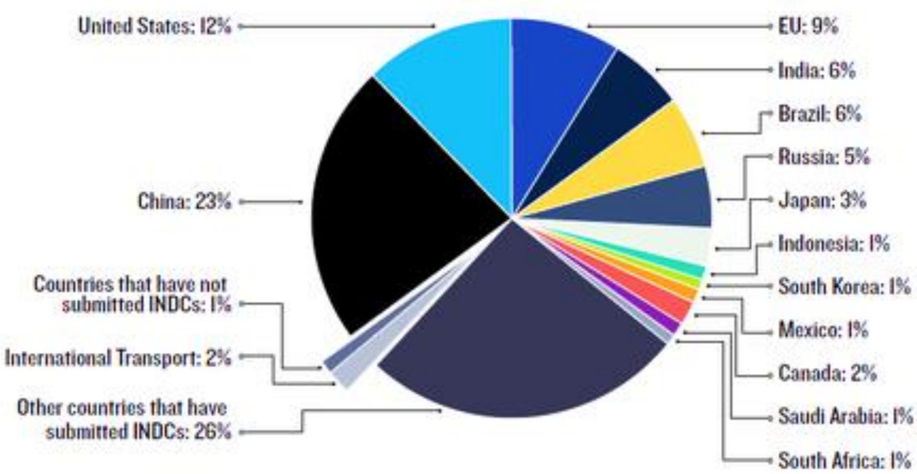


Figure 31 Share of greenhouse gas emissions by countries (Schmidt, 2015).

Perhaps the declining disadvantages of urbanization to reduce consumption of non-renewable resources such as urban lands are one of the main reasons. According to this study, increasing investments in new technologies to reduce the consumption of natural resources and fossil fuels can effectively decrease urbanization's disadvantages. For example, tiny mobile houses are the new generation of home building that have enabled people to be mobile and transport their homes and this creative design has reduced the consumption of land parcels.

4.2. Criteria of urban changes concerning the urban environment

A city functionally is as a centralized factory that includes people, buildings, needs, production, consumption, interactions, and transportation as inputs. So, workers, land, capital, technology, and natural resources are required forces in the growing process of a city. This thesis believes that, identifying the main forces of urban changes and analyzing the scale and pace of these changes in the formation of artificial environments is crucial in urban studies. It helps to find the reasons of the current non-sustainable urban development and providing effective solutions for today's urban challenges. Because the interaction and link between urban issues are multi-levels and became complicated with many internal and external factors. It means there are many reasons just for one problem and one change in a city. And any change can be a reason for emerging new changes or issues. And they are constantly circling from one space to another space and changing from one form to another form Figure 33.

Generally, the following forces have accelerated urban changes:

A) The factor of **place** as a base that has provided the possibility for constructing and promoting a multi-level interaction between places

B) The factor of **natural resources** that helped to fulfill the needs and promoted welfare

C) **Shelters** (house or apartment) functionally are a place that meets human material needs, (survival needs), spiritual needs (about the soul and intellect), and reconsidering the urban dwellers as a consumer of goods and services.

So, this thesis emphasizes finding new sustainable and renewable building materials to control rapid urban land use changes and reduce environmental tensions created by human activities. In this regard, in the early 21st century, UNESCAP[5] suggested the "Green Growth" theory to support cities and realize compatibility between human settlements and green areas and to promote low-carbon cities

5 The United Nations Economic and Social Commission for Asia and the Pacific

(UNESCAP, 2011). For example, Resnick and colleagues (1990) have studied the relationship between economic forces and green growth policies and found out the main roles of economic forces in reforming and creating urban spaces. The growth of economic activities in lower-developed urban zones has increased the green building projects in these zones significantly (Danielle Resnick, Finn Tarp, James Thurlow, 2012). Also the results of the other study on the effects of economic activities on urban structure have shown that, in some urban zones with less financial growth, the quality and quantity of economic activities, diversity of landuses, attractivity, and landscapes are significantly inadequate and insufficient. Therefore, they have proposed establishing new services, facilities, technological infrastructures, and developing social skills are required for the development of these zones (TinglinZhang, Bindong Sun, Wan Li, 2017). Christopherson, in a study, has revealed that changes in economic interactions, production, and spatial division of labor market are the main reasons to reconstruct or arrange urban spaces, determine the land-use type, and change the urban spaces (Christopherson, 1989).

Further to the local economy, the global market plays a significant role in organizing urban spaces. Globalization expanded the free market and linked local markets to the global and specially developed urban economy and accelerated urban changes (Gordon, 1995). International economic forces have rearranged spatial patterns activities, deciding where to build up a factory and, of course, job market. The intensity of changes in the urban spatial organization depends on the concentration and densification of economic activities concerning a city's local potentials and social-economic characteristics (Mingxing Chen, Hua Zhang, Weidong Liu, Wenzhong Zhang, 2014). Thus, control of both natural and human spaces without control of the market would be challenging. In this regard, the green growth approach tries to consider social and environmental concerns in the economic development policies to realize urban and environmental sustainability faster (UNESCAP, 2011).

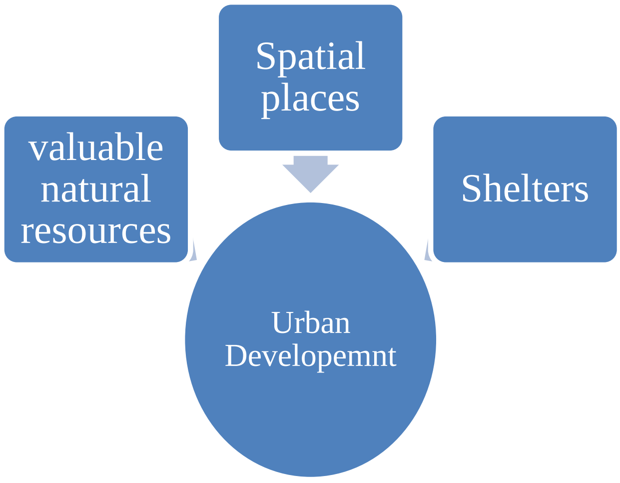


Figure 32 significant forces that participate in the urban development (by the author)

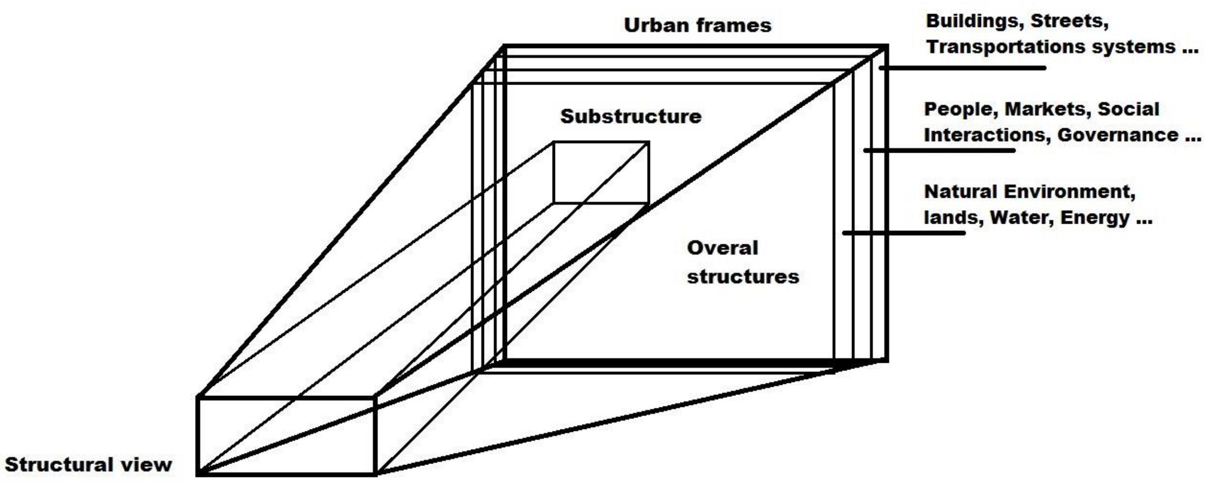


Figure 33 Urban frames, layers, and the formation of urban spaces and structures (by the author)

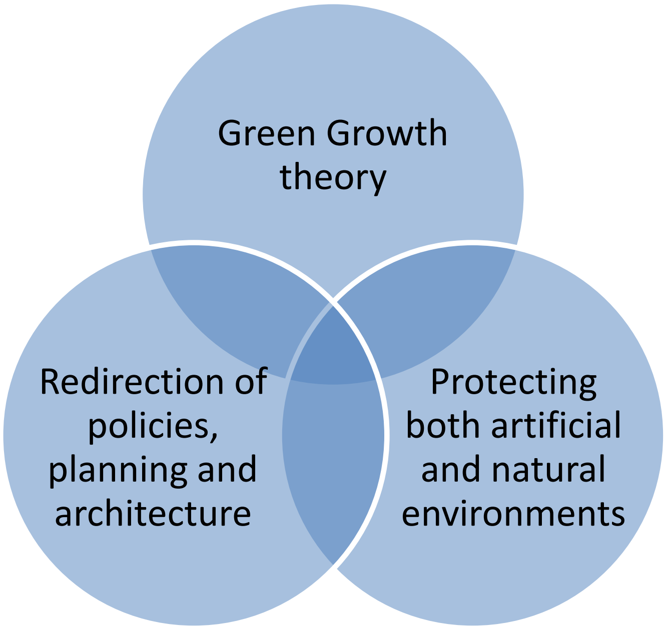


Figure 34 The three main pillars of the Green Growth theory (by the author)

4.3. Changing urban environment under social changes

Change in the social and cultural sectors can change social behaviors to control urban changes. For example, changing demographic control policies from one-child culture to the two or three-child consequently increases demand for new and bigger buildings, increases demands for new land parcels, and increases the construction of new infrastructures (Fong, 2002). As a result, emerges new changes in urban space, structure, activities, and land use are conceivable. In the land uses planning and locating practice, attention to principles of the green growth theory helps to establish compatible structural linkages among people, land parcels, and activities Figure 35. As shown in Figure 35, the pattern one -increases the costs of time and transport, -increases traffic and consumption of fossil fuels, and -increases air and sound pollution than the pattern two. The first pattern encourages using private cars instead of using trains or buses. However, the second pattern provides a shorter way to go to work or other activities and encourages walking or using bikes.

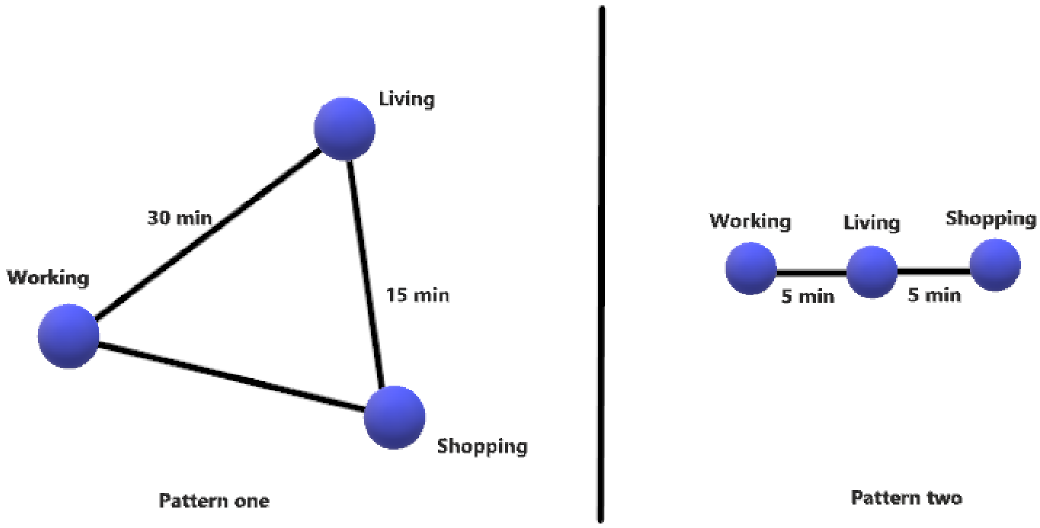


Figure 35, intracity transport patterns (by the author)

Figure 36 Major factors with significant roles in the sustainability area (Brand, 2005)

According to Hall and Peiffer, new social values and internal or external factors affect lifestyle, activities, and mobility patterns in an urban space. These novel changes later can generate new urban special-physical landscapes. Change in social-cultural values directly affects the household size and influences public tendency even to be single or childless, which happened in the industrialized countries. Studies have shown the rise of childlessness, and more adults do not have children in European cities (Gottdiener, 1994). For example, since 2005, the POCKET LIVING Company build and sell small flats in London. These apartments have many required spaces for young or single people, such as bicycle storage, and lack the things they do not, such as large kitchens and lots of bookshelves. At first, Pocket has expected that most buyers would be in their late 20s. Instead, the average age is 32 and rising. It is not that many purchasers are yet to have children; rather, they perhaps will never have them (Corfe, 2019).

The growing European urban population are in the same situation. 9% of English and Welsh women born in 1946 had no children. For the cohort born in 1970—who, barring a few late surprises, can be expected to be done with babies—the proportion is 17%. In Germany, 22% of women reach their early 40s without children; in Hamburg, 32% do (Economist, 2017).

This difficulty affects the structure of jobs, wealth state, and rearranges urban spaces, land use type, and locating.

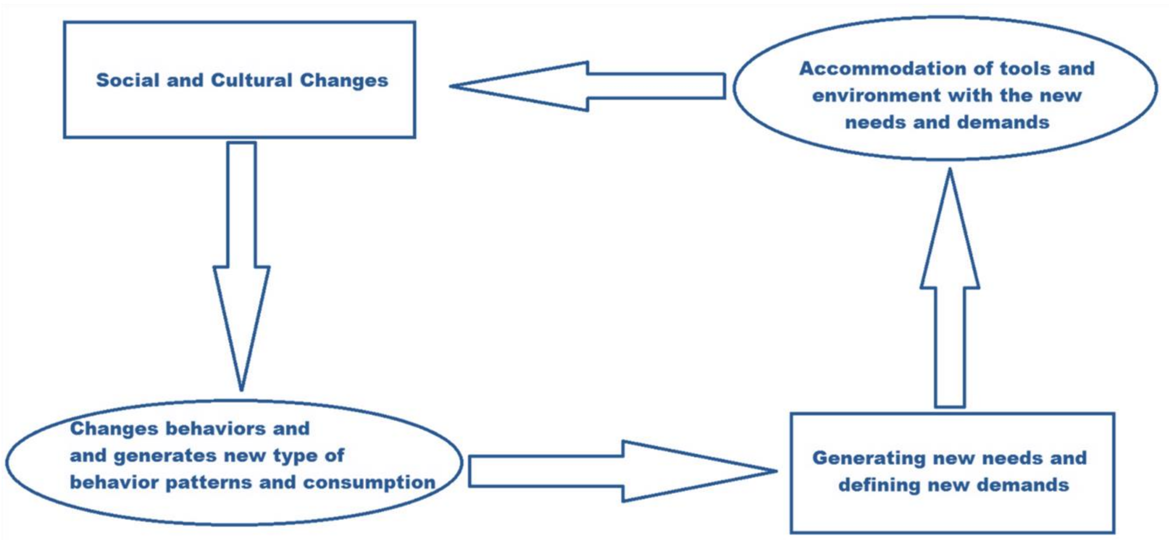


Figure 37 Engineering social behavior towards sustainability issues (by the author)

Human behavior and activities are a reflection of social-cultures values. Thus, it is possible to embed environmental concerns within social and cultural values to change human behavior and finally change spaces. In this sense, between the variables people and activities, people are considered as a fixed variable. And activities are regarded as a dependent variable and create new spaces.

Hence, given the significant influences of social and cultural values on human activities, it is no overstatement if we claim, "social-cultural factors are one of the main shapers of artificial spaces." Therefore, for the management and control of urban land use, cultural planning and building new values to draw public attention to the environmental concerns are required.

Figure 38 engineering social space to reshape environmental space (by the author)

Consequences of land use changes on the quality of urban spaces

In today's land use planning, attention to the principles of sustainability is necessary for creating new spaces with respect to the type of activities, health issues, and environmental limitations (Tulshi Kumar, Rony Basak, 2020). According to the studies, allocating land to the public and private green spaces such as parks and gardens enhance urban health, decrease sound pollution, and provides a more desirable environment, particularly in crowded urban zones with high density (C. Yu, 2006). Therefore, designing and creating desirable and environmentally friendly places increases social interactions and encourage people to walk instead of using a car.

Land use activities affect the physical and mental health of urban dwellers directly and indirectly. Different land-use types such as (green space, residential, commercial, sport, etc.), single or mixed-use create diverse landscapes. Thus, measuring public welfare, physical activity, health, social integration, and ecological matters should be considered in land use planning. For example, single or mixed-use land or building gives different accessibilities for urban dwellers when they want to go shopping, sport, etc. (Byoung-Suk Kweon, Christopher D Ellis, Pedro I Leiva, George O Rogers, 2010).

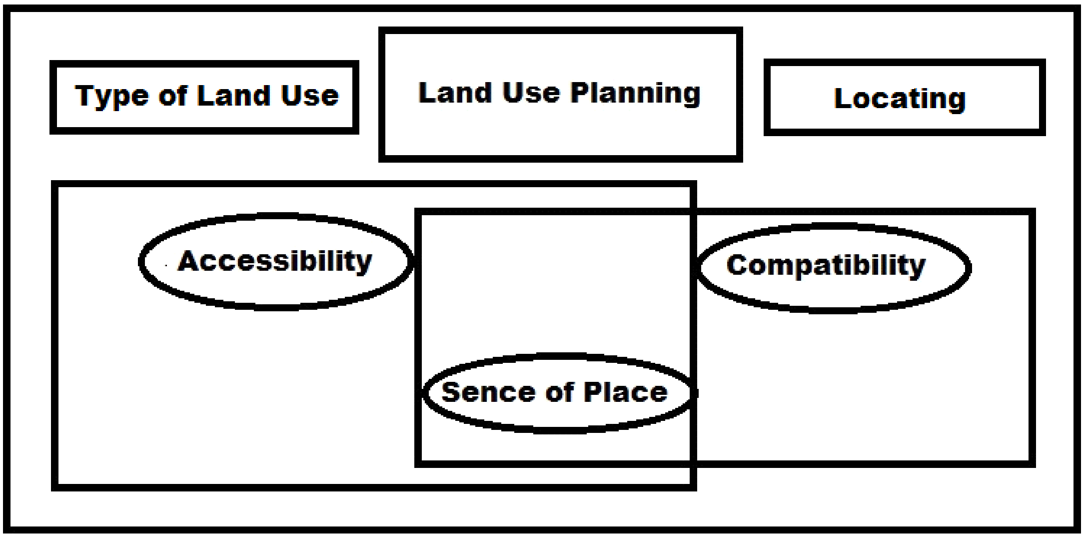


Figure 39 The influential factors for delivering a better sense of place in the land use planning act (by the author)

4.4. The consequence of population changes on land use changes

Rapid population growth increases dwellers' needs and simultaneously increases pressures on the capacities and infrastructures of a city such as urban lands and causes many problems (Clark, 1977). Population growth considering the social-economic conditions of places will happen rapidly or gradually. Rapid population growth in a short time usually results from a massive migration of people from many areas to a city. This issue in overcrowded cities faces urban dwellers with unequal access to daily services to fulfill their needs (Tine Ningal, A.E. Harteminka, A.K. Bregtc, 2008). Regarding the United Nations reports, massive increasing urban-rural migration since the past century (Berry, 2008), has dramatically changed the form, texture, and landscape of cities. The impacts of this trend regarding the local conditions from one place to another were different; thus, its effects in some places were dramatic and in some places were not remarkable (Jaňos P. Hrabovszky, K. Miyan, 1987).

It should be noted that migration and population growth in developing countries for example Iran are substantially higher than in developed countries especially since the last decades, even it will be more in the following decades (Bilsborrow, Richard E.

Okoth-Ogendo, 1992). The extreme imbalance between the urban and rural populations in Iran mainly resulted from unequal development policies, local potentials, and polarized growth. New urbanism and change of lifestyle, supporting the cities more than the rural area, increasing job opportunities in urban areas than rural areas, and growth of consumerism are the main reasons for this uncontrolled urban-rural migration.

4.5. Social equality and land use sustainability

Unequal development and polarization have escalated social gaps and created different urban landscapes as follows:

1- Settlements without infrastructures for low-income families
2- Structured settlements for middle and high-income families with more facilities and services (Michael C. Lens, Paavo Monkkonen, 2016).

Generally, in developing countries, low-income families are settled around urban edges or suburbs. In contrast, usually in developed countries, low-income groups are settled in the center. And middle or high-income groups are settled far away from the center (Pepijn Schreinemachers, Prasnee Tipraqsa, 2019), see Figure 40 and Figure 41.

Figure 40 A planned and infrastructured suburb (Fettmann, 2019)

Figure 41 A slum without basic infrastructures closed to the developed zone with big-buildings and best infrastructures (Villa, 2017)

Today, high and middle-income groups tend to live in some suburbs to have larger houses, gardens and lower sound pollutions. While the majority of low-income families living in the slums or informal sectors under inappropriate conditions (Long Cheng, Xuewu Chen, Shuo Yang, 2016). This thesis argues that, both forms of land consumptions are non-sustainable Figure 40 and Figure 41. Maybe new technologies and finding new building materials and methods can effectively provide small and lightweight constructions for settling people in slums and decreasing consumptions of raw land. For example, please look at the following pictures Figure 42 and Figure 43. This project resulted from a novel combination of science and industry to offer compacted and cozy rental homes in the Netherlands. This project has focused on the three main aims: sustainability, efficiency, and minimizing environmental degradations, and realize a sustainable linkage between artificial phenomena and nature (Davis, 2018).

Figure 42 A conceptual model of Stone-shaped 3D-printed rental homes in the Netherlands (Davis, 2018)

Figure 43 A conceptual model of Stone-shaped 3D-printed rental homes in the Netherlands, by Houben/Van Mierlo architects (Davis, 2018)

According to studies, generally, the informal sectors are settled by low-income people (Tarsi, 2020). Because of financial problems, they tend to prepare needed land parcels by occupying or buying cheaper than the land market price. And then, land parcels will be constructed without permits and cheap materials (Meagher, 1995). For example, in most Iranian cities, growing informal sectors have increased informal land occupations, land consumptions, and also land value. In the year 2019 was done a national project in 77 cities of Iran, and planners found about 851 informal sectors in about 52443 hectares and with more than 5900,000 population (Armin, 2019). Unfortunately, there is no supportive housing plan for low-income families. For example, in the Comprehensive Plan, studying the social-economic aspects of cities are just limited to writing a short report on cities' social-economic situation. Therefore, an effective social-economic analysis considering the principles of sustainability must be provided to improve urban health and support low-income groups. Yıldız and colleagues in their study have argued that social equality has a close linkage in the realization of social-economic sustainability and environmental sustainability (Serkan Yıldız, Serkan Kıvrak, Arzuhan Burcu Gültekin, Gökhan Arslan, 2020). As a result, in urban land use planning, attention to the social justice, supporting low-income families, making new supportive strategies to settle low-income families are essential for realizing social-environmental sustainability.

4.6. The characteristics of suburbans

In this study, suburb means a residential or mix-used settlement that are placed around of a city (Caves, 2004) and includes social, political, environmental, and economic characteristics. Suburbs is the result of the continuation of centrifugal development (Dembski, Sebastian; Schulze Bäing, Adreas; Sykes, Olivier, 2017). Suburbanization has emerged as an uncontrolled trend in American cities by offering new desirable private spaces and accessible by car.

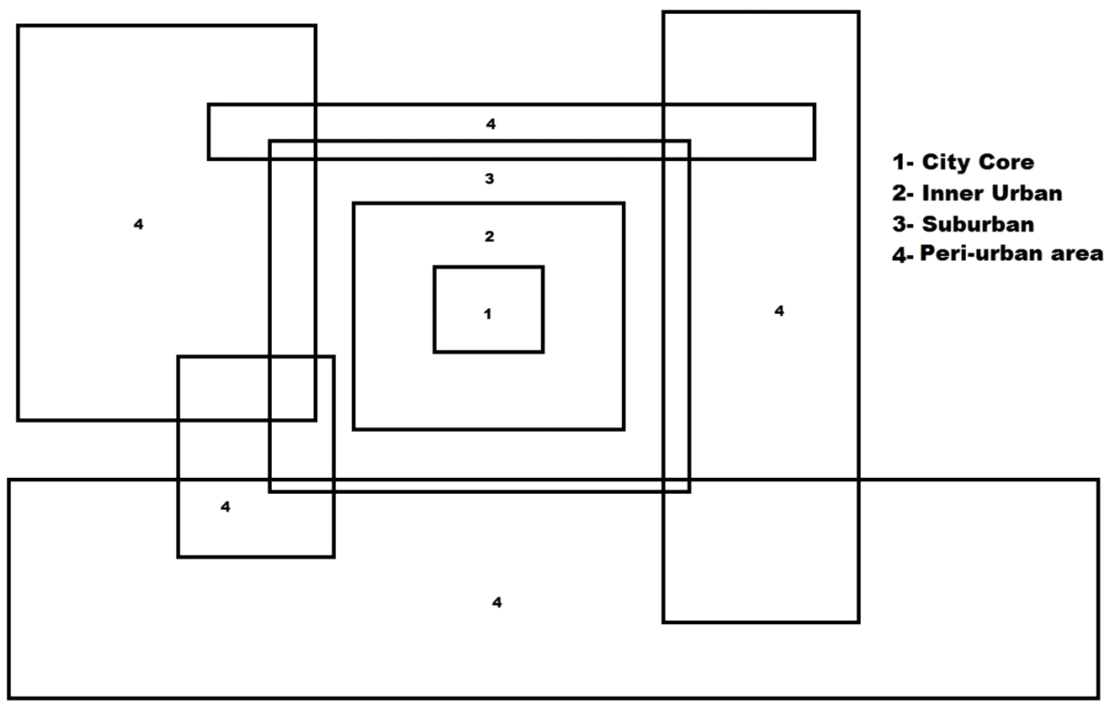


Figure 44 The conceptual model of developing urban zones (by the author)

The progressive urbanization and emerging new forms of settlements such as suburbs and exurbs resulted from drastic social-economic changes, especially since the second half of the twentieth century (Murtagh, 2004), (Ivonne Audirac, Emmanuèle Cunningham-Sabot, Sylvie Fol, Sergio Torres Moraes, 2012). Moreover, European urban planning literature has used "suburb" to describe a disadvantaged area that is segregated from a central city. But in the USA, this term don not used to describe underprivileged regions. In some references, suburbs or exurbs refer to areas that have low-density development (Harris, 2010).

Infrastructured suburbs with the enough accessibility to service centers have progressed suburbanization and motivated people to move from the inside of cities towards the outside such as suburbs (Schmidt James W, Arnold Robert K, Levy Stephen, 1972). Suburbanization has progressed non-sustainable urban growth and transformed valuable natural spaces into built-up zones Figure 40 and Figure 41.

4.7. Urban sprawl growth

In urban studies the word "urban sprawl" was used for the first time in the year 1956 (Gregory D Squires, 2002) (S.Habibi, N.Asadi, 2011), (Gillham, 2002). Sprawl growth is an uncontrolled and scattered form of urban physical growth (Frumkin, 2002). But, any physical growth doesn't mean sprawl growth. A city can also have a progressive physical growth but planned and integrated, which will be horizontally or vertically considering densities (Thomas J. Nechyba, Randall P. Walsh, 2004). Urban sprawl represents a low-density type of land use development, and emerges in different forms like ribbon, strip, and leapfrog (Johnson, 2001). However, this type of growth is non-sustainable and since the last decades created or escalated many environmental and social issues (Ottensmann J. R., 1977).

4.8. Urban density, efficiency and effectivity

In general, urban density has an effect on social-economic activities (Glaeser, 2011). Increasing the density of buildings will increase the density of activities and population in a place. So, increasing urban density without considering environmental and spatial limitations is unsustainable and escalates urban issues. For example, the Coronavirus pandemic faced cities with social-economic crises (Jingjing Wang, Yiyang Yang, Jiandong Peng, Linchuan Yang, Zhonghua Gou, Yi Lu, 2021). Particularly, the places with more density of population, buildings, and activities became more vulnerable than other places. Because of more infections, these places were faced with more lockdowns than other zones (Gilles Duranton, Diego Puga, 2020).

However, sustainable urban design and land use planning decrease the imbalance between spaces and activities of land parcels, especially in the agglomerated and high-density zones. An excellent example of the high density and effective usage of land parcels and urban spaces is compact city building.

Figure 45 a sample model of a compact city (Sang-gil, 2018)

A compact city concept promotes mixed-use activities and provides better accessibility for people. In the following are mentioned some advantages of this concept:

- promoting mixed-use instead of single-use increases the scale of activities, which improves the quality of service to the people
- developing the capacity of urban spaces and decreasing consumption of raw land parcels,
- providing faster access to the daily service, which reduces the time and length of daily trips and decreases the dependency of people on using private cars
- reducing traffic and consumption of fossil fuel
- reducing air pollutions and improving air quality (Muhammad Zia Mahriyar, Jeong Hyun Rhob, 2014), (Nicola Dempsey, Mike Jenks, 2010).

The compact and high-density building has remarkable economic benefits for cities and dwellers. Because, the cost of time and transport will decrease by increasing density (Burgess, 2000). In addition, high buildings with more density reduce the cost of the establishment of infrastructure (YifanYang, S. Thomas Nga, Frank J.Xu, Martin Skitmore, 2018). Since, city building vertically reduces the growth of cities horizontally, and as a result, the length of transportation infrastructures including asphalts, railroads, and bus lines in a compact city are not longer than in other cities. Even the cost of gathering garbage in a compacted city is more affordable than in cities with sprawl growth Figure 46, Figure 47.

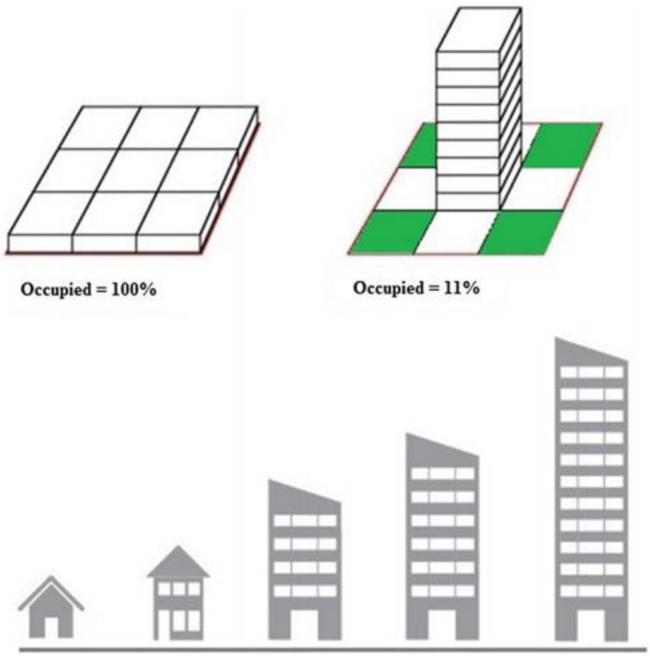


Figure 46 Decreasing the occupation of urban spaces by increasing urban density and High-rise building (Saleh Abdullahi, Biswajeet Pradhan, Abubakr Al-sharif, 2017)

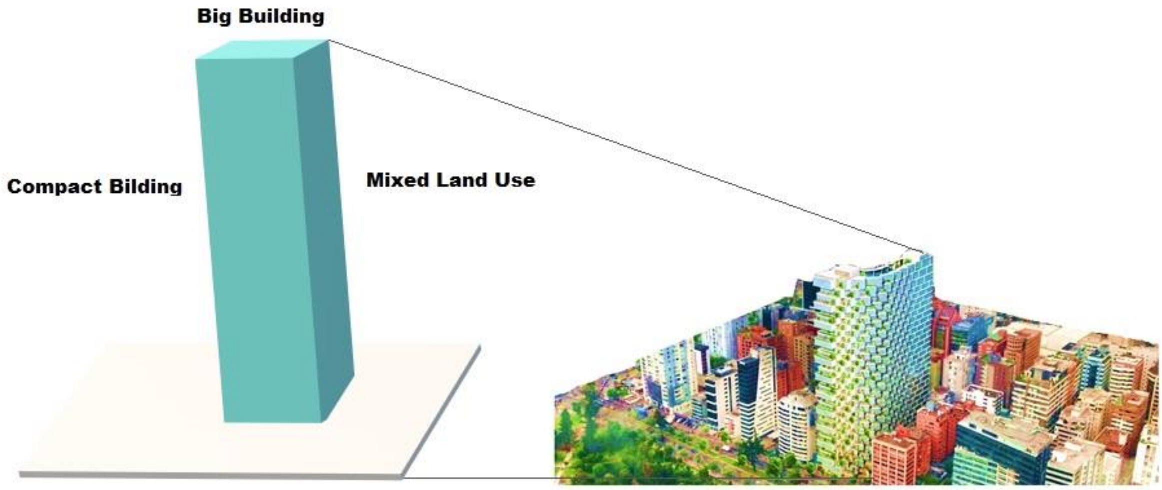


Figure 47 Potentials of urban horizontal growth and its effects on the urban activities and land consumption (by the author)

4.9. Density and optimizing structure and size of cities

For the first time, the theory of optimal city size was developed to analyse the relative between the population and area of a city. But later this term was used to analyze the relationship between the efficiency of spaces and the size of cities considering economic factors (Yuhong Cheng, 2017). For example, Roberte and colleagues were done a study to analyze the size (area) of a city considering the following factors: quality of life, economic agglomeration, social tension, and rent of land parcels (Roberto Camagni, Roberta Capello, Andrea Caragliu, 2013). Or Yang in his study considered social well-being per capita to define the optimal size for a city (Yang, 2020). In European urban planning literature, the population is the main factor in defining the optimal size of a city (Javier Monclús, Carmen Díez Medina, 2018), (Sadowski, 2020). Because, the agglomeration of the population has a connection with the costs of establishing public services (Peter Nijkamp, Adriaan Perrels, 2014). For example, in cities with horizontal growth and low-density development it is necessary to have a larger transportation system, but this issue increases the consumption of resources (Hadi Arbabi, Martin Mayfield, Philip McCann, 2019). Also, Arnott (1979), who is in favor of the compact cities idea, has argued that, the concentration of population reduces the cost of production, which is very important for sustainable urban Development (Arnott, 1979). Therefore, growth in the area of cities increases the costs of service, spatial costs, and disturbs the balance between resources and needs, and affects on cities' functions negatively.

Unfortunately, today's urban policies generally have concentrated on achieving economic growth, and this problem imposes many costs to the societies, environment and declines the quality of open spaces (Frenkel, 2004). Contemporary urbanization has progressed suburbanization and sprawlization growth. And hope that post-urbanization would control and direct urban growth and development towards sustainability locally and globally. Continuing interregional migration towards urban areas while most people move from city centers to the periphery or suburbs develops multicentric urban systems Figure 47.

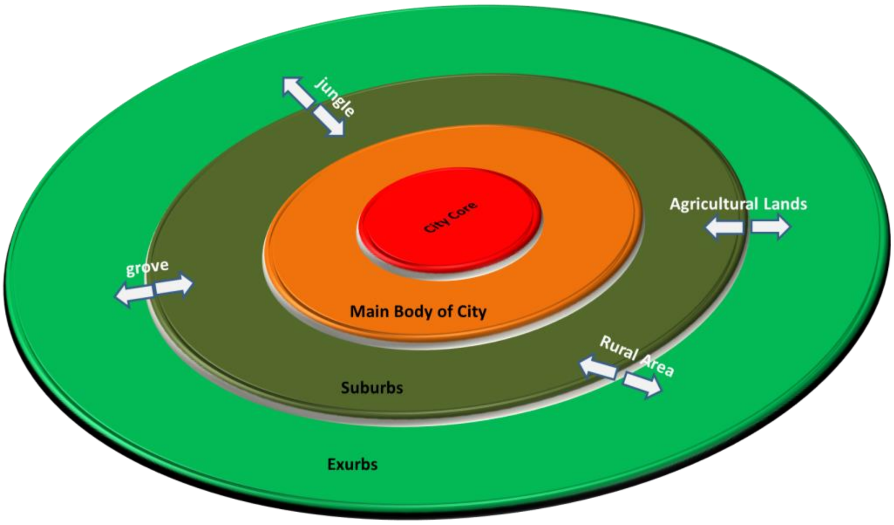


Figure 48 The conceptual pattern of Sprawl growth (by the author)

According to most empirical studies, sprawl development is quite unsustainable and has many disadvantages for the social, economic, and environmental sectors compared to the compact model.

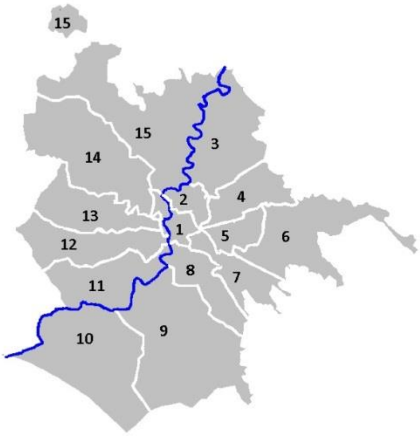
In the contemporary urbanization era, market forces play a significant role in changing cities' functions, urban growth, quantities and qualities of land consumption, type of activities, and also changing desire of consumers (Amelia F. Darrouzet-Nardi, William A. Masters , 2015), (Amanda J. Lea, Dino Martins, Joseph Kamau, Michael Gurven, Julien F. Ayroles, 2020). In such a condition, urban land use principles are one of the main tools to control the unsustainable use of valuable natural lands by market forces.

4.10. Costs of sprawlization

Urban sprawl growth and physical expansions, as one of the main negative aspects of contemporary urbanization and suburbanization, have imposed social-environmental costs on the communities and environment (Burchell, R. W., Lowenstein, G., Dolphin, W. R., Galley, C. C., Downs, A., Seskin, S., ... & Moore, T., 2002). Implementing temporary and inappropriate urban policies particularly after the second half of the last century have increased the costs of sprawlization. The sprawling growth has replaced soft surfaces such as green or open spaces with hard surfaces like asphalt roads and buildings. Sprawlization destroyed agricultural lands, threatened ecosystems, and increased intergenerational inequity. It also led to unequal access to natural resources and eventually has diminished the desirability of human life and even the quality of the environment. In continue provided some examples to show the area of some cities with compact growth in comparison with the cities with sprawl growth considering the population and density (see Table 5).

Table 5 Comprising the cities with sprawl growth versus the cities with compact growth (by the author)

Sprawling City				Compact City			
City	**Population**	**Total area (km^2)**	**Population density**	**City**	**Population**	**Total area (km^2)**	**Population density**
Ankara	4,470,800	1,910	2,340	**Kolkata**	4,496,694	185	24,306
 							
Cape Town	3,740,026	2,444	1,530	**Giza**	4,239,988	289	14,667
 							

<table>
<tr><td>Rome Capital</td><td>4,353,738</td><td>5,363</td><td>812</td><td>Cairo</td><td>7,601,018</td><td>302</td><td>25,582</td></tr>
<tr><td colspan="4">
</td><td colspan="4"></td></tr>
<tr><td>Shenyang</td><td>8,106,171</td><td>12,980</td><td>625</td><td>Seoul</td><td>9,806,000</td><td>605</td><td>16,202</td></tr>
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<tr><td>Los Angeles</td><td>3,976,322</td><td>1,213</td><td>3,276</td><td>Mumbai</td><td>12,442,373</td><td>437</td><td>28,426</td></tr>
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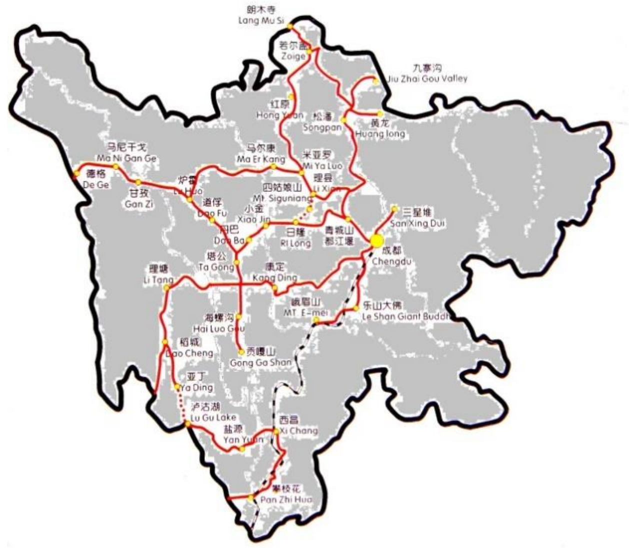
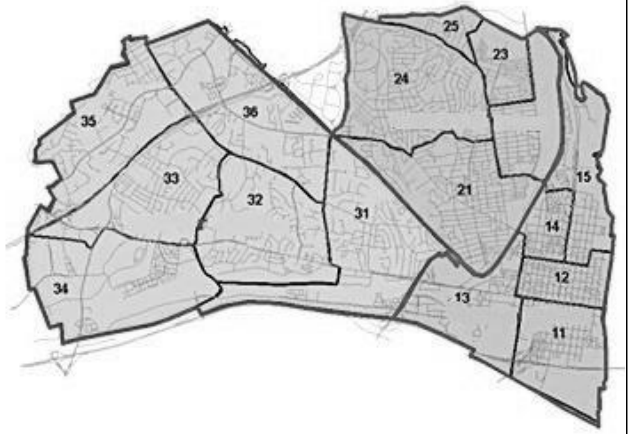
Chengdu	9,012,000	14,312	630	**Tokyo**	13,515,271	626	21,556
							
Alexandria	4,616,625	2,300	2,007	**Dhaka**	14,399,000	337	42,659
							

Sprawlization and uncontrolled growth of cities since the last decades generally welcomed most groups of citizens (Robert W. Burchell, David Listokin, Hilary Phillips, 1997). As a result, today’s cities have two different landscapes including old tissues with more density, and new tissues with lower density of population, activities and buildings. Therefore, people don't like more living in the cities' zones with old tissues, where threats their health and security (Roman Trubka, Peter Newman, Darren Bilsborough, 2010). It should be noted that, the fragmentation of open spaces and scattering residential areas increases social-economic inequality (Robert H. Freilich, Bruce G. Peshoff, 1997). Thus, in addition to the environmental costs, social and economic costs are identified as one of the main costs of sprawlization.

4.10.1. Social costs

According to studies, the value of land or house in the suburbs are generally higher than in other urban zones. Therefore, low-income families have a lower chance to live with other social groups together in a place. And this issue led to the polarization, increased social gaps, and created new urban spaces based on the income (Bajari, Patrick, Matthew E. Kahn, 2004). Therefore, the privatization of places, spatial and social segregations progressed urban expansion from the core towards suburbs and exurbs. Moreover, Euclidean or single-use zoning and land segregation change social behaviors and living conditions (Robert H. Freilich, Bruce G. Peshoff, 1997).

Reducing the quality of living conditions in the inner cores of cities because of air pollution, noise pollution, highly dense population, and traffic motives people to live in suburbs (Gerda R. Wekerle, Paul S. B. Jackson, 2010) (Barros, 2012), (John I Carruthers, Gudmundur F Ulfarsson, 2003). This thesis belives that, these issues resulted from inefficient urban development policies. If the low-income families are accepted to live in the city centers doesn't mean they are satisfied; perhaps this is their last alternative to find a temporary shelter. Maybe as soon as they have better living conditions they would live in suburbs. In such a chaos condition, maybe participation of researchers from different scientific fields such as urban planning, architecture, sociologist, politicians, NGOs and people is necessary in decision-making. Because, in this new millennium, urban issues became more complex than before. Today's urban challenges result from the pure idealism and execution of inappropriate policies.

Contemporary cities still are not an ideal living place for people. According to the **relativity** of **time**, **local and spatial conditions**, human needs and desires change over time. And the intensity of these changes depending on the lcoal and spatial conditions will be high or low. In this regard, today' changes of the **wishes** and **needs** of the current generation in comparison with the past generations in terms of quality and quantity have changed public desires and encouraged them to experience new places and things. For example changes of values, norms, culture, technologies, transportation, and economic activities. And these changes distinguish places from each other and create places with different landscapes and issues. For example, developing urban transportation systems increased urban mobility and enabled people to find a job rather far away from where they live. Aa a result, this issue is has increased suburbanization, and today's urban management tools are not enough effective to settle people within the official border of cities. Thus, accommodation of urban planning theories, methods and procedures, design, and management with the contemporary urban problems and challenges is inevitable.

We have to consider that, human needs are endless, and nothing can guarantee to keep all people within a city's borders for a long time. In tomorrow's cities, not only urban planners, architects, or policy-makers, but all social and scientific groups have to be invited in the city planning and building steps. In addition, unfortunately, over the past half-century, we have paid more attention to urban economic development than urban social and health development. And this issue has driven urban development towards non-sustainability.

This thesis argues that, modernism is the other main factors that has intensified urban changes, suburbanization and counterurbanization since the last decades. Actually, the modern urbanism was born to correct development policies mistakes of industrial cities using the Utopian proposals and new urban planning ideas (Pearlman, 2000). For example, London, with two development plans including County of London Plan (1943) and the Greater London Plan (1944) is a classic model of modernity that were provided by Patrick Abercrombie and his team. In both plans, designs of new residential areas were committed to a functional approach, and despite criticism were widely imposed to be implemented (Abercrombie, 1912), (Patrick Abercrombie, 1943). The other example is Europe's mass housing estate policy between the 1960s and 1970s and this policy is the result of the International Congresses of Modern Architecture or (CIAM[6]) (Miles Glendinning, 2019). This

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6 Congrès Internationaux d’Architecture Moderne (CIAM) or International Congresses of Modern Architecture

policy was designed to solve the shortage of housing quickly, but led to the rapid urban growth (Javier Monclús, 2016) (Javier Monclús, Carmen Díez Medina, 2018).

The other forces is technological urbanism that appeared as an alternative to traditional cities, with new ideas such as urban transportation vehicles and systems on the air. Rapid changes in technologies have supported modernisem to have more effects on the social economic sectors and generate new values and norms to reform social behaviors and reconstruct new landscapes and spaces. This thesis believes that, realizing a balance between technologies, places and life will be one of the most urban challenges in this century to give people a good sense of place and secure their health. Even, most western cities that were affected from modernism, however have intensified environemntal issues, and could not be able to give the people a good sense of place.

In tomorrow's cities, advanced technologies and machines will be the dominant shapers of the spaces with the following general revolutionary effects:

- Effecting on local and global mobilities and increasing compression of time, space, and place
- Effecting on the pattern and rate of activities and emerging new dramatic changes in human and natural landscapes.

Today, technologies are the critical part of daily life; therefore, managing and building a city just based on the architectural or planning theories and tools cannot be enough to move new urbanization and city development towards sustainability considering health and safety. Having a comprehensive view and proper understanding of the world's changes helps avoid any one-dimensional view in studying cities with multidimensional and complicated problems. This thesis belives that, studying technical forces must be an inseparable part of today and future urban studies and planning for sustainably shaping tomorrow's cities. Human behavior and lifestyle changed by changing and progressing technological tools, machines, and spaces, and helped us construct more complex and enormous constructions and spaces that we could not do before. Tools have been always a significant part of human life and civilization and will remain so. Humans have formed, structured, and shaped their settlements based on the need, behavior, and tools Figure 49.

Figure 49 A shift from the human's traditional lifestyle to the new and modern lifestyle. Designed by the author. And the first picture from the right at the top of this presentation was acquired from (Goswami, 2020), and the last picture from the left at bottom of this presentation was acquired from (de labour, 2020)

For example, it is clear if we argue that the nature and structure of historical cities referred to the era that was constructed based on local time and conditions. Regardless, how much the nature of historical cities contradicts modern cities, both are responsible for giving the people a good sense of place. But the quantity and quality of human needs, activities, norms, values, and abilities have been affected by the progress of technological tools over time. And today's cities are experiencing different conditions of space and time owing to the new smart technological tools and big data. And on the one hand, we can't prevent or restrict development trends. On the other hand, this is a complex challenge to limit the adverse effects of technologies on daily life and environmental degradation. Because of technological urbanism, carrying on the safety and health of people and cities will be one of the main challenges of tomorrow's cities.

Regarding technological urbanization, comprssion of the time, and complixity of the place and space, we do not know where we are going, and what will be happened negatively as a consequence of technological urbanization! But this thesis belives that, emerge of Urban Sustainable Development Agendas (USDA) and mobilization of all cities and governments to commit to this Agenda's principles are a conscious movement to direct development towards a projected future. It helps to have a shared goal for organizing global actions to shape a common future concerning safty and sustainablity.

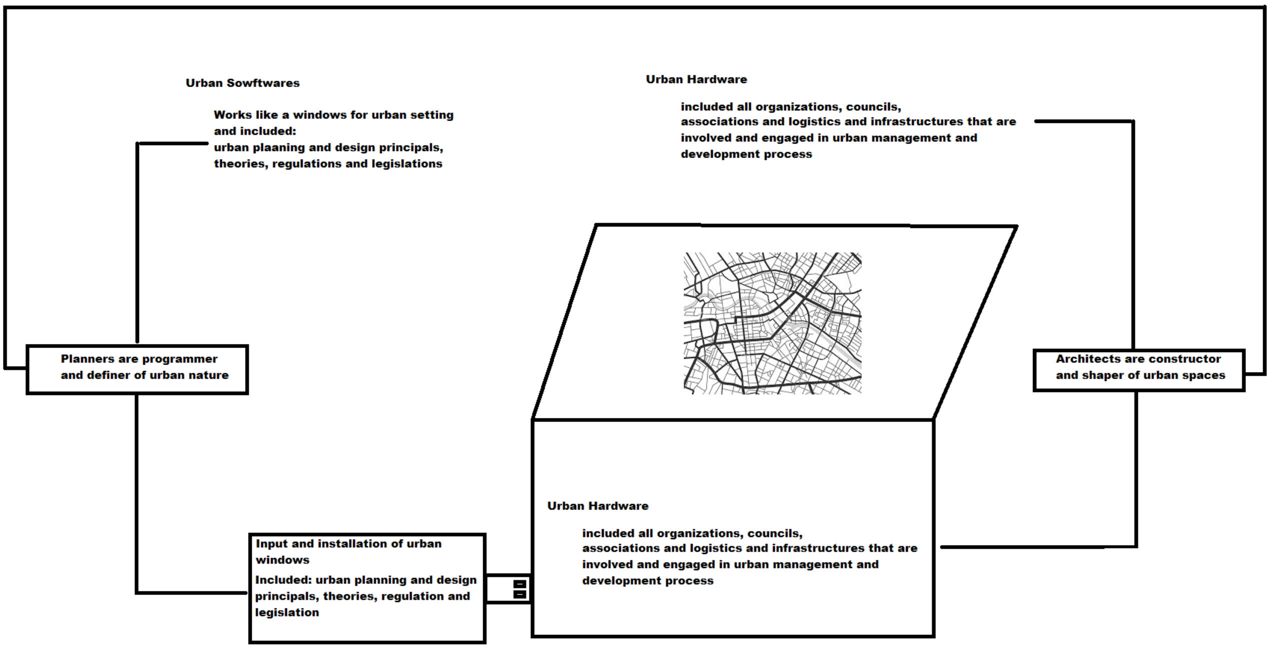


Figure 50 looking at the cities from the lens of technological urbanization (by the author)

4.10.2.Economic cots

Land value plays a significant role in allocating land and shaping the pattern, content, and structure of today's cities (Robert W. Burchell, Anthony Downs, Barbara McCann, Sahan Mukherji, 2005), (Chris Couch, Gerhard Petschel-Held, Lila Leontidou, 2008). It means any growth or reduction in the price of land parcels can increase or decrease the consumption of land parcels. In other words, the intensity of uncontrolled sprawl growth will be increased or reduced by land value. But it is different regarding urban zones. Generally, the density of space, place, elements, or activities tends to decrease from the center to the outside of cities Figure 51.

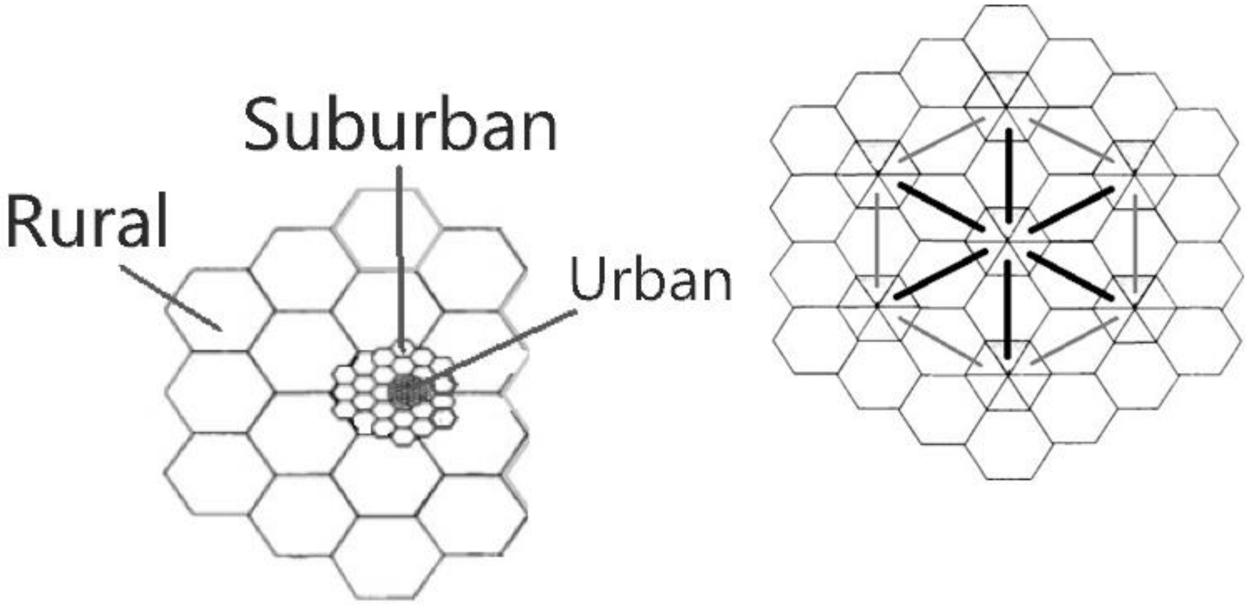


Figure 51 Different densities of land consumption between the urban, suburban, and rural areas (by the author)

For example, in Dhaka, the increase of land values expanded housing projects in non-development zones of this metropolitan area near flood zones, lakes, ditches, freshwater canals, etc. (Alam, 2018).

Figure 52 Living on the water, the new housing development project for the middle class, Dahaka, Pakistan, (Shafi, 2011).

Ottensman has done an empirical study that included fifty-one metropolitan areas on "Urban Sprawl, Land Values and the Density of Development." And the results have shown that a one percent growth in the population had increased the land value between twenty-five up to fifty dollars per acre at the whole of study areas

(Ottensmann J. R., 1977). Usually, landowners defer the development of their land parcels and sell parcels some years later to fill out additional land costs and attain more profit (Clawson, 1962). Because, population growth increases land demands and, it raises the land value. So landowners and stakeholders constantly monitor and analyze population and economic changes (Christopher Slemp, Mae A. Davenport, Erin Seekamp, Joan M. Brehm, Jon E. Schoonover, Karl W.J.Williard, 2012). Land value and population growth have a close linkage with the density of development. Large-scale migration and immigration to big cities have pressure on urban lands and spaces.

Low land value is one of the main factors that have made agricultural lands vulnerable in front of urban expansion, which escalated by home builders to achieve more profits (Fischel, 1982) (Karakayacı, 2018). Because, as long as selling a land parcel gives landowners more profit than planting, so they try to be rich through an easier way. Maybe, increasing the price of agricultural goods will be one of the best strategies to encourage farmers to keep farming instead of selling, and of course, this strategy is effective to control sprawl growth.

Uncontrolled land segregation and low-density development make the land market unstable and growth the land value (Paavo Monkkonen, Erick Guerrac, 2018) (Zana Naab Francis, Dinye Romanus Dogkubong, 2013). Suburbanization and nonstop land segregation have increased the cost of the building because of distance and transportation costs. Distance has imposed additional costs for constructing and maintaining new infrastructures and also providing public service (Roman Trubka, Peter Newman, Darren Bilsborough, 2010). Indeed, suburbanization grown by using the potentials of natural resources inefficiently and imposed severe costs to societies and the environment. For example, a study on the "cost of water and sewer infrastructure" has shown that the establishment of infrastructures in the sprawled areas imposes expensive and extra costs to the cities compared to other zones located in the insight of a city (D'Amato, 2010), (Maria-Pia Gennaio, Anna M.Hersperger, Matthias Bürgi, 2009). Also, in further research, were used 12 variables such as garbage collection, the establishment of public safety against crime and disasters, provision of services, education, library, etc.., to study the interactions between the density and general costs by per capita. And finally, the results have indicated that the intensification of density decreases the per capita of cost of services (John I Carruthers, Gudmundur F Ulfarsson, 2003). The continuation of suburbanization affects the type and area of services, investment rate, and quantity and quality of development projects in sprawled cities. In these cities, suburbanization declined the operating radius of central cores and changed the circulation of distribution of services at the whole of cities.

The other point is that, the rate of tax in the suburbs is lower than in the centers of cities, and this factor decreases the ability of centers to sell of competitive products (Myron Orfield, 2011). Also it affects urban mobility, makes suburbs more attractive and motivates residents to move from the main body of cities towards the suburbs or exurbs (David R. Morgan, Patrice Mareschal, 1999). For example, in the American cities many people that today live in the suburbs first have lived in the city centers. Because after the migration of people from other regions to the city centers, most of old habitants moved from centers to suburbs or urban fringes between 1950 and 1960. And this issue degraded the gravity and attraction of city centers (Levin, 1974).

4.11. Smart growth and counterurbanization

Considering the increasing public concerns on the negative consequence of sprawl growth patterns, supporting desprawlization ideas and long-term strategies in today's urban development policies is essential. And in this regard, some planners and policy-makers have been taken into account some approaches and strategies to control, and manage the sprawlization as follows:

- Reviewing and developing regulations and legislation to protect the environment (Harriet Tregoning, Julian Agyeman, Christine Shenot, 2002),
- Developing sustainable and effective public transformation systems (Turner, 2007),
- Redefine of urban functions for the non-functional and dead spaces (Ewing, 1999),

- Sustainable land use planning to control and decline degradation of segregated valuable land resources (H.J. Heineke, W. Eckelmann, A.J. Thomasson, R.J.A. Jones, L. Montanarella, B. Buckley (eds.), 1998).

In the late twentieth century, new theories such as Smart Growth was proposed to control and direct urban physical growth, especially in sprawled zones. In the early 1970s, urban planners considering the costs and difficulties of acquiring land to construct and expand highways tried to develop compact cities and communities approaches and adopt many regulatory approaches related to smart growth. Today, researchers employ this theory during planning and policymaking steps to integrate and protect the environment, sustain economy and resources, improve social justice, and enhance the quality of life. For example, in some research, smart growth was introduced as a promoter of high-density urban development and used to control the sprawl growth pattern or to revitalize unproductive urban spaces (Downs, 2005). In this regard, this thesis believes that, the Big Building with Multiple Functions Model (BMF) can be one of the best strategies to increase the capacity of land parcels, and change the direction of physical development in vertical form instate of horizontally like sprawl form. BMF model decreases the dependency of cities on land and also environmental degradations Figure 53.

Figure 53 A sample model of compacted and multifunctional building regarding the principles of smart growth (mixed-use)-(barbara-porada, 2013)

4.12. Concept of urban smart growth

Based on the philosophy and principles of smart growth, the American Planning Association noted that the smart growth theory helps reconstruct the allocation of resources from regionals to the local communities (O'Connell, 2009). The goals of the smart growth theory are not in contradiction to urban growth, and these goals attempt to propose a form of urban growth to a) sustain urban development, b) reconstruct and optimize unproductive spaces c) promote urban efficiency and liveability (Nabiollah Kolbadi, Mahmoud Mohammadi, Fahimeh Namvar, 2015). But It doesn't mean that the smart growth theory claim that the other past urban theories and plans were not smart. In fact, the smart growth theory attempts to meet reasonable and practicable strategies through a smart (cooperative and interactive) decision-making process considering todays' cities' conditions, potentials and challenges. Urban researchers in urban studies have always integrated this theory with the other urban ideas and concepts such as Sustainable Development, Green Growth, and Compact City to find practical solutions towards realizing sustainable urbanization.

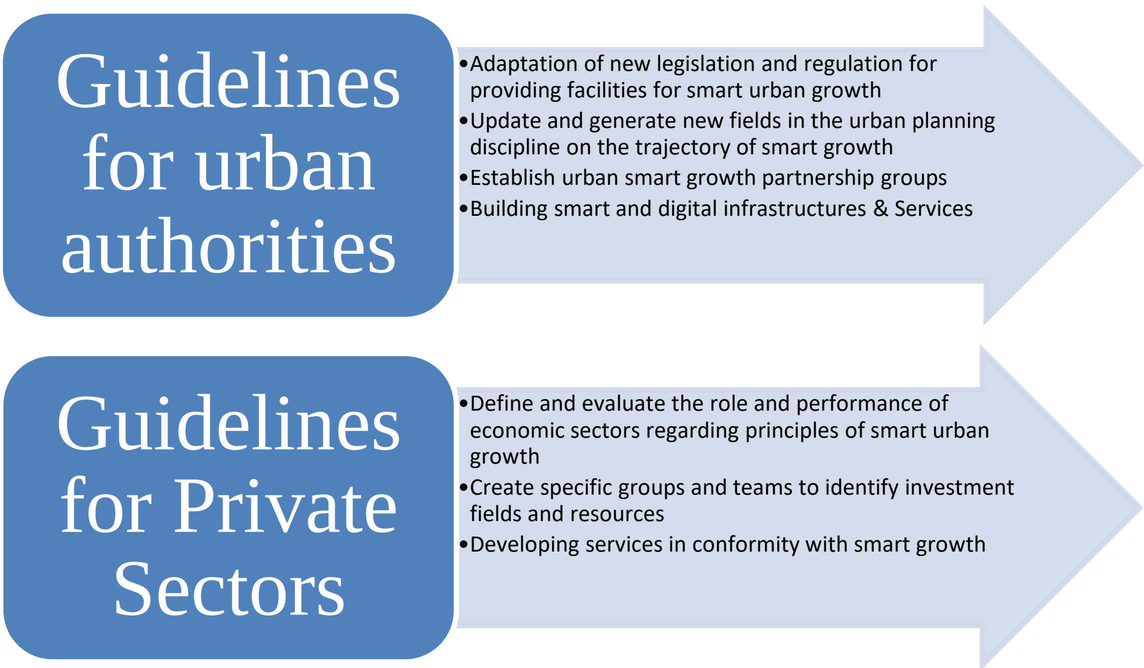


Figure 54 Guidelines for urban authorities and private Sectors (by the author)

This theory promotes "participation" at all the decision-making processes (L. Christopher Plein, Jeremy Morris, 2017). In fact, smart growth theory invites all social groups with different opinions or views to participate in the urban development process and making development policies based on a collective wisdom. This theory maximizes participation by assuring the citizens that their views are central and will be considered in the decision-making process. Because the mutual respect and interaction between dwellers and planning teams play a substantial role in implementing successful urban development plans.

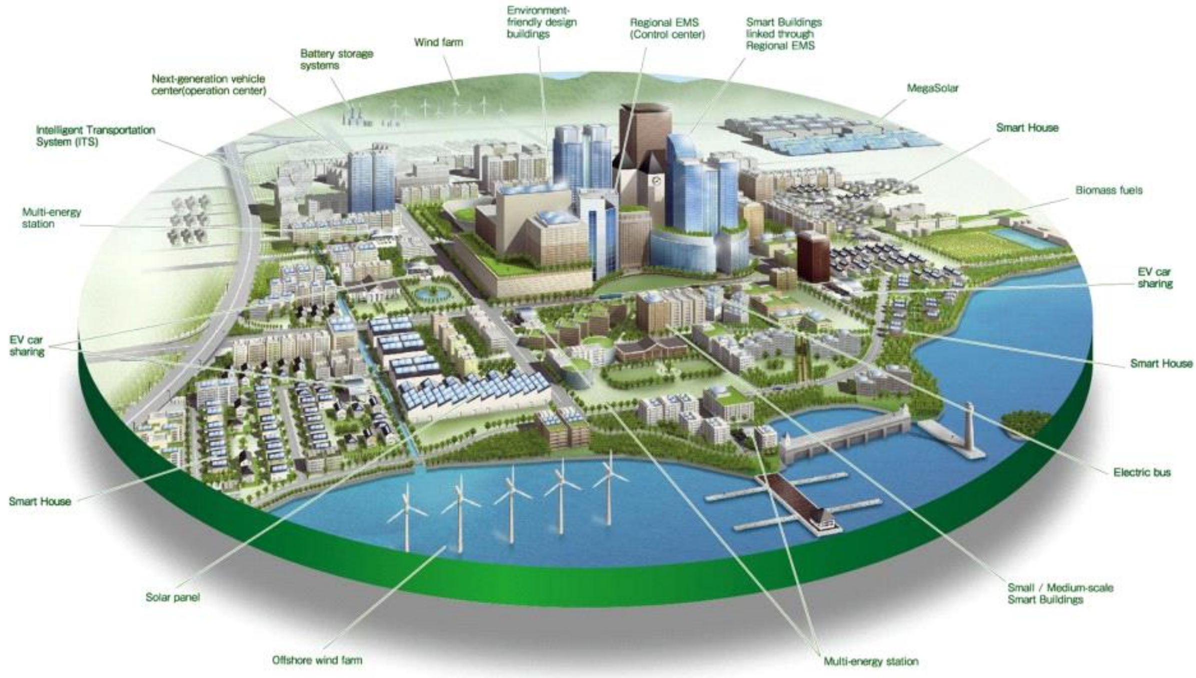


Figure 55 Conceptual model of a smart city according to the principles of the Smart Growth theory (Schilling, 2015)

The significant effects of the smart growth theory:

1- Increasing the efficiency of mixed-use buildings

2- Enhancing advantages of a compact building

4- Increasing productivity and efficiency of urban spaces and social dynamism

5- Protecting open spaces and valuable resources

6- Attempting to develop and employ some strategies with more predictability

7- Providing a sustainable form of transportation systems and options

8- Encouraging people and stakeholders to participate in the decision-making process to meet the best development strategies (Lin Ye, Sumedha Mandpe, Peter B. Meyer, 2005), (Zhang, 2017).

Chapter Five

Land use planning

5.1. Land

There are different descriptions for the word "land" in the scientific fields. Examplarly, for economists, the definition of land mainly concentrates on the economic characteristics of the land. Or geomorphologists conceptualize and classify a land regarding topographic and bathymetric features. For geomorphologists, the type, material, and form of the land are more significant than the economic characteristics of a land parcel.

Cloak (1989) defined land as a basic form of private ownership that can be traded or used as public ownership (Isilda da Conceçäio, Joäo Nhantumbo, 1997).

This study defined land as a base for activities considering the social-economic and environmental aspects for each land parcel.

Land activities are the leading factors that have accelerated land cover changes. For example, on the one hand, we are experiencing massive changes in technologies and tools since the 1970s. But, on the other hand, these changes increase the presence of technologies and machines in humans' daily life and changes human behavior. As a result, changing human behavior changes human activities, and changes in human activities will change places and spaces. Technological developments have imposed extraordinary changes to the spatial forms and interactions, communication, and transportation systems. And these significant changes have increased the sphere of influence of cities and developed physical, social, cultural, and economic sectors. As a result, have provided millions of new job opportunities, especially in urban areas, and increased welfare, public health, and population size. Hence, rapid urbanization and agglomerated cities have increased demands for new land parcels regarding the type of activities and densities.

5.2. Land use

In general, land use plans emerged in the 1950s and was included remarkable principles and guidelines for each land parcel and type of activity considering social-economic aspects to direct urban growth and development (Edward J. Kaiser, David R. Godschalk). Land use planning is an activity that involves human interaction with the land (Grzybowski, 2014). In other words, the land-use plans rearrange land and activities for specific goals (Kumar P. , 2013).

Later many researchers have been tried to develop this model as Chapin, who has played a significant role in developing principles of the urban land-use plan between the 1950-the 1960s (F.Stuart Chapin, 1965). In general, this plan embraces the following steps: mapping, predicting, and planning urban lands. And also, a land-use plan covers the following actions, including locating, determining the type of activity for each land parcel, such as commercial, retail, residential, cultural, educational, etc. Today, principles of this plan regarding the spatial complexity will be reviewed and tried to import environmental concerns and sustainable development principles in the land use planning studies to control and diminish environmental tensions like climate changes, air pollutions, or degradation of natural capitals.

Regarding this thesis, land use planning is a practice to provide a safe and pleasurable place and accommodate human behaviors with the daily needs considering the local potentials and limitations. In this state, **human needs** are regarded as leading landscape shapers, but the rate of changes depends on the role and levels of **activity**.

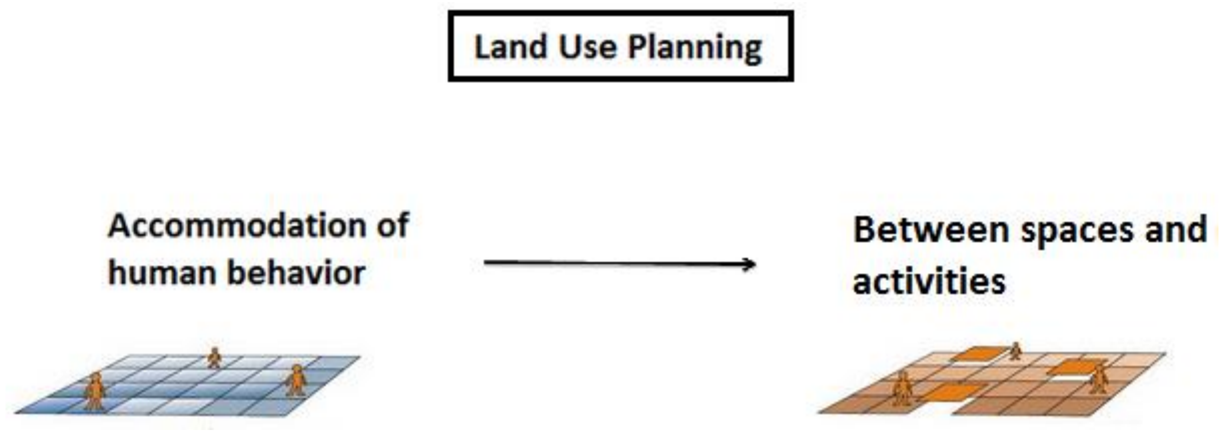


Figure 56 A conceptual representation of land use planning (by the author)

Land use maps can be regarded as a well-connected thematic plan and prepared through the technical and official processes. Today, these plans are employing by planners for monitoring recent changes in the land development process, better direction and management of land development, also identifying new sites for development (Matsuoka, 2004). Land-use planning practice is regarded as a mechanism that helps us meet the needs and interests of private or public sectors.

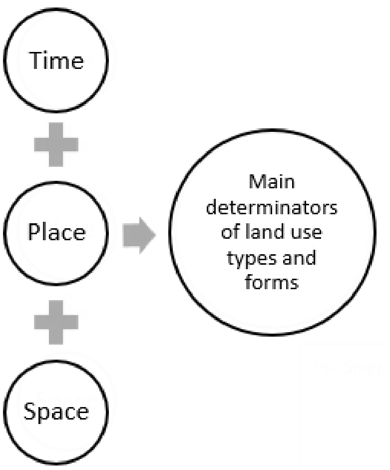


Figure 57 The main pillars engaged in the evolution of land use planning (by the author)

Regarding this thesis, the following three factors play significant roles in the change of the land use types and activities including Time, Place, and Space.

5.2.1. Time

The factor Time is a significant part of occurred changes in landuse types and activities and quantitatively or qualitatively. For example, since 19th century have been occurred significant changes in the urban activities and land uses. And these changes have changed or even reformed urban forms, spaces, and interactions among humans, activities, and places. Therefore, redefinition of "land" and "land use" is required in the land-use studies regarding these massive changes. Moreover, it is necessary to understand better the new phenomena and their interactions over time.

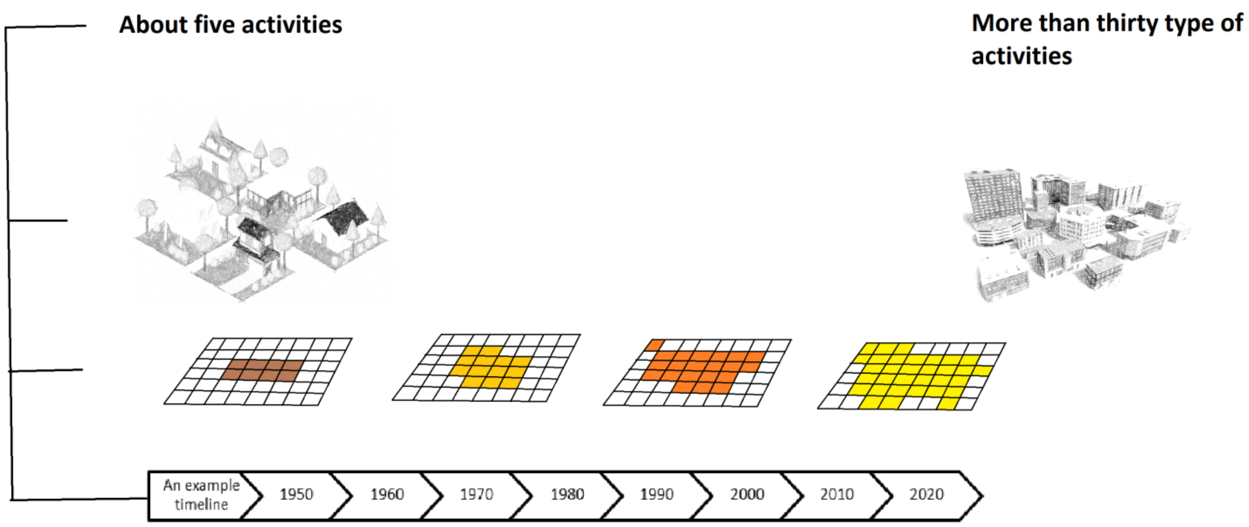


Figure 58 Change and progress of land use quantitatively and qualitatively (by the author)

5.2.2. Place and space

In this study, "**place and space**" are regarded as two inseparable parts with significant roles in creating and changing phenomena such as land use.

"Place" is defined as a physical or nonphysical base for human activities and divided into known space and unknown space. The interactions between the physical or nonphysical places have reshaped the type of land use and activities in a large-scale and multiple set of spaces and places. For example, cyberspaces have changed land uses by changing and reforming human activities and behavior. Please consider the consequences of these changes on the physical and nonphysical urban elements. The cyberspace reshapes the environment, generates new physical forms in urban spaces, and reconstructs places and buildings. In the following decades, growing the dependency of humans on the internet, will increase the presence of cyberspace in reshaping and rearranging physical spaces and forms remarkably.

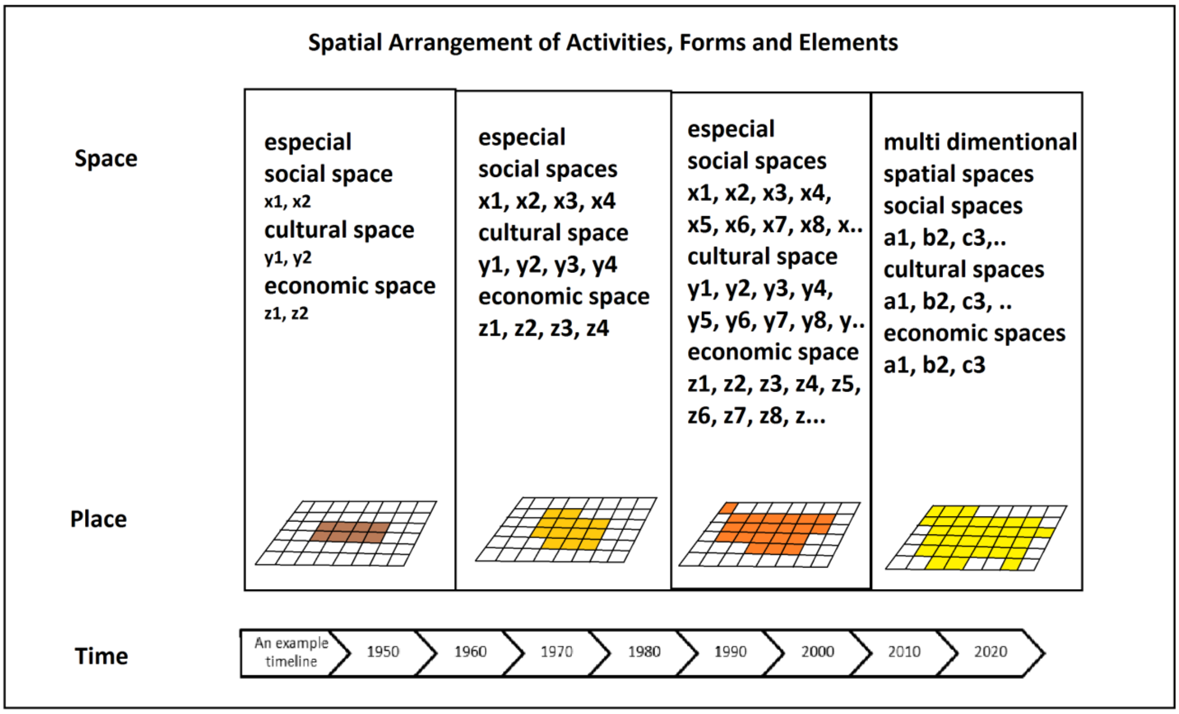


Figure 59 Develop and increase of land use activities considering time, place, and space (by the author)

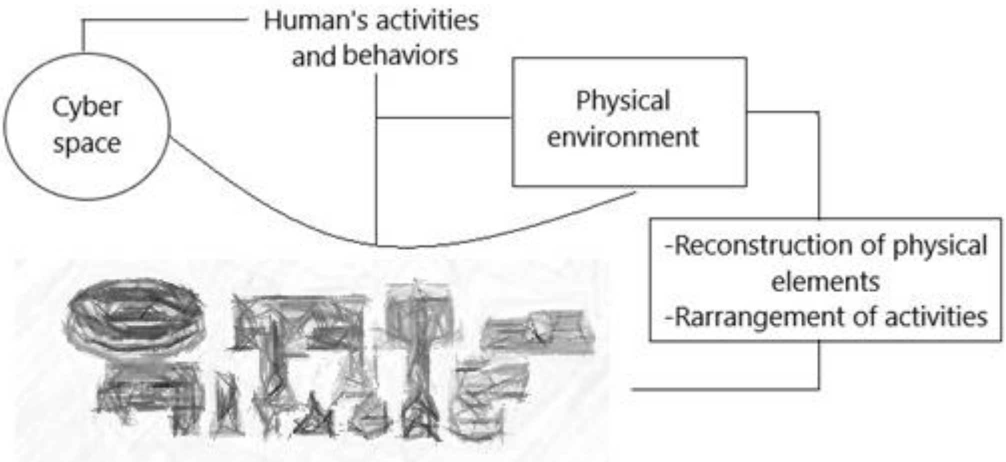


Figure 60 The interaction and communication between human's real-world and cyberspace (by the author)

5.3. Sustainable land use

Since the last decades many researchers have studied "land use planning and sustainability" from different aspects, especially after publishing the two following reports including: the report of "Brundtland Commission" in 1987 on the, "Our Common Future," and the report of "Earth Summit" in Rio de Janeiro in 1992 (UN-HABITAT, 2010). These conferences have progressed using the principles of sustainable development in urban land use planning globally (Xiaoling Zhang, Yuzhe Wu, Liyin Shen, 2011). Management and protection of land and environment are tied to the sustainability of social, and economic sectors. In this regard some theories such as Mixed-use and Compact Development were developed to improve land use management regarding sustainability. And also to enhance the efficiency of land parcels and decreased the consumption of raw lands.

After the appearance of sustainable development theory, researchers have developed or promoted this theory in different fields including technologies, politics, and industries, to apply the principles of sustainable development in the social and economic strategies. For example, In 1993, the American food and agriculture organization has provided a framework for assessing land use and management sustainability. According to the designed framework, sustainable development principles have also been employed for measuring land development and helped to realize an effective and sustainable form of land use.

5.4. Land management and land administration

United Nations Economic Commission for Europe UNECE (1996) had explained the land administration plan to provide a big databank around land use data and land tenure. In contrast, land management is considered a set of policies, legislation, and functions for land development. The land administration is an attempt to preserve the potential of land, run sustainable land uses, and conserve valuable natural resources (Peter Dale, John McLaughlin, 2000). Given Enemark (2003), land management includes all sectors mentioned above in realizing sustainable land development (Agnieszka Dawidowicz, Winrich Voß, Bernd Leonard, 2013).

Regarding UNECE, the land administration system is designed for achieving the following goals:

- Increasing the security of land ownership and reducing conflicts
- Monitoring the land development
- Land management considering the environmental limitations
- Providing a data bank of land ownership

The land administration helps allocate land resources concerning social-economic factors and provides needed lands for housing projects. Or providing a databank of land ownership helps for providing urban infrastructures. The informal land tenure and illegal land grabbing due to the lack of comprehensive lands ownership databank have expanded the urban informal sectors. Tracing and recording land use changes help to manage and monitor urban lands effectively (Agnieszka Dawidowicz, Winrich Voß, Bernd Leonard, 2013). Unfortunately in many countries, because of the lack of efficient land management system, controlling the land value and land use changes are one of the main challenges particularly in developing countries (Daniel Hoornweg, Mila Freire, 2013). For example, suburbanization has progressed informal settlements and in some cases, people occupied land parcels illegally and built up without a building permit (Kwasi Gyau Baffour Awuah, Felix Nikoi Hammonda, Jessica Elizabeth Lamond, Colin Booth, 2014). Hence, using an efficient land administration system can help to manage land-use changes (UN-HABITAT, 2010).

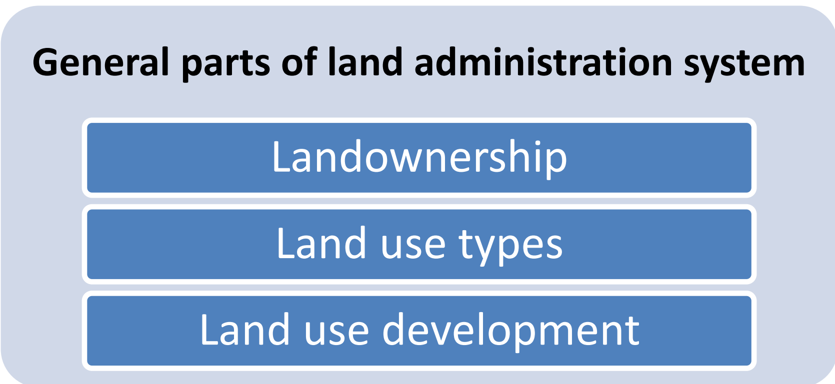


Figure 61 General parts of land administration system (by the author)

In general, the land administration system (LAS) records the following information for a land parcel:

- Landownership
- Land use types
- Land use development

5.4.1. Land ownership

It refers to the identification and recognization of people's real estate in a place through law (Kimani, 1972) . Regarding the factor of time, ownership can be temporary or permanent. Regardless types of land ownership, securing the right of ownership is very important for owners. Ownership has various types such as: rental houses (private and public), Housing co-op, House lease, Owner-occupancy, Emergency housing, and informal settlements.

5.4.2. Land-use types

The factor land use type is employed to detect and define types of land use for each parcel in a databank, such as, residential, agricultural, industrial, commercial, etc.,.

5.4.3. Land use development

It includes all roles, actions, and strategies for the development of land parcels (Agbosu, 1980).

Numerous of land parcels and owners at the regional and national levels shows the necessity of an efficient land administration system. For example, industrialized countries have provided required infrastructures and tools for an effective land administration system especially using Geographical Information System (GIS), Remote Sensing, and satellite images, to trace and control land-use changes. Such advanced technologies reduce the factor time during data collection. But one of the other main tools is, *public participation* For data collecting and providing an effective land administration databank. Therefore, developing some strategies considering local conditions and potentials for encouraging people to participate in this project is necessary.

5.5. Urban land-use planning

In urban studies, the concept of urban land use planning has been employed and defined vary regarding the geographical and local conditions (Wei-Ning Xiang, Keith C Clarke, 2003). Since the last decades, most of land use planning studies were "issue-oriented" to identify the reasons of inefficient land development strategies and policies (Caroline Raphael, 2011), (Raphael, 2011). Urban land-use planning can be considered as a conscious practice for the management of urban lands regarding the social-economic conditions, environmental concerns, and limitations. This plan is a try to meet the needs of people and balancing the pattern of activities. The implementation of this plan encompasses a set of tools, data, methods for analyzing, assessing, measuring and evaluating the urban development, urban growth, urban land market, land demand and supply. And also this plan studies the social, political, and economic factors in land use planning.

This study believes that, urban land-use planning determines people's interactions in a place. Also it is regarded as a spatial distribution of the urban functions and allocation of spaces to the activities such as residential, commercial, industrial, and ect. (Yu-Hsin Tsai, 2015), (White, 1979). For defining a type of activity for a land parcel paying attention to some factors is important such as: slope, soil, climate, density, distribution, compatibility, desirability, dependency, capacity, accessibility, and functions (Shaheen L. , 2006), (B. L. Turner, William B. Meyer, David L. Skole, 1994).

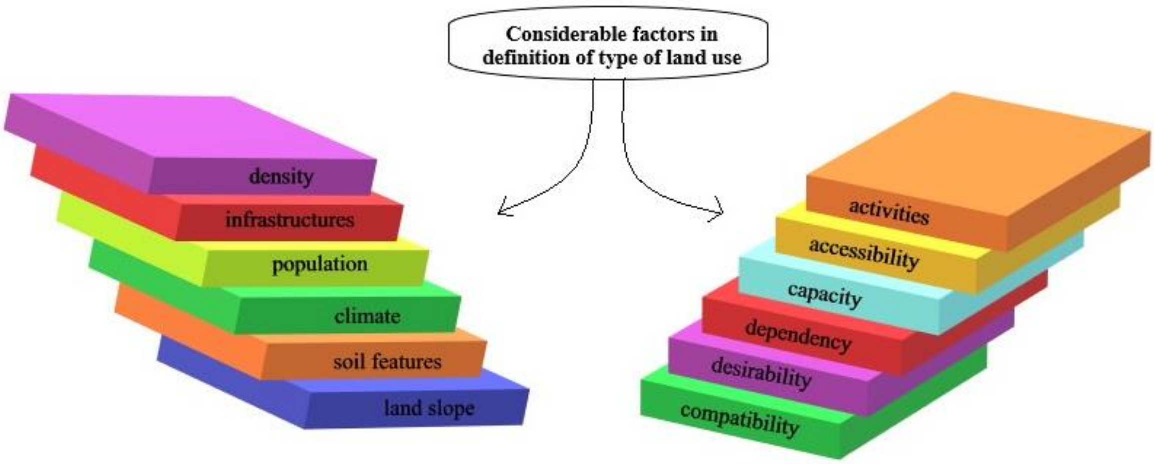


Figure 62 The important factors in the determination of activities for land parcels (by the author)

5.6. Complexity in the process of urban land use planning

Since the last decades the land-use planning practice became more complex than before. Because the unpredicted internal and external dynamic factors have always faced this plan with some unwelcome challenge So, we need new land-use planning models to analyze many criterias simultaneously and comprehensively. In an complex urban system, there are many influencive factors among people, activities, and land parcels that faces the implementation of land use plans with difficulties. According to this study, in Iran, human factors more than the other factors have faced this plan with many challenges.

The general parts of this complexity includes players, spatial setting, and cooperating process.

Players:

According to this study, the involvement of people and groups in the land use planning process regarded as one of the main drivers and shapers of an "urban spatial organization" that encompasse both human and natural spaces. The duration of the execution depends on the urban authorities and participation of groups and organizations in the planning process. But depending the case and interests, the power groups under political backing endeavor to increase their financial and political interests. If their request encountered a disagreement in the planning process, they tried to manipulate the plan and impose their interests in the project by force or other tools. So, respect to the law and order, increasing presence and power of the regulatory agencies help to diminution such problems considerably and implement the plan successfully.

Spatial setting:

Divers of spatial functions regarding different land-use types have escalated the complexity of spatial settings. Therefore understanding the compatibility or incompatibility of spatial roles with these activities is challenging. How much can it be challenging if we use a land parcel for an spacific activity that actually is not allowed in a land-use plan? For example, using a land parcel with educational aims for commercial activity? Regarding the area of a parcel and the necessity of the activity it can influence all social-economic interactions in a city zone or even at the whole of a city. It can intensify traffic by increasing the rate of daily trips and mobility in an especific zone of a city. But in this example we talked about a zone of a city. Imagine if all cities of a country like Iran have been faced with this issue! In Iran, unfortunately no city could successfully implement a land-use plan! Generally just between ten to twenty percent of the plan's goals became realized. About eighty percent of the proposed activities and allowed densities for each parcel in this plan couldn't come true. Now you can imagine what disaster happened to the Iranian cities. This is one of the main challenges of Iran's contemporary cities. This difficulty created many issues and imposed pressure on the capacity of infrastructures.

Cooperating processes:

Cooperating practice and how it can be succeeded hang on some political and administrative structures and social-economic capacities in the land use planning and executing phases (Arnab Chakraborty, Nikhil Kaza, Gerrit-Jan Knaap, Brian Deal, 2011), (A.Huberman, 1990). The cooperation improves communication among all project parts and increases the proportion of a successful implementation of the plan.

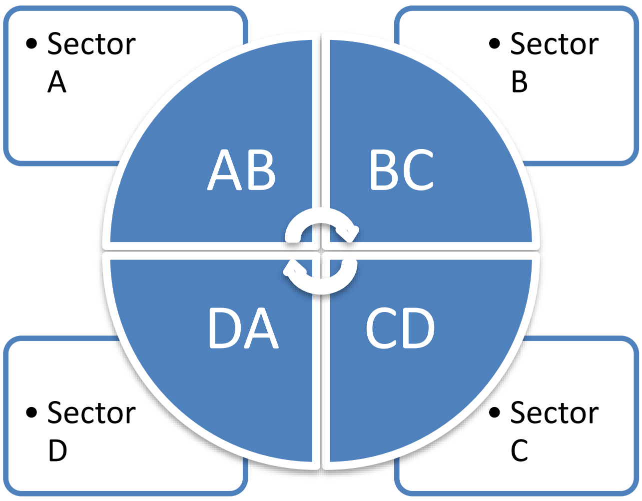


Figure 63 Conceptual networking model to have exact data sharing between sectors in a system (by the author)

If we consider the land-use plan as a project that tries to realize harmony among the people, activities, and needs to minimize the tensions between humans and the environment. So, in this sense, the environment is conceived as an independent factor in land use planning. The environment is the space where people are working and living and, because of that, constantly is in changing. But the dimensions of change are conditional, and depending on the place, forces and humans' activity will be different. But it should be noted that the connections and interactions between urban activities determine land use segregation or integration.

5.7. The land use classification

Land use classification is a more general map to identify and specify the type of land uses on a map on a large or small scale. And the covered features on this map will be different thematically; exemplary contains forest, mountain, built-up areas, rivers, cultivated lands, and vegetation covers. This plan helps the planners and organizations to classify all environmental elements, potentials, capacities, and limitations in a particular place. For example, encourage urban growth in some places with the lowest ecological concerns and limiting urban expansion in the natural protected areas (Daniel Hoornweg, Mila Freire, 2013), (Arend Ligtenberg, Arnold K. Bergt, Ron van Lammeren, 2001).

In urban studies, land use classification regarded as a regulator tool that helps the local and national organizations to monitor and control land cover changes and determine what parcel, when and under what rule and legislation must be used. In addition, it is a supportive tool to protect non-development areas, especially vulnerable regions. Additionally, this model provided a prototype concept for land classification and prioritization of planning area in three classes: 1- protected natural areas, 2- Cultivating lands, 3- Settlements.

Protected natural areas: this class has the highest priority and includes all places that must be protected against any buildings and constructions.

Cultivating lands: this class has the second priority and includes cultivating lands such as agricultural lands, forests, etc. (Edward J. Kaiser, David R. Godschalk, 1995).

Settlements: this class has third priority and includes all built up areas for living, working, and other activities.

Chapter Six

Methodology

Methodology

The type of this thesis considering the aims is descriptive and analytical to describe the current issues and give reliable answers to the questions. Methodologically, this thesis is qualitative and quantitative and uses used statistical data, mathematical models, and softwares to analyze and measure social-economic changes, urban development, and sprawl growth of Sari city.

6.1. The applied demographic projection models

6.1.1. Projection of population growth

Population predictions are like 'what-if' scenarios to determine how the population will grow in the expectation (United States Census Bureau, 2017). These projections are essential to calculate the population's force on this planetoid and the communities' future well-being (Kaneda, Toshiko, 2014). Patterns of population growth take trends in social development and employ predictions into the prospect (Roser, 2019). These models use trend-based presumptions concerning how populations react to business, social and technological powers to determine how they influence fertility, mortality, net migration, and population growth (Office for national statistics, 2021).

In this chapter, some prediction models for population change are provided included the Modified Exponential Model and the Linear Regression Model to predict the population growth in the next few years and decades.

6.1.2. Modified exponential model

Exponential growth is a example of data that reveals greater increases with passing time, creating the curve of an exponential function (Chen, 2021). According to Malthus' model, once population size exceeds available resources, population growth decreases dramatically. This accelerating growing population size is called "exponential growth," signifying that the population increases by a fixed rate each year (Zehnder, 2021).

This type of growth can be represented by applying a mathematical function known as the exponential growth model:

$$P_{(t+n)} = P_{(t)}(1+r)^n$$

$P_{(t+n)}$: population in the year t+n (end of period)

$P_{(t)}$: population in the year t (start of the period)

n: period considering (month, year, half of a year)

r: the annual growth of population

So that r (the annual growth of population) will be calculated by using the following formula:

$$r = (\sqrt[n]{\frac{P_{(t)}}{P_{.}}} - 1) \times 100$$

In this model, the amount of population growth is addressed to the size of the current population. The proportion between the population growth and the total population is fixed (Mirnajaf Mossavi, Hassan Hekmatnia, 2011).

6.1.3. Linear regression model

Linear regression enables you to make predictions on the data, and it is intuitive and easy to understand (Ognjanovski, 2018).

Using the relationship between two variables, this model can calculate and estimate a variable by another variable. So that the variable Y changes concerning the time X. Therefore, can realize a linear relation between two groups of variables as follow:

Y= ax+b
Linear equation

The amount of a and b is coefficients that can be calculated through the following formulas:

$$a = \frac{\sum xy}{\sum x^2}$$

$$b = \frac{\sum y}{N}$$

N: is the number of periods (Mirnajaf Mossavi, Hassan Hekmatnia, 2011).

6.1.4. Elasticity analysis

This study has applied elasticity analysis to know which life-history stages most impact on population growth. Sensitivity and elasticity are long-established, widely-used instruments for pinpointing effective peculiar demographic rates in this process (Lee, 2016). Elasticity analysis is a manageable initial measure in clarifying essential issues in evolutionary and population science. (Benton, Tim & Grant, Alastair, 2000). Elasticity analysis estimates the proportional change in population growth rate for a given change in a population rate parameter (Bart W. Durham and Gene R. Wilde, 2004).

This model is an index to estimate the percent of the urban population versus the total population. It means how much has increased or decreased the city's population as a case study for each one percent increase in the total population at the (national, regional, or local) levels in a specific period.

This study used the following formula for estimating the elasticity rate of population growth:

$$E_{(t,t+10)} = \frac{Y_u(t, t+10)}{r(t, t+10)}$$

E: is equal to the elasticity rate for a period t,t+10

Y_u: the annual growth rate of urban population

r: the annual growth rate of the total population

6.2. The Rank-Size Rule and Zipf's law

Flix-Auerbach is a German geographer and, in 1913, has provided the Rank-Size Rule to analyze the relationship between the size and place of cities (Mirnajaf

Mossavi, Hassan Hekmatnia, 2011). And later in the 1940s, George Zipf identified a curious regularity in the distribution of cities of varying sizes; if cities were ranked from largest to smallest populations, then

$$P_r = \frac{P_1}{R^b}$$

P1: the population of the largest city or town,

PR: is the population of the smallest city by rank,

b: is a coefficient that must be established through empirical observation for each investigation. The superior the value of b, the steeper the slope, and the greater the primacy of the largest city or town.

George Zipf defines the above formula in a logarithm form as follow:

$$LogP_r = LogP_1 - bLogR$$

$$b = \frac{Log\ \frac{P_1}{P_r}}{LogR}$$

The contribution of rank-size rule in urban regional planning:

- It helps in the understanding of the relationship between rank and population size of settlements.
- It helps in analyzing the settlement networks.
- It explains settlements concerning economic activities as an increase in activities increases the population.
- It explains the imbalance between the settlements due to rapid growth in population or activities (Kumar V. , 2017).

6.3. Regression model

It is normally possible to relate the ranks and sizes rule by using regression analysis (Minimum squares method) and calculate the rate of the line of slope (b).

Y= a+bx

b: the rate of the line of slope

a: is a fixed value

x= is the logarithm of the rank of a city

y= is the logarithm of the size of the population of a city

If b>1 means there is no balance between the size of population and rank of cities, and most of the population is moved to the big cities. And if b<1, means a balance between the size of population and rank of cities and importance of the medium and small-sized cities in the urban hierarchy.

6.4. Location Quotient model (L.Q)

Location Quotient (LQ) is a useful way of quantifying how concentrated industrial, agricultural, and services in a region as compared to the nation (Strotebeck, 2010). It can show what makes a individual region unique compared to the national average (Walter, 2019). Utilizing the location quotient is a powerful way to identify growth opportunities and comparative regional advantages (Goodwin, 2018).

$$L.Q = \frac{\frac{TNi}{TNa}}{\frac{CNi}{CNa}}$$

$L.Q$= Location Quotient

TNi= the number of employments in i sector locally

TNa= Overall employment locally

CNi= the number of employments in i sector regionally or nationally

CNa= Overall employment regionally or nationally

If $L.Q > 1$ means the place that can be a city is the exporter of that product or service, and if $L.Q < 1$ means the city is an importer of that product or service. And if $L.Q = 1$ means the city is independent.

6.5. Entropy Index

This model helps measure the inequal distribution of population and cities in the urban network at the regional and national levels. It helps to know if a balance is established between the population and size of cities in a metropolitan area.

The formula for entropy is:

$$H = \sum P_i LnP_i$$

$$G = \frac{H}{LnK}$$

H= Sum of the frequency in the natural logarithm

Pi= Frequency

LnPi= frequency of the natural logarithm

K= the number of classes

G= the value of entropy

According to the principles of the Entropy Index, (G) is the rate of entropy. If the rate tends toward the value (0), it means intensifying population agglomeration and imbalance in the population distribution. Suppose the value tends towards (1) or even more, so it means normal distribution of population and establishing a balance among the cities in an urban area.

As presented in table 56, the cities are classified into different groups based on the population size in the first column. In the second column showed the real population, and then calculated rate of Pi: frequency, Ln (Pi) Ln Pi: Nehprii frequency logarithm, and Pi*Ln (Pi)].

6.6. Isard's Longitudinal and Transverse model

This model is a method to analyze economic conditions to understand and project the share of economic sectors at the local, regional, and national levels.

In this matrix, x shows the percent of employment change at the national level, y shows the percent of employment change at the regional or city levels.

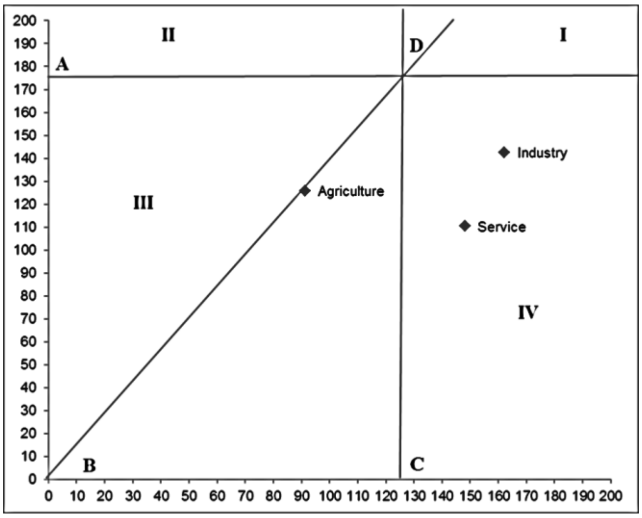


Figure 64 Isard's longitudinal and transverse matrix (by the author)

Suppose one of the economic sectors is placed in part **I**. In that case, the sector has a better condition than the average economic growth at the local, regional or national levels.

Suppose one of the economic sectors is placed in part **II**. In that case, it means the sector is less than the average economic growth of the nation and more than the average economic growth at the local or regional levels.

Suppose one of the economic sectors is placed in part **III**. In that case, it means the average economic growth of that sector is less than the average economic growth at the local, regional, or national levels.

Suppose one of the economic sectors is placed in part **IV**. In that case, it means this sector is more than the average economic growth of the nation and less than the average economic growth at the local or regional levels.

$$Percent\ of\ changes = \frac{The\ beginning\ of\ a\ period}{The\ end\ of\ a\ period} \times 100$$

6.7. Lorenz Curve

One of the methods to measure hierarchies of cities and spatial distribution of population in a metropolitan area. This curve has two axes, horizontal (x) and vertical (y) and values between 0-100 and means the percentage of cumulative frequency.

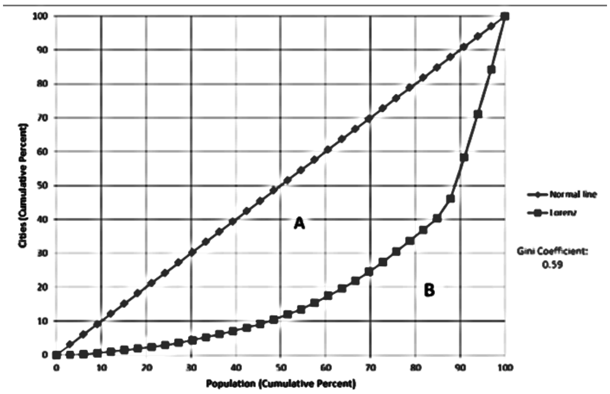


Figure 65 A simple view of the Lorenz Curve (by the author)

In order to show how the cities are populated in this curve, the axis X is used to indicate the cumulative frequency percentage of cities, and axis Y to show the cumulative frequency percentage of cities groups.

The straight or normal line is the "line of perfect equality. Continue of this text in the Gini coefficient part.

6.8. The Gini coefficient

The Gini coefficient is the area ratio between the line of ideal equality and the observed Lorenz curve to the area between the line of ideal equality and the line of perfect inequality. The higher the coefficient, the more unequal the distribution is.

$$J = \frac{A}{A + B}$$

J: The Gini coefficient

A: The area between the Lorenz Curve and the normal line

A+B: are the areas of the parts A and B

Based on the Gini coefficient, if G=0 means complete equality, G>0 and up to 0.25, means relative unequal. If the result is between 0 .25 – 0.5 expresses Unequal; if between 0.5 – 0.75 means more unequal, and if between 0.75 – 100 says total inequality (Critical situation).

6.9. MAXLIKE (Maximum Likelihood)

The MAXLIKE module has provided the Maximum Likelihood procedure in the IDRISI Image Processing toolset to compensate for the main deficiencies of both the Parallelepiped and Minimum-Distance-to-Means procedures. The Maximum Likelihood procedure is based on Bayesian probability theory. The MAXLIKE module uses the mean and variance/covariance data of the signatures to estimate the posterior probability to determine which pixel belongs to predefined classes (Clarklabs, 2020).

In many ways, the MAXLIKE module is similar to the MINDIST with the standardized distance option. The only difference refers to the MAXLIKE accounts for intercorrelation between bands (Reveshty, 2011). MAXLIKE incorporates information about the covariance between bands as well as their inherent variance and produces an elliptical zone of characterized signature but conceptualized (Paul, S. S., Li, J., Wheate, R., & Li, Y., 2018). In fact, it determines the posterior chance of belonging to each class, where the probability is highest at the mean position of classifications and falls off in an elliptical pattern away from the mean (Parth Sarathi Roy, Lars T. Waser, 2017).

6.10. Land change modeler

6.10.1. The Change Prediction Process in LCM

Land change prediction is an empirical observation driven process in Land Change Modeler that moves in the following stages 1) Change Analysis, 2) Transition Potential Modeling, to 3) Change Prediction. It is based on the historical change of land cover maps from time point 1 to time point 2 to project future scenarios (Kshitij Mohan, Praveen Kumar Rai, Varun Narayan Mishra, 2014).

The Land Change modeler interface is structured around a set of six main tasks:

- Change Analysis: Analyzing earlier landcover change
- Transition potentials: Modeling the potential for land transitions
- Change prediction: Calculating the possibility of change into the future
- Planning: Calculating planning interventions
- REDD Project: Estimating GHG emissions from REDD projects
- Harmonize: Constructing land cover maps to use in Land Change Modeler (lab only launches when landcover maps are incorrectly formatted) (Clarklabs, 2020)

The landcover maps used by LCM must be formatted to meet the following conditions:

1. legends in both maps are the same.
2. Classifications in both maps are the same and progressive.
3. Backgrounds in both maps are the same and have a quantity of zero.
4. Spatial dimensions, including resolution and coordinates, are the same (R. K. Jain, Kamal Jain, S. Rehan Ali, 2017).

6.10.2. Change analysis

The change is calculated concerning time point 1 and time point 2 between two land cover maps in Change Analysis. Identified changes are transitions from one land cover state to another. It is likely that with many landcover classes, the possible combination of transitions can be very large. What is important is to identify the dominant transitions that can be grouped, modeled, and termed submodels (Nidhi Nagabhatla, C. Max Finlayson, Sonali Seneratna Sellamuttu, 2012).

6.10.3. Transition Potential Modeling

Transition Potential Modeling is the subsequent phase in the change projection process, where we can identify the potentials of land to transition. This step will create potential transition maps of suitability for each transition. In LCM, a collection of potential transition maps is organized within an empirically evaluated transition sub-model that has the same underlying driver variables (Clarklabs, 2020). A transition sub-model can contain a single land cover transition or a group of transitions that have the same underlying driver of variables. These driver variables use to model the historical change process. For instance, if you are modeling deforestation due to agriculture, river variables to consider would be slopes, proximity to roads, or previously deforested areas (Florencia Sangermano, J Ronald Eastman, Honglei Zhu, 2021). Transitions are modeled using either a multilayer perceptron (MLP) neural network, logistic regression, or a similarity-weighted instance-based machine learning tool (Same Weight) (Rahim Aguejdad, Thomas Houet, Laurence Hubert-Moy , 2017). Once calibrated, the model is employed to predict future scenarios.

6.10.4. Change prediction

The third and final step in the Change Analysis is Change Prediction. Using the historical rates of change and the transition potential model, LCM can expect a future scenario for a specified future date. In its easiest form, the model will define how the variables influence future change, how much change took place between time 1 and time 2, and then calculate a relative amount of transition to the future date (Clarklabs, 2020). To remake the model more robust, the Land Change Modeler make available for the incorporation of constraints and incentives, such as zoning maps; and planned infrastructure changes, such as new roads or land cover development. Driver variables can also be dynamic in nature so that at regular interim intervals, they can be recalculated and reenter the model (Megersa Kebede Leta, Tamene Adugna Demissie, Jens Tränckner, 2021). For instance, you may have as one of your driver variables distance from formerly deforested areas. This variable could be recalculated at regular intervals as and cover transitions from forest to agriculture.

6.10.5. Hard classifying

The distinguishing characteristic of complex classifies is that they all decide the landcover class to which any pixel belongs. TerrSet offers a host of supervised classifiers in this group. Some like (MAXLIKE) means maximum likelihood, and this procedure is unquestionably the most widely used classifier in the classification of remotely sensed imagery.

6.10.6. Soft classifying

Contrary to the hard classifier, the sot classifier does not decide the landcover class to which each pixel belongs. Instead, they develop statements of degrees to which each pixel belongs to each of the landcover classes being considered. Thus, for example, a soft classifier might indicate that pixel has a 20.72 probability of being forest, a .24 probability of being pasture, and a 0.04 probability of being bare ground. A hard classifier would resolve this uncertainty by concluding that the pixel was a forest. However, a soft classifier makes this uncertainty explicitly available for various reasons (Clarklabs, 2020).

6.11. Markov model

Markov model has been broadly used in ecological modeling (Nouri, J., Gharagozlou, A., Arjmandi, R. et al. , 2014). Markov model considers past states to predict how changes a particular variable over change modeling is promising because of its ability to quantify the states of conversion between land-use types and the rate of conversion among the land-use types (Ye B., Bai Z., 2008). A homogenous Markov model for predicting land-use change is presented mathematically as follow;

$$L_{(t+1)} = P_{ij} * L_{(t)}$$

and

$$P_{ij} = \begin{bmatrix} P_{11} & P_{12} & \cdots & P_{1m} \\ P_{21} & P_{22} & \cdots & P_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots \\ P_{m1} & P_{m2} & \cdots & P_{mm} \end{bmatrix}$$

where, $L_{(t+1)}$ and $L_{(t)}$ are the land-use status at time t+1 and t respectively. ($0 \leq P_{ij} < 1$ and $\sum^{m}_{j=1} P_{ij}=1$, ($i,j= 1,2, \dots ,m$) is the transition probability matrix in a state.

6.12. Cellular utomaton Markov model

A cellular automaton model is developed to investigate its utility in constructing scenarios of future urban land transformations (Clarke KC, Hoppen S, Gaydos L., 1997). CA-Markov model combines cellular automata, Markov chain, multi-criteria, and multi-objective land allocation to predict land cover change over time (BEHERA, M.D., BORATE, S.N., PANDA, S.N. et al., 2012). It adds into the Markov model not only spatial contiguity but also the probable spatial transitions occurring in a particular area over time. MARKOV and CA_MARKOV modules in IDRISI are used to create transition probability and transition area matrix (Adhikari, S.; Southworth, J., 2012). A transition probability matrix is obtained by cross-tabulation of two images of different times. It determines the probability of a pixel in a land-use class to change into another class during that time (Sylvertown J, Hotlier S, Johnson J and Dale P, 1992). On the other hand, a transition area matrix contains the number of pixels expected to change to a land-use class from another class during a period.

Chapter Seven

Demographic analysis, Urban population growth, Urban-rural migration

7.1. Population

The population is a social entity with multiple contents and a type of social relations. It involves gender, age, actual structure, and various social-economic compositions and relations (Wei Li, Zhongyu Su, Pengcheng Guo, 2019). The origins and consequences of urban population growth must be understood and evaluated towards realizing sustainable urban growth and sustainable cities (cliolu, 2016). Urban population growth in developing countries has been one of the most significant concerns that have brought considerable difficulties since the second half of the twentieth century (Mardiansjah, F.H., Rahayu, P., Rukmana, D., 2019).

This chapter presents an overview concerning urban population growth, explains the importance of analyzing it, and explains it using the population prediction model.

7.2. Population growth rate

Calculating Elasticity Rate of the population for Sari City, and define its place concerning the National and Regional Changes

At the National level:

Table 6 Iran's population, Source: Analysed and classified by the author, 2021, and raw data from the (Statistical Center of Iran, 1956-2017).

Decades	1956	1966	1976	1986	1996	2006	2016
Iran's population	18500000	25789000	33709000	49445000	60055000	70495000	79926270

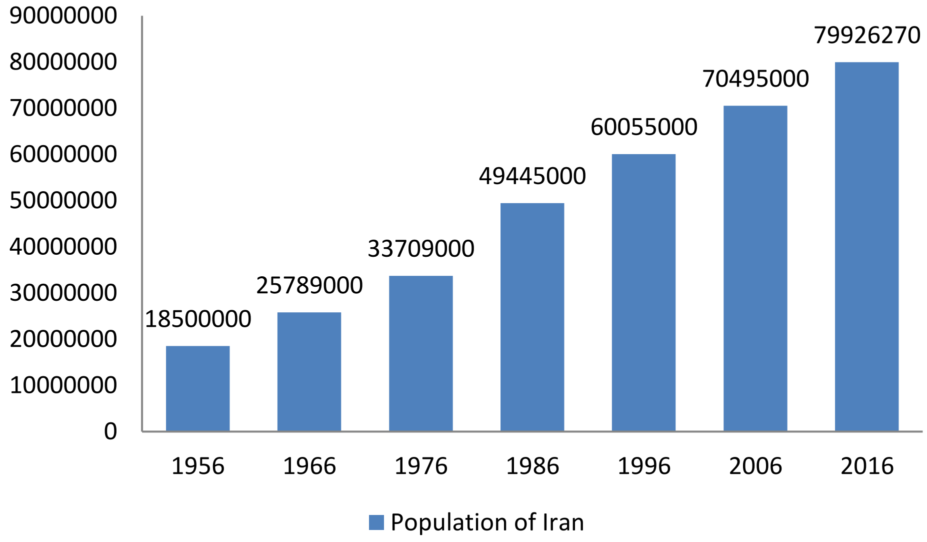


Figure 66 Iran's population, Source: the column chart designed by the author, and the data from the (Statistical Center of Iran, 1956-2017).

Table 7 Iran's urban and rural population changes, Source: Analysed and classified by the author, 2021, and the data from the (Statistical Center of Iran, 1956-2017).

Decades	1956	1966	1976	1986	1996	2006	2016
Urban population	6002121	9795810	15854680	26844561	36817789	48245057	59146847
The percent of the population	32.44	37.98	47.04	54.29	61.31	68.44	74.01
Growth in %		5.54	9.06	7.25	7.02	7.13	5.57
Rural population	12497879	15993190	17854320	22600439	23237211	22249943	20779423
Percent of the population	67.56	62.02	52.96	45.71	38.69	31.56	25.99

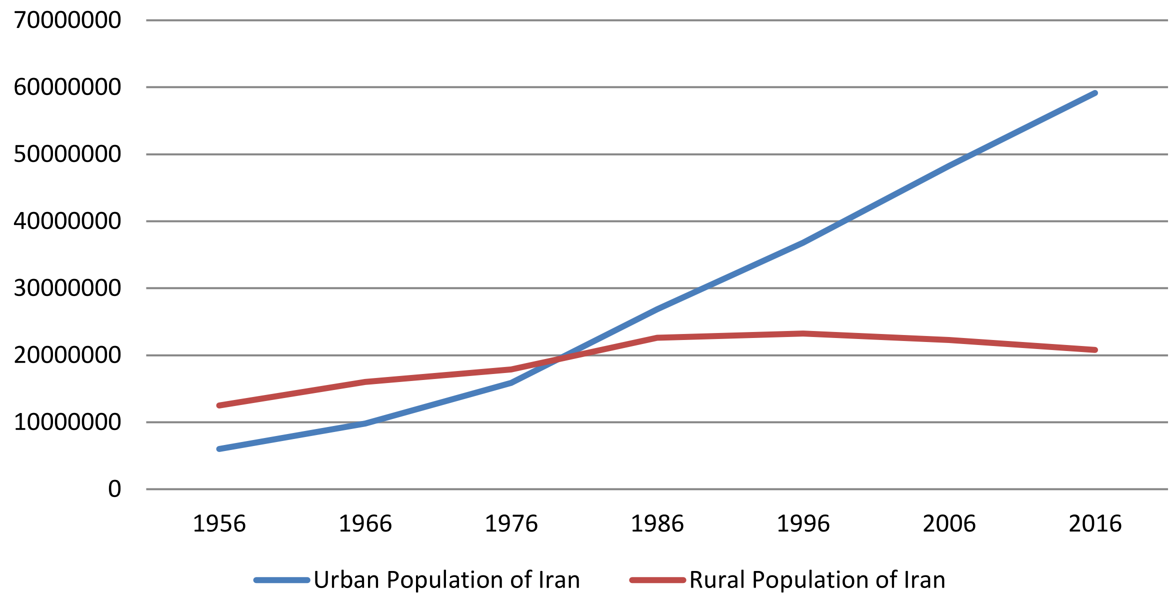


Figure 67 Iran's urban and rural population. Source: the graph designed by the author, and the data from the (Statistical Center of Iran, 1956-2017).

Table 8 The migration of urban or rural areas. Source: Analysed and classified by the author, 2021, and the data from the (Statistical Center of Iran, 1956-2017).

Decades	The rate of migration at the national level	The migration to the urban area	The migration to the rural area	Precent of the migration to the urban area	Precent of the migration to the rural area
1976-1986	4816702	3447767	1368935	71.58	28.42
1986-1996	8435865	5952076	2483789	70.56	29.44
1996-2006	11783774	8715719	3068055	73.96	26.04
2006-2016	10243815	8384934	1858881	81.85	18.15

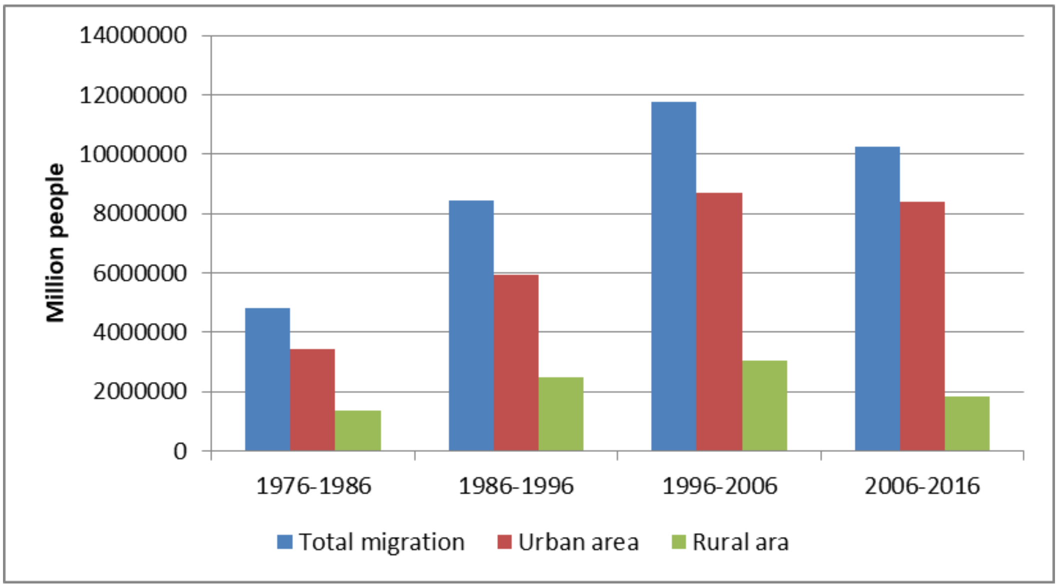


Figure 68, The migration of urban or rural areas. Source: the column chart designed by the author, and the data from the (Statistical Center of Iran, 1956-2017).

As presented in the above chart, the blue color shows the total migration at the national level. The red color indicates the total migration to the urban area, and the green color for the rural area.

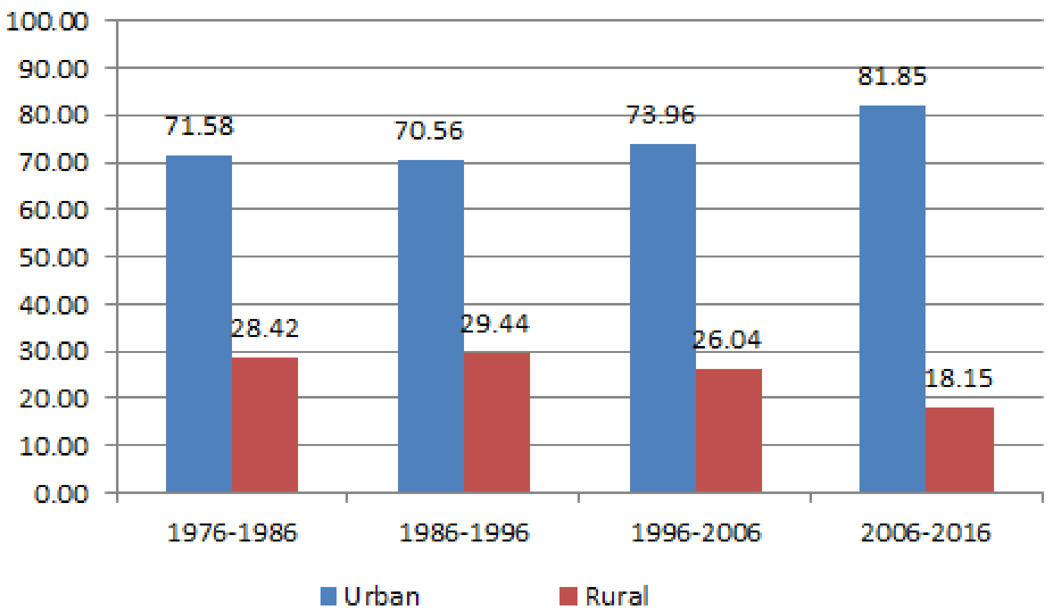


Figure 69, The urban-rural migration at the national level in percent. Source: the graph designed by the author, and the data from the (Statistical Center of Iran, 1956-2017).

In Iran, the urban population growth is accompanied by the development of the urbanization process. On the one hand, based on the results of chapter eight, the number and areas of the Persian cities have increased. On the other hand, after the executed statistical analysis, the find outs of this chapter have shown that Irans' population growth also grows the population of the urban areas due to the extreme migration from rural to the cities, which was started in the last decades. The reasons for such trends are discussed in chapter eight, and this chapter has tried to discuss and present the demographic changes and analysis with the selected models to figure out what demographical changes happened during the last decades? How these changes happened? and why? Also, what is going to happen in the future?

As shown in Table 7, about 67.56 percent of the population lived in the rural zones and 32.44 % in the urban zones in the 1956s. After six decades, in 2016, approximately 74.01 % of the population lived in urban areas and 25.99 % of the people in non-urban areas. According to the results illustrated in Figure 67, the graph shows gradual urban population growth, and the line goes up. And expected this urban population growth would be continued for the following decades. The most rate of urban population growth happened between the decades 1976 and 1986 Table 7.

There is a significant relationship between the statistical results of urban population growth and the increase of migration from rural to urban. If we look at Table 7, besides the urban population growth, the rate of migration from rural to urban has increased sharply Table 8. For instance, about 11,783,774 million of the total urban populations of the country were the rural dwellers that were migrated to the urban zones between the decades 1996-2006. In other words, about 35,280,156 or 59.65% of Iran's urban population were the migrated people from the rural areas!

At the Regional level:

Table 9 The total population of the Mazandaran metropolitan area. Source: Analysed and classified by the author, and the data from the (Statistical Center of Iran, 1956-2017).

Decades	1956	1966	1976	1986	1996	2006	2016
The population of the Mazandaran metropolitan area	973964	1247102	1596565	2274862	2602008	2922432	3283582

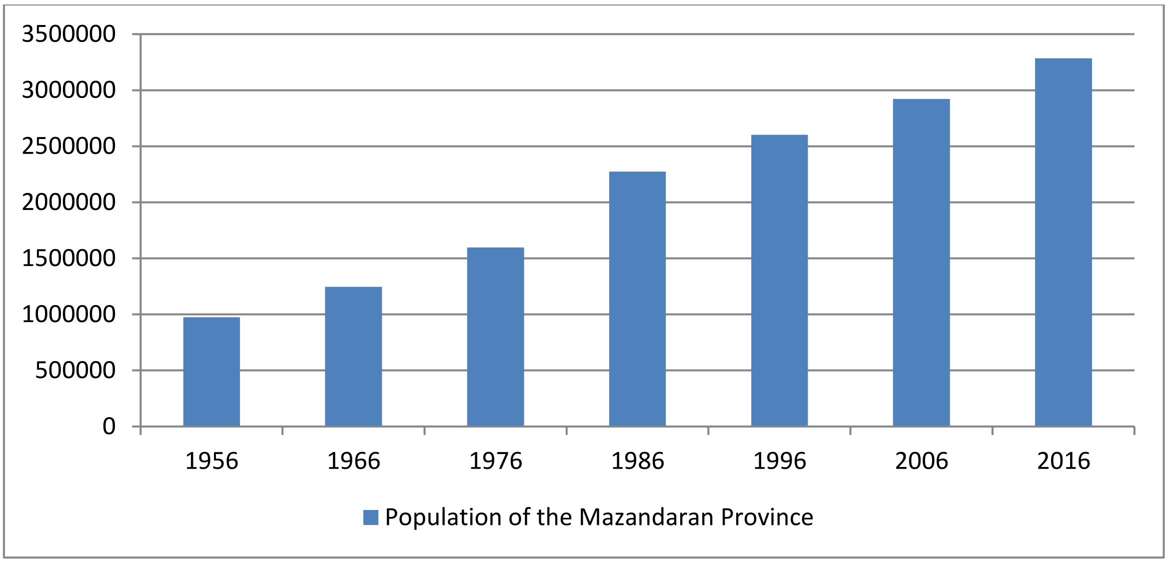


Figure 70 The total population of Mazandaran. Source: the graph designed by the author 2021, and the data from the (Statistical Center of Iran, 1956-2017).

Table 10 The population of the Mazandaran metropolitan area and rural area. Source: Analysed and classified by the author, and the data from the (Statistical Center of Iran, 1956-2017).

Decades	1956	1966	1976	1986	1996	2006	2016
The urban population of the Mazandaran metropolitan area	156329	301729	511787	897667	1223326	1554143	1936662
The percent of the population	16.05%	24.19%	32.06%	39.46%	47.01%	53.18%	58.98%
The rural Population of Mazandaran	817635	945373	1084778	1377195	1378682	1368289	1346920
The percent of the population	83.95%	75.81%	67.94%	60.54%	52.99%	46.82%	41.02%

Table 11 The changes in the growth of urban-rural population at the Sari city and district levels. Source: Analysed and classified by the author, and the data from the (Statistical Center of Iran, 1956-2017).

Decades	**1956**	**1966**	**1976**	**1986**	**1996**	**2006**	**2016**
The total population of Sari district	129168	204982	262877	370515	422461	490830	504298
The urban population of Sari district	27037	44547	70753	141020	207900	272000	352111
The rural population of Sari district	102131	160435	192124	229495	214561	218830	152187
The population of Sari city	27037	44547	70753	141020	195882	259413	347402

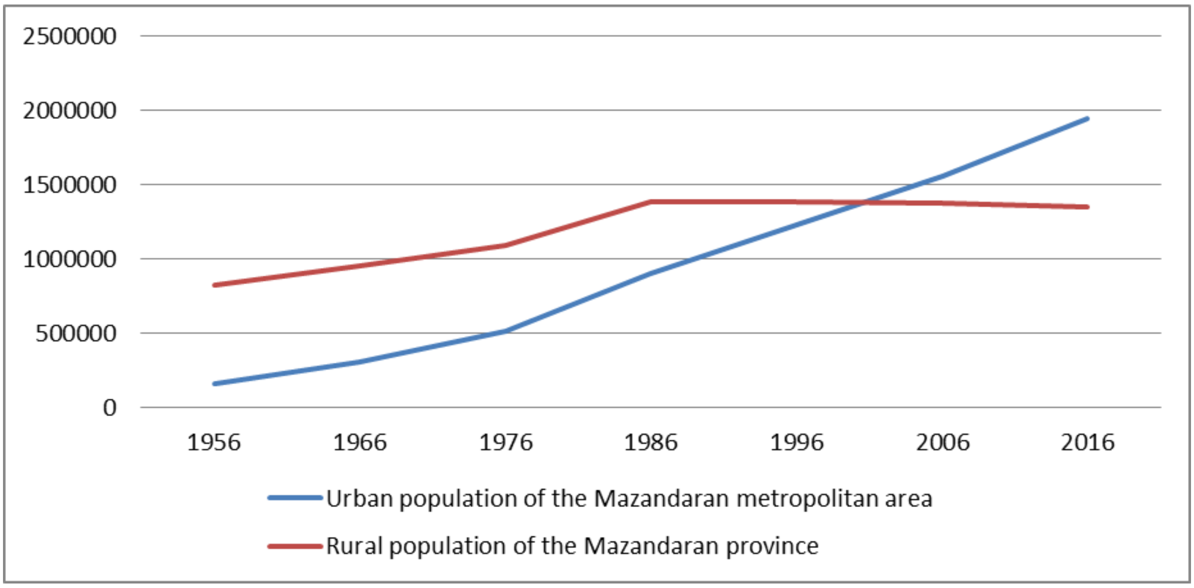


Figure 71 The growth of populations in the urban and rural areas of the Mazandaran metropolitan area. Source: the graph designed by the author, and the data from the (Statistical Center of Iran, 1956-2017).

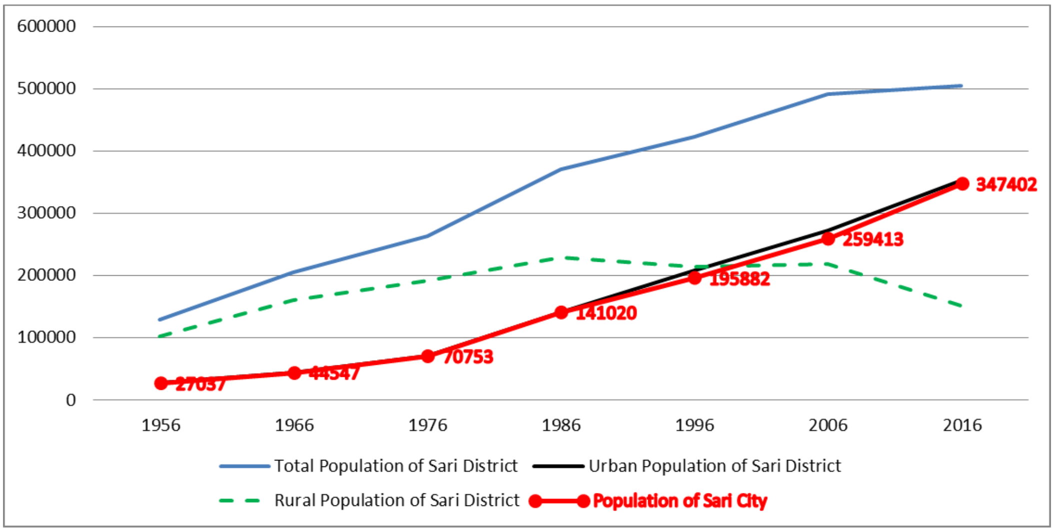


Figure 72 The changes in the growth of urban-rural population at the Sari city and district levels Source: the graph designed by the author, and data from the (Statistical Center of Iran, 1956-2017).

Calculating the rates of population growth and changes for Sari city and compared to the national and regional levels

Table 12 Calculating the rate of populations growth and changes at the national, regional, and local levels (by the author)

Decades	1956-66	1966-76	1976-86	1986-96	1996-2006	2006-2016
The rate of growth	**Growth in %**	**Growth in %**	**Growth in %**	**Growth in %**	**Growth in %**	**Growth in %**
Iran's population	3.378	2.714	3.905	1.963	1.616	1.264
Iran's urban population	5.020	4.933	5.407	3.210	2.740	2.058
Iran's rural population	2.497	1.107	2.385	0.278	-0.433	-0.681
The total population of the Mazandaran metropoitan area	2.503	2.501	3.604	1.353	1.168	1.172
The urban population of the Mazandaran metropolitan area	6.797	5.426	5.780	3.144	2.422	2.225
The urban population of Sari district	1.462	1.385	2.415	0.011	-0.076	-0.157
Big cities' population of Mazandaran metropolitan area	5.120	4.735	7.140	3.958	2.724	2.615
The population of Sari city	4.798	4.569	5.967	3.100	2.458	2.195
The rate of changes	**Change in %**	**Change in %**	**Change in %**	**Change in %**	**Change in %**	**Change in %**
Iran's population	-	-19.636	43.875	-49.734	-17.692	-21.797
Iran's urban population	-	-1.742	9.613	-40.641	-14.632	-24.883
Iran's rural population	-	-55.665	115.487	-88.335	-255.697	-57.297
The total population of the Mazandaran metropolitan area	-	-0.070	44.101	-62.467	-13.648	0.334
The urban population of the Mazandaran metropolitan area	-	-20.169	6.522	-45.609	-22.945	-8.156
The rural Population of this metropolitan area	-	-5.280	74.399	-99.553	-800.890	-107.933
The urban population of Sari district	-	-7.519	50.796	-44.571	-31.178	-3.996
Big cities' population of Mazandaran metropolitan area	-	-4.761	30.587	-48.050	-20.695	-10.705
The population of Sari city	-	-7.519	50.796	-53.215	-14.721	4.028

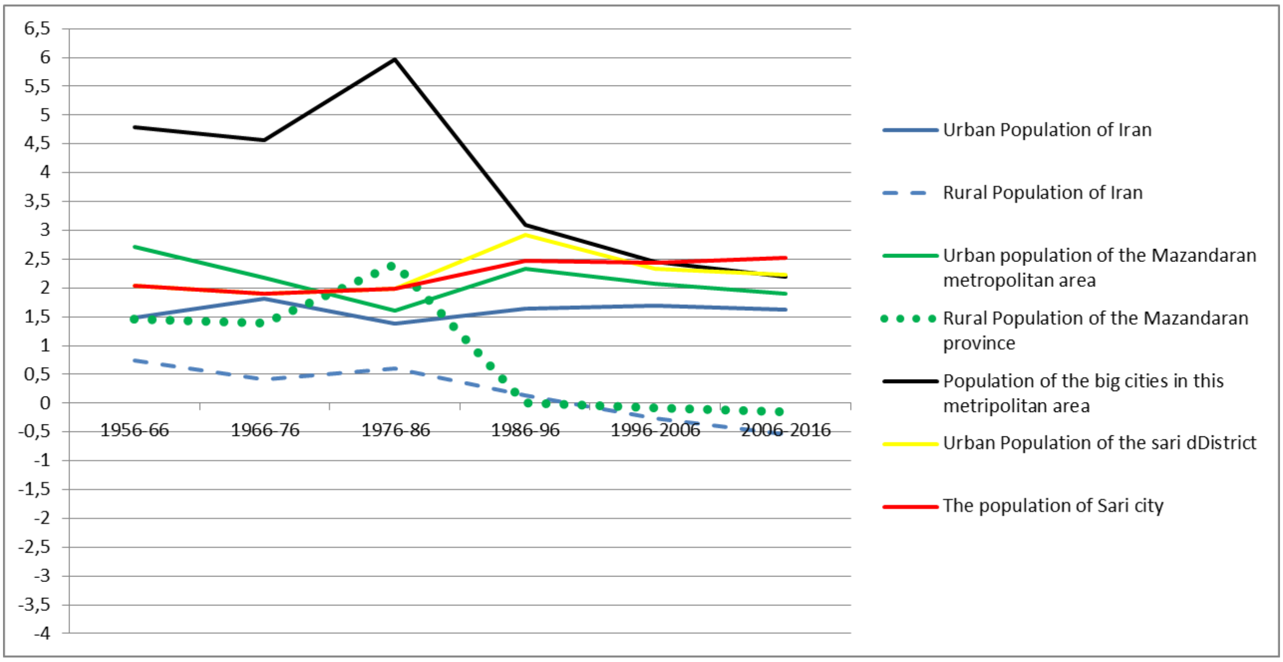


Figure 73 The linear graph of the population changes at the national, regional, and local levels (by the author)

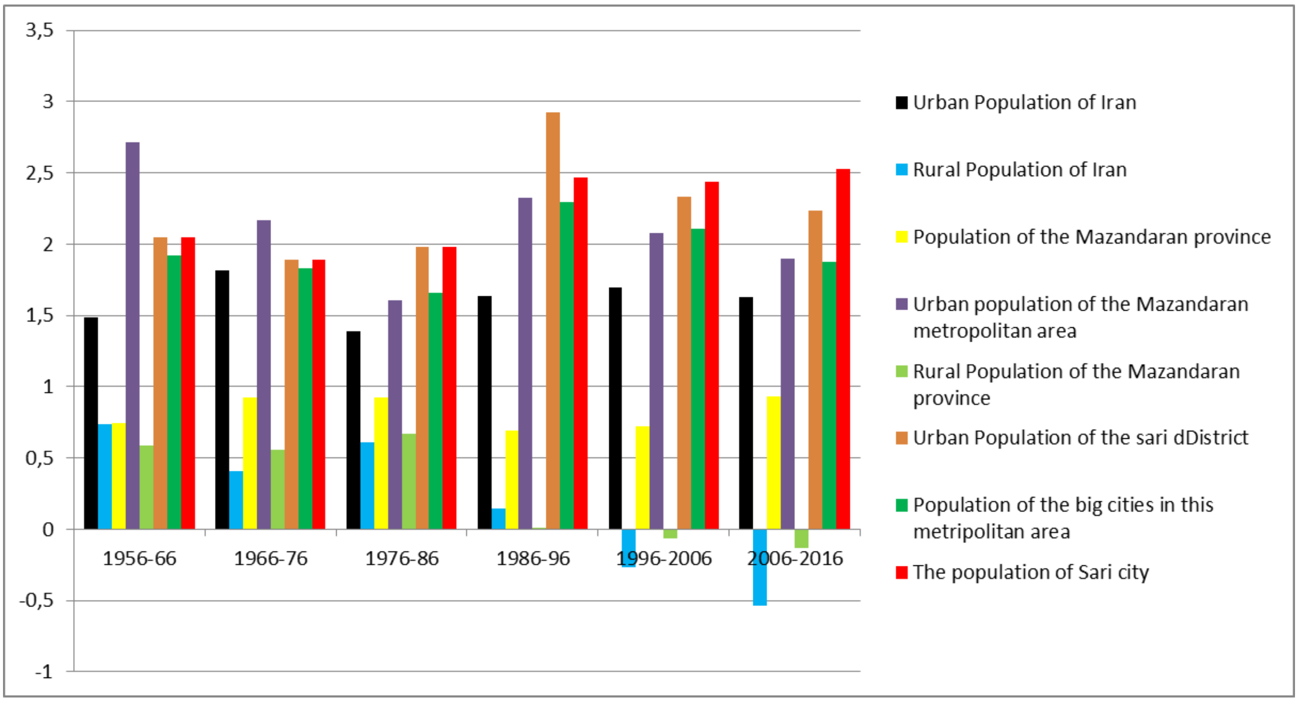


Figure 74 The column chart of the population changes at the national, regional, and local levels (by the author)

Since the 1921s, Iran's annual population growth rate was low for about 0.6% per year. Lack of health facilities was the main factor. And later, the 1925s, after the change of political system and foundation of the Pahlavi dynasty, consequently have emerged considerable changes in all social, cultural, political, and economic sectors. Iran has started to move towards development gradually. The foundation of the Pahlavi dynasty, with many positive changes in Iran, also improving Iran's health facilities, political-economic stability is one of the main reasons for increased population growth. From 1957 to 1966, the government executed many development projects at the national level that positively changed living conditions, especially in the urban area. For more information, please see chapter nine. For example, the Family Planning projects for supporting Iranian families, constructing many new hospitals, or foundation of the first national education system that was free for all people, or for the first time foundation of national universities and university clinics had improved and enhanced living conditions for Iranian people. And also, for the first time in the history of this country, Reza Shah has provided recognition for women's rights to have more role in all sectors in the developing process of this country, which had increased women's employment officially. Finally, the cities became more populated than before Figure 72.

According to the final results, especially Table 12, in this case, there is a significant relationship among the demographic changes at the national level and consequently at the regional and local levels. In 88.09 % of cases at all levels and periods, the same modifications happened with little tolerance Figure 73 -Table 12. For instance, 1986 was one of the remarkable decades in the history of Iran's demographic changes because one of the highest rates of population surge had happened in this time at the national level.

Because the revolution in 1979 had collapsed the Pahlavi dynasty and driven Iran into chaos and political instability. Three years later, Iraq used this political instability and invaded Iran, and this war lasted for eight years. At this time, the government had concerns about population growth and directly executed incentive policies to increase population growth, which led to an extremely high rate of 91.3. They are the main reasons for these enormous demographic changes Figure 74.

7.3. Elasticity analysis

This study has applied elasticity analysis to know which life-history stages most impact on population growth. Sensitivity and elasticity are long-established, widely-used instruments for pinpointing effective peculiar demographic rates in this process (Lee, 2016). Elasticity analysis is a manageable initial measure in clarifying essential issues in evolutionary and population science. (Benton, Tim & Grant, Alastair, 2000). Elasticity analysis estimates the proportional change in population growth rate for a given change in a population rate parameter (Bart W. Durham and Gene R. Wilde, 2004).

This model is an index to estimate the percent of the urban population versus the total population. It means how much has increased or decreased the city's population as a case study for each one percent increase in the total population at the (national, regional, or local) levels in a specific period.

This study used the following formula for estimating the elasticity rate of population growth:

$$E_{(t,t+10)} = \frac{Y_u(t,t+10)}{r(t,t+10)}$$

E: is equal to the elasticity rate for a period t,t+10

Y_u: the annual growth rate of urban population

r: the annual growth rate of the total population

Calculating the elasticity rate of the population of Sari city compared to the national and regional levels

Table 13 The elasticity rate of the populations at the national, regional, and local levels (by the author)

Decades	1956-66 Elasticity rate	1966-76 Elasticity rate	1976-86 Elasticity rate	1986-96 Elasticity rate	1996-2006 Elasticity rate	2006-2016 Elasticity rate
Iran's urban population	1.4863	1.8173	1.3845	1.6350	1.6958	1.6289
The population of the Mazandaran metropolitan area	0.7410	0.9214	0.9228	0.6890	0.7229	0.9275
The urban population of the Mazandaran metropolitan area	2.7155	2.1694	1.6036	2.3240	2.0737	1.8982
The urban population of Sari district	2.0457	1.8932	1.9812	2.9258	2.3319	2.2312
Big Cities' population of Mazandaran metropolitan area	1.9168	1.8269	1.6555	2.2915	2.1044	1.8729
The population of Sari city	2.0457	1.8932	1.9812	2.4696	2.4389	2.5287

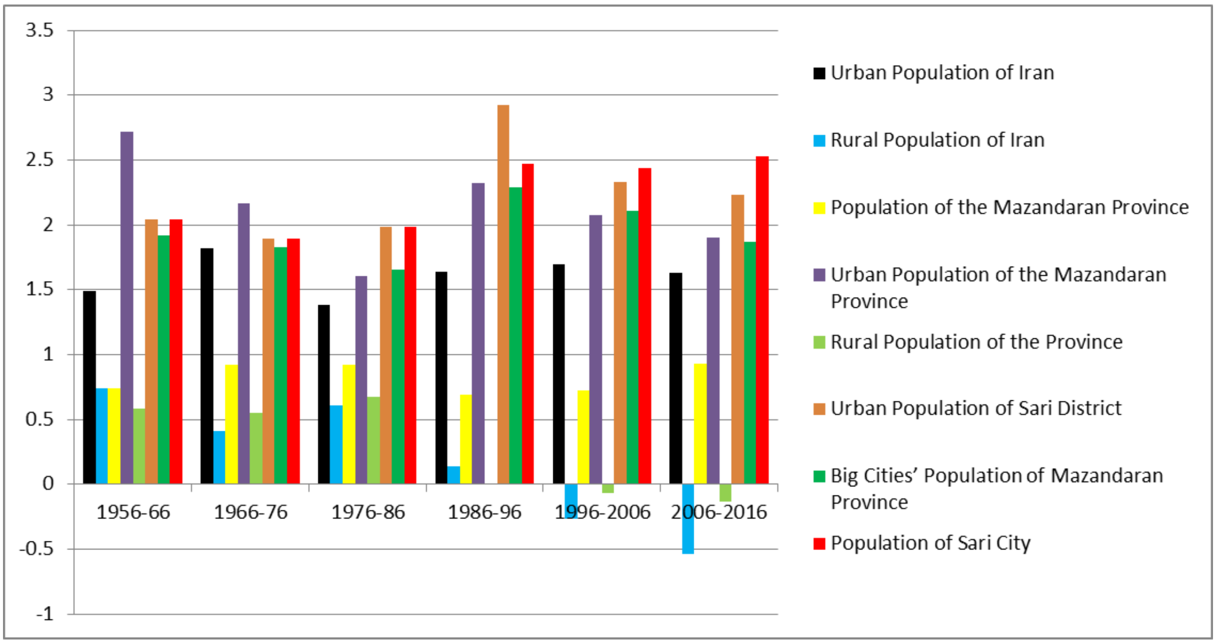


Figure 75 The column chart of the population's elasticity rate at the national, regional, and local levels (by the author)

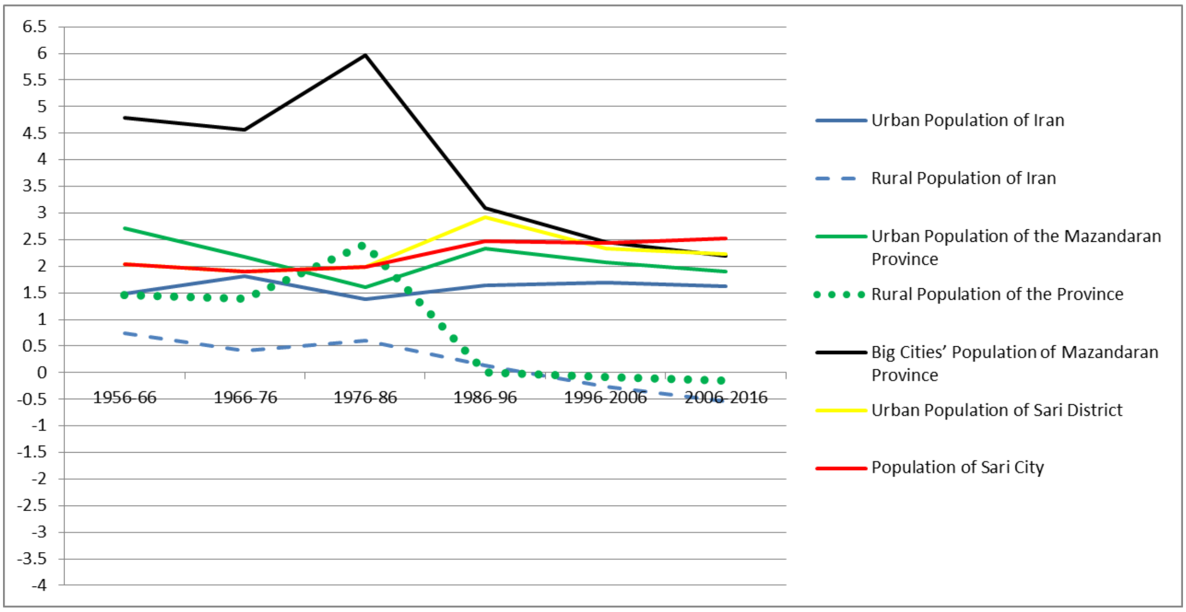


Figure 76 The linear graph of the changes in the elasticity rate of the populations at the national, regional, and local levels (by the author)

First, this study has calculated the elasticity rate of the population at the national, regional, and local levels and then has tried to comparison the elasticity rate of Sari city with the other sectors. According to the results of as shown by Table 13, the ratio of changes in the population growth except in the 1986s for the different decades was negative. In the 1976s, about 0.476 percent of Sari's population growth rate had decreased for every one percent decrease in the national population growth rate. Meanwhile, this rate for the big cities of this Metropol was 0.751, and for the Metropol was 0.20. In 1986, the growth rate changed drastically and was 43.875% positive growth at the national level and 30.587% positive growth for Sari. It means, for every one percent increase in the national population growth rate, about 0.305% of Sari's population growth rate had increased. Sari city, in comparison with the other sector, not only was faced with the low changes but also in 2016 experienced positive changes.

Unfortunately, the highest rate of these population changes refers to the rural area, especially at the regional levels. Except for the 1986s, the rate of dwellers has been decreased in this Metropol surprisingly. For example, for every one percent decrease in the rural population growth at the national level, about 8.890 % of the rural population of this Metropol has decreased.

The population of all big cities at the regional levels has been changed and decreased more than in Sari city. It represents the superiority of the city in comparison with the other big cities based on the results of Rank-Size Role that is illustrated in Chapter eight.

7.4. The projections of the population growth

Population predictions are 'what-if' scenarios to determine how the population will grow in the expectation (United States Census Bureau, 2017). These projections are essential to calculate the population's force on this planetoid and the communities' future well-being (Kaneda, Toshiko, 2014). Patterns of population growth take trends in social development and employ predictions into the prospect (Roser, 2019). These models use trend-based presumptions concerning how populations react to business, social and technological powers to determine how they influence fertility, mortality, net migration, and population growth (Office for national statistics, 2021).

In this chapter, some prediction models for population change are provided included the Modified Exponential Model and the Linear Regression Model to predict the population growth in the next few years and decades.

7.4.1. The results of the projected population growth at the national level

The projection of the population changes in Iranian cities using the Modified Exponential Model

According to Malthus' model, once population size exceeds available resources, population growth decreases dramatically. This accelerating growing population size is called "exponential growth," signifying that the population increases by a fixed rate each year (Zehnder, 2021).

This type of growth can be represented by applying a mathematical function known as the exponential growth model:

$$P_{(t+n)} = P_{(t)}(1+r)^n$$

$P_{(t+n)}$: population in the year t+n (end of period)

$P_{(t)}$: population in the year t (start of the period)

n: period considering (month, year, half of a year)

r: the annual growth of population

So that r (the annual growth of population) will be calculated by using the following formula:

$$r = (\sqrt[n]{\frac{P_{(t)}}{P_{.}}} - 1) \times 100$$

In this model, the amount of population growth is addressed to the size of the current population. The proportion between the population growth and the total population is fixed (Mirnajaf Mossavi, Hassan Hekmatnia, 2011).

Table 14 The projected population change in Iranian cities between 2016-2026 using the Modified Exponential Model at the national level (by the author)

Decades	**Iran's urban population**	**The rate of growth**	**The result of ME model**
1956	6002121		
1966	9795810	5.020374022	
1976	15854680	4.932909013	15987331
1986	26844561	5.407104247	25661061
1996	36817789	3.209610678	45452223
2006	48245057	2.739988301	50496247
2016	59146847	2.05819366	63219047
2026			**72512082**

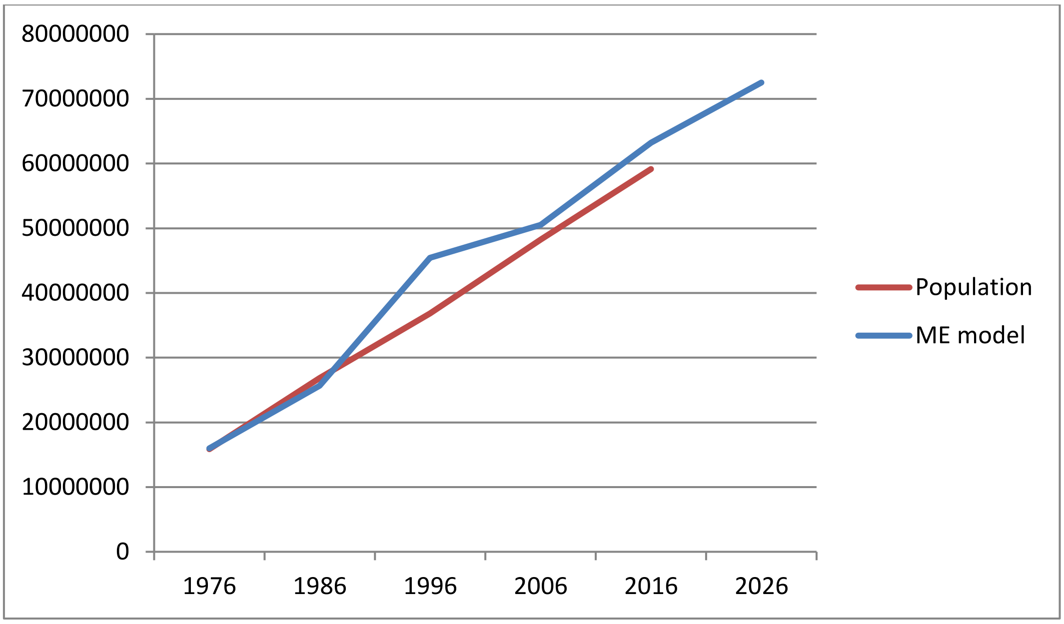


Figure 77 The projected population growth in Iranian cities using the Modified Exponential Model at the national level (by the author)

Projection of population for Iranian cities using the Linear Regression Model

Linear regression enables you to make predictions on the data, and it is intuitive and easy to understand (Ognjanovski, 2018).

Using the relationship between two variables, this model can calculate and estimate a variable by another variable. So that the variable Y changes concerning the time X. Therefore, can realize a linear relation between two groups of variables as follow:

$$Y= ax+b$$

Linear equation

The amount of a and b is coefficients that can be calculated through the following formulas:

$$a = \frac{\sum xy}{\sum x^2}$$

$$b = \frac{\sum y}{N}$$

N: is the number of periods (Mirnajaf Mossavi, Hassan Hekmatnia, 2011).

Table 15 The projected population change in Iranian cities for the decades 2026 and 2036 using the Linear Regression Model at the national level (by the author)

Decades	Iran's urban population	x	X^2	XY	The result of LR model
1956	6002121	-3	9	-18006363	
1966	9795810	-2	4	-19591620	
1976	15854680	-1	1	-15854680	
1986	26844561	0	0	0	
1996	36817789	1	1	36817789	
2006	48245057	2	4	96490114	
2016	59146847	3	9	177440541	
Sum	**202706865**		**28**	**257295781**	
2026					**65714664**
2036					**74903799**

Concerning the results of both models, Iran's urban population will be increased extremely high. As presented in the above tables, the urban population was 59,146,847 in 2016, about 74.01% of the total population. The Modified Exponential Model has projected a continuation of urban population growth of approximately 72,512,082 for the following years in 2026 Table 14. Besides, the Linear Regression Model has also predicted urban population growth for the following decades, about 65,714,664 for 2026 and 74,903,799 people for 2036 Table 15.

7.4.2. The results of the projected population growth in the Mazandaran metropolitan area

The projection of the population changes in the Mazandaran metropolitan area using the Modified Exponential Model

Table 16 The prediction of population change using the Modified Exponential Model for the Mazandaran metropolitan area (by the author)

Decades	The population of the Mazandaran metropolitan area	The rate of growth	The result of ME model
1956	156329		
1966	301729	6.796679611	
1976	511787	5.425876327	582364
1986	897667	5.779765762	868083
1996	1223326	3.143697181	1574495
2006	1554143	2.422383229	1667129
2016	1936662	2.224803745	1974421
2026			2413329

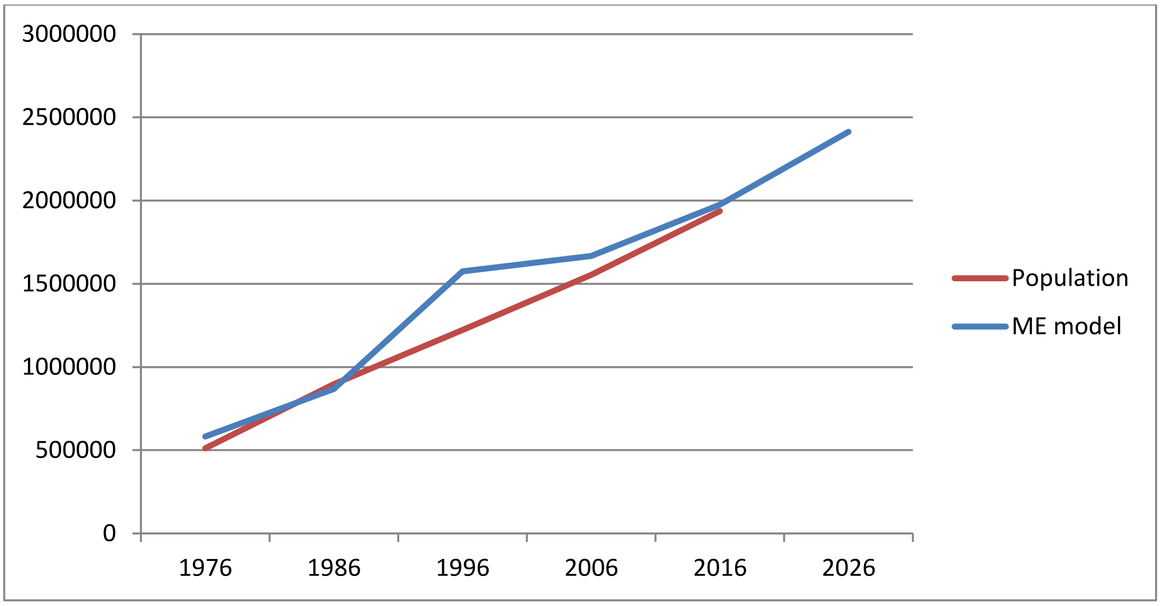


Figure 78 The predicted population growth of the Mazandaran metropolitan area for the years 2026 (by the author)

Prediction of population based on the Linear Regression Model

Table 17 The predicted changes in the population of the Mazandaran metropolitan area using the Linear Regression Model for the decades 2026-2036 (by the author)

	The population of the Mazandaran metropolitan area				
Decades	**y**	**x**	**X^2**	**XY**	**The result of LR model**
1956	156329	-3	9	-468987	
1966	301729	-2	4	-603458	
1976	511787	-1	1	-511787	
1986	897667	0	0	0	
1996	1223326	1	1	1223326	
2006	1554143	2	4	3108286	
2016	1936662	3	9	5809986	
Sum	6581643		28	8557366	
2026					**2162716**
2036					**2468336**

Concerning the results of both models, the urban population of this metropolitan area will be increased considerably high. As presented in the above tables, the urban population was 1,974,421in 2016, about 58.98% of the total population. The Modified

Exponential Model has projected a continuation of urban population growth about 2,413,329 for the following years in 2026 Table 16.

Besides, the Linear Regression Model has also predicted urban population growth for the following decades, about 2,162,716 for 2026 and 2,468,336 people for 2036 Table 17.

7.4.3. The results of the projected population growth at the local level

The projection of the population changes in the city of Sari using the Modified Exponential Model

Table 18 The projected changes in the population of Sari city between 2016-2026 using the Modified Exponential Model (by the author)

Decades	The population of Sari city	The rate of growth	The result of ME model
1956	27037		
1966	44547	5.120155849	
1976	70753	4.735193573	73397
1986	141020	7.140479358	112375
1996	195882	3.340695936	281071
2006	259413	2.848916461	272087
2016	347402	2.963680387	343549
2026			**465,235**

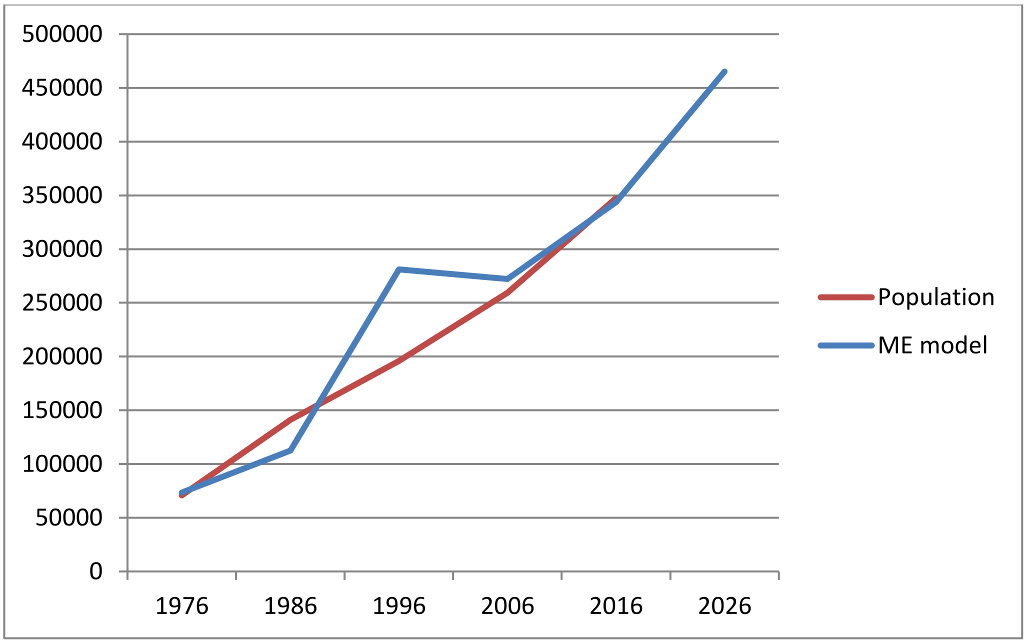


Figure 79 The predicted population growth of Sari city between 2016-2026 (by the author)

Prediction of the population of Sari city using the Linear Regression Model

Table 19 The predicted population growth in Sari city using the Linear Regression Model for the decades 2026-2036 (by the author)

	The population of Sari City				
Decades	**y**	**x**	**X^2**	**XY**	**The result of LR model**
1956	27037	-3	9	-81111	
1966	44547	-2	4	-89094	
1976	70753	-1	1	-70753	
1986	141020	0	0	0	
1996	195882	1	1	195882	
2006	259413	2	4	518826	
2016	347402	3	9	1042206	
Sum	1086054		28	1515956	
2026	-	-	-	-	**371716**
2036	-	-	-	-	**425857**

Concerning the results of both models, the urban population of this metropolitan area will be increased considerably high. As presented in the above tables, the urban population was 347,402 in 2016, about 17.93% of the total urban population in this metropolitan area. The Modified Exponential Model has projected a continuation of urban population growth of about 465,235 for the following years in 2026 Table 18.

Besides, the Linear Regression Model has also predicted urban population growth for the following decades, about 371,716 for 2026 and 425,857 people for 2036 Table 19.

Chapter Eight

Economic Sector

Flix-Auerbach is a German geographer and, in 1913, has provided the Rank-Size Rule to analyze the relationship between the size and place of cities (Mirnajaf Mossavi, Hassan Hekmatnia, 2011). And later in the 1940s, George Zipf identified a curious regularity in the distribution of cities of varying sizes; if cities were ranked from largest to smallest populations, then

$$P_r = \frac{P_1}{R^b}$$

P1: the population of the largest city or town,

PR: the population of the smallest city by rank,

b: a coefficient that must be established through empirical observation for each investigation. The greater the value of b, the steeper the slope, and the greater the primacy of the largest city or town.

George Zipf defines the above formula in a logarithm form as follow:

$$LogP_r = LogP_1 - bLogR$$

$$b = \frac{Log\,\frac{P_1}{P_r}}{LogR}$$

The contribution of rank-size rule in urban regional planning:

- It helps in the interpretation of the relationship between rank and population of settlements.
- It helps in analyzing the settlement networks.
- It explains settlements concerning economic activities as an increase in activities increases the size of population.
- It explains the imbalance between the settlements due to rapid growth in population or activities (Kumar V. , 2017).

8.1. The results of Rank-Size Rule, Zipf's law for the decade 1986

Table 20 The result of the Rank-Size Rule, Zipf's law, and Regression Model for the cities of Mazandaran metropolitan area between decades 1976- 1986, Iran (by the author)

Class Of Cities	Row	Cities	Real population	Rank	Zipf's law	Population surplus or decline	Regression Model LogR=x	Regression Model LogR=y
B2	1	**Sari**	141020	1	141020	0	0	5.14928
	2	**Amol**	118242	2	70510	47732	0.30103	5.07277
	3	**Babol**	115320	3	47007	68313	0.47712	5.0619
	4	**Ghaemshahr**	109288	4	35255	74033	0.60206	5.03857
B1	5	**Behshahr**	52461	5	28204	24257	0.69897	4.71984
A	6	**Tonekabon**	29380	6	23503	5877	0.77815	4.46805
	7	**Challos**	29308	7	20146	9162	0.8451	4.46699
	8	**Babolsar**	28589	8	17628	10962	0.90309	4.4562
	9	**Nooshahr**	28216	9	15669	12547	0.95424	4.4505
	10	**Ramsar**	25352	10	14102	11250	1	4.40401
	11	**Neka**	23604	11	12820	10784	1.04139	4.37299
	12	**Freydonkenar**	20997	12	11752	9245	1.07918	4.32216
	13	**Juybar**	18942	13	10848	8094	1.11394	4.27743
	14	**Amirkolah**	18295	14	10073	8222	1.14613	4.26233
	15	**Galogah**	18073	15	9401	8672	1.17609	4.25703
	16	**Katalem Sadatshahr**	13509	16	8814	4695	1.20412	4.13062
	17	**Nor**	13055	17	8295	4760	1.23045	4.11578
	18	**Mahmoodabad**	11856	18	7834	4022	1.25527	4.07394
	19	**Zirab**	9595	19	7422	2173	1.27875	3.98204
	20	**Rostamkolah**	9220	20	7051	2169	1.30103	3.96473
	21	**Abbasabad**	8169	21	6715	1454	1.32222	3.91217
	22	**Khoramabad**	8154	22	6410	1744	1.34242	3.91137
	23	**Shirgah**	7452	23	6131	1321	1.36173	3.87227
	24	**Salmanshahr**	7087	24	5876	1211	1.38021	3.85046
	25	**Polsefeed**	6423	25	5641	782	1.39794	3.80774
	26	**Nashtarood**	4760	29	4863	-103	1.41497	3.67761
	27	**Kelarabad**	4267	33	4273	-6	1.43136	3.63012
	28	**Royan**	4035	34	4148	-113	1.44716	3.60584

29	**Kelardasht**	4030	35	4029	1	1.4624	3.60531
30	**Marzanabad**	3889	36	3917	-28	1.47712	3.58984
31	**Keeyakolah**	2964	48	2938	26	1.49136	3.47188
32	**Rineh-e-Larijan**	1225	115	1226	-1	1.50515	3.08814
33	**Alasht**	890	158	893	-3	1.51851	2.94939
	SUM	**897667**		**564413**	**333254**		

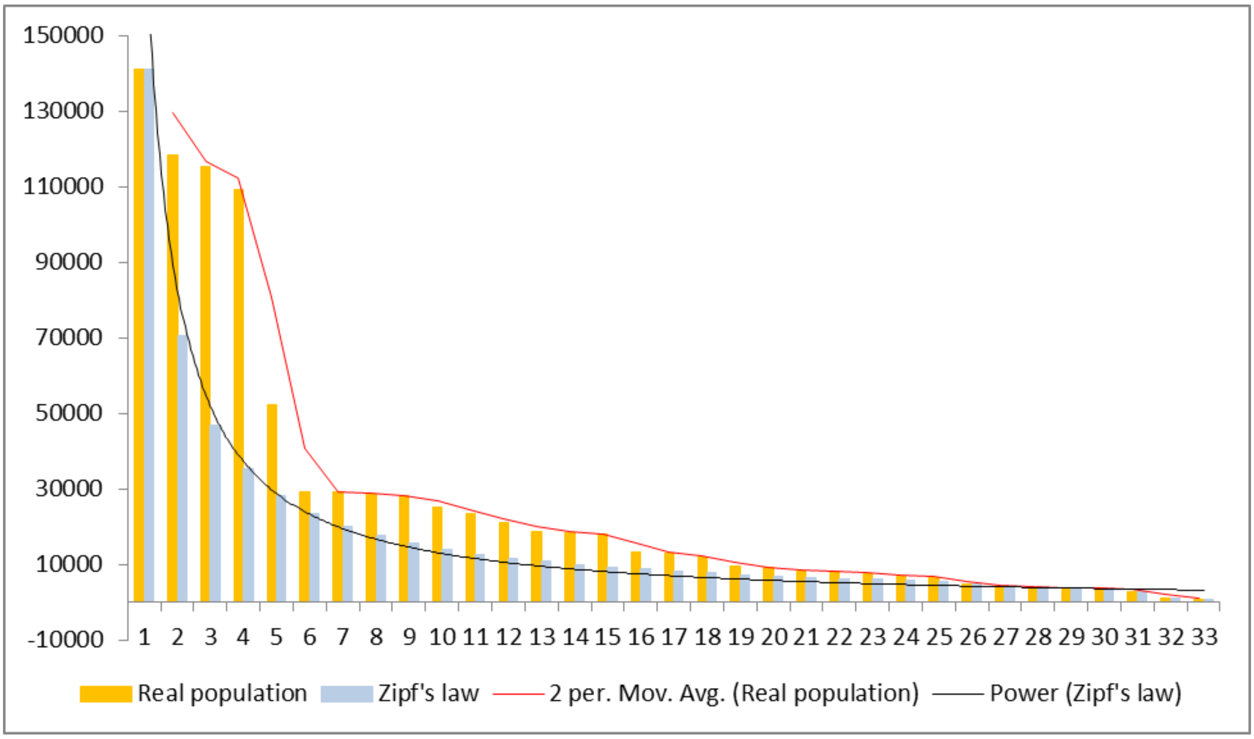


Figure 80, The imbalance between the actual size of the population with the ideal size of the population of cities in the Mazandaran metropolitan area considering the results of Zip's law; between 1976- 1986, Iran (by the author)

8.2. The results of Regression model for the decade 1986

The calculation of Rank-Size Rule using the Regression Model

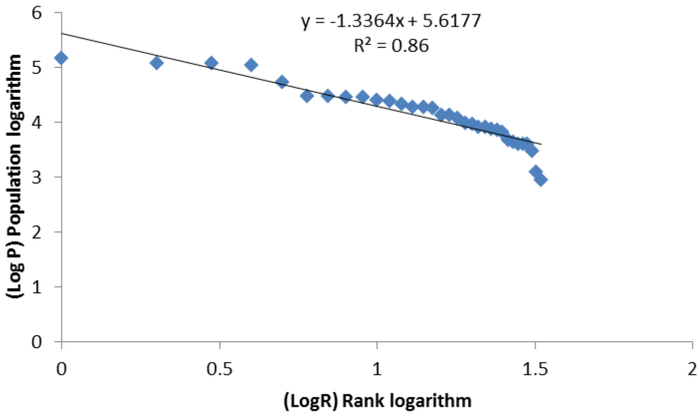


Figure 81 The logarithmic distribution of cities in the Mazandaran metropolitan area considering the rsults of Rank-Size Rule between 1976- 1986, Iran (by the author)

Best-fit values	
Slope	-1.336 ± 0.09685
Y-intercept	5.618 ± 0.1141
X-intercept	4.204
1/Slope	-0.7483
95% Confidence Intervals	
Slope	-1.534 to -1.139
Y-intercept	5.385 to 5.850
X-intercept	3.803 to 4.742
Goodness of Fit	
R square	0.8600
Sy.x	0.2042
Is slope significantly non-zero?	
F	190.4
DFn,DFd	1,31
P Value	< 0.0001
Deviation from horizontal?	Significant
Data	
Number of XY pairs	33
Equation	Y = -1.336*X + 5.618

In Iran, based on the National Spatial Plan, the cities are classified into five groups according to the rate of population Table 21:

Table 21 The calcification of urban area based on the population in Iran (by the author)

Classes	Urban Groups	Population
A	Small cities	less than 50000
B1	Medium-sized cities (small-class)	50000 to 99999
B2	Medium-sized cities (big-class)	100000 to 249999
C1	Big cities (Medium-class)	250000 to499999
C2	Big and very big Cities	500000 to 2000000

In the first row of Table 20, this thesis has defined the rank of cities according to the annual data. And in the second row is listed the cities' name and their population in the next row. After that, in the next raw, we are considering the result of the Rank-Size Rule. Then, in the next row, we can see the results of Zipf's law and the ideal population size for the cities. According to Zipf's law, the next row shows the difference between the actual and perfect population size.

As showed in Table 20, the numbers of cities in the Mazandaran metropolitan area were about 33, with 897,667 dwellers. The outcomes of the model show four cities have been placed in medium-sized cities (big class), one city in medium-sized (small-class), and the rest have been placed in class A. About 53.90% of the total urban population in class B2, 5.85% of people in class B1, and 40.25% in small cities Figure 82.

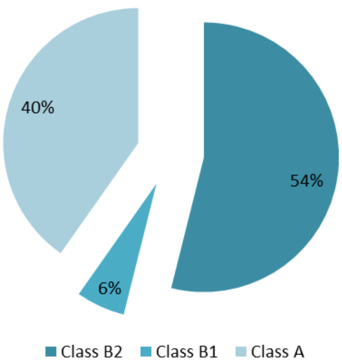


Figure 82 The percent of the spatial distribution of population in the cities of the Mazandaran metropolitan area (by the author)

Concerning the result of Zipf's law in Table 20, the measured population size for the urban area is about 564413, but statistics show the cities had 897667population. This metropolitan's urban system faced a surplus of almost 333254 people. In other words, there is a considerable imbalance between the rank of cities and the size of the population. The concentration of 53.90% of the people in four cities (class C1) explains the growth of centralization in this region. Economic, social, and political factors have played a significant role in intensifying such unequal regional-spatial distribution. As shown in the above graph Figure 80, the cities with ranks 1 to 4 have significant heterogeneity between the size of the actual population and Zipf's law with the highest distance between the two graphs on the column chart Figure 80. Also, this imbalance was continued between the cities with ranks 5 to 19. But the distance between the graphs is closer than the cities with upper ranks.

In addition to the Rank-Size rule, this study used the regression model for further analysis and the results represented in Figure 81. Based on this model's law, if the slope of b is negative or ($b<1$), it means there is no balance. Unfortunately, for these decades, the slope is -1.336, therefore clearly representing unbalance between cities rank and population size.

As shown in Figure 81, the logarithmic distribution of population is presented vertically, and the logarithmic distribution of cities ranks horizontally. The slope line goes down, and the distance between points of the four bigger cities is too much than the other size of cities. Just for the cities between ranks 20 to 48, the imbalance rate is less than other cities. Moreover, the imbalance and distance have risen dramatically concerning the calculated ranks for the last two cities.

8.3. The results of Rank-Size Rule, Zipf's law for the decade 1996

Table 22 The result of the Rank-Size Rule, Zipf's law, and Regression Model for the cities of the Mazandaran metropolitan area between 1986- 1996, Iran (by the author)

Class Of Cities	Row	Cities	Real population	Rank	Zipf's law	Population surplus or decline	Regression Model LogR=x	LogR=y
B2	1	**Sari**	195882	1	195882	0	0	5.291995
	2	**Amol**	159092	2	97941	61151	0.30103	5.201648
	3	**Babol**	158346	3	65294	93052	0.477121	5.199607
	4	**Ghaemshahr**	143286	4	48971	94316	0.60206	5.156204
B1	5	**Behshar**	72067	5	39176	32891	0.69897	4.857736
A	6	**Challos**	41403	6	32647	8756	0.778151	4.617032
	7	**Babolsar**	38644	7	27983	10661	0.845098	4.587082
	8	**Neka**	35208	8	24485	10723	0.90309	4.546641
	9	**Nooshahr**	35133	9	21765	13368	0.954243	4.545715
	10	**Tonekabon**	33650	10	19588	14062	1	4.526985
	11	**Ramsar**	28954	11	17807	11147	1.041393	4.461709
	12	**Freydonkenar**	27976	12	16324	11653	1.079181	4.446786
	13	**Jouybar**	23909	13	15068	8841	1.113943	4.378561
	14	**Amirkolah**	21280	14	13992	7288	1.146128	4.327972
	15	**Mahmoodabad**	20054	15	13059	6995	1.176091	4.302201
	16	**Galogah**	18073	16	12243	5830	1.20412	4.25703
	17	**Zirab**	17196	17	11522	5674	1.230449	4.235427
	18	**Noor**	16808	18	10882	5926	1.255273	4.225516
	19	**Katalem sadatshahr**	16239	19	10310	5929	1.278754	4.210559
	20	**Rostamkolah**	10773	20	9794	979	1.30103	4.032337
	21	**Kelardasht**	10482	21	9328	1154	1.322219	4.020444
	22	**Khoramabad**	9881	22	8904	977	1.342423	3.994801
	23	**Shirgah**	9546	23	8517	1029	1.361728	3.979821
	24	**Abbasabad**	9384	24	8162	1222	1.380211	3.972388
	25	**Salmanshahr**	8302	25	7835	467	1.39794	3.919183
	26	**Sorak**	8236	26	7534	702	1.414973	3.915716
	27	**Chamestan**	7926	27	7255	671	1.431364	3.899054

28	**Polsefeed**	7648	28	6996	652	1.447158	3.883548
29	**Keeyahkolah**	6810	29	6755	55	1.462398	3.833147
30	**Marzanabad**	6488	30	6529	-41	1.477121	3.812111
31	**Royan**	5592	35	5597	-5	1.491362	3.747567
32	**Kelarabad**	4973	39	5023	-50	1.50515	3.696618
33	**Nashtarood**	4770	41	4778	-8	1.518514	3.678518
34	**Keyahsar**	3782	51	3841	-59	1.531479	3.577722
35	**Sorkhrood**	3772	52	3767	5	1.544068	3.576572
36	**Rineh-e-Larijan**	1337	147	1333	4	1.556303	3.126131
37	**Alasht**	424	462	424	0	1.568202	2.627366
	SUM	**1223326**		**807307**	**416019**		

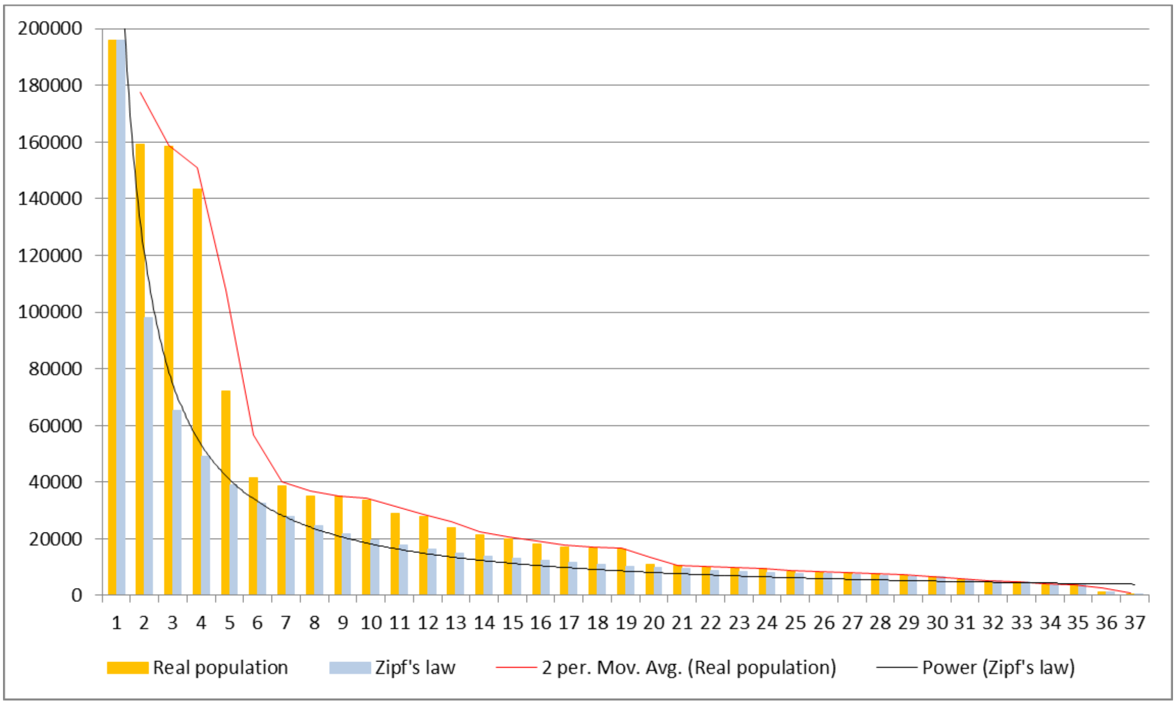


Figure 83 The imbalance between the actual size of the population with the ideal size of the population of cities in the Mazandaran metropolitan area considering the results of Zip's law; between 1986- 1996, Iran (by the author)

8.4. The results of Regression model for the decade 1996

The calculation of Rank-Size Rule using Regression Model

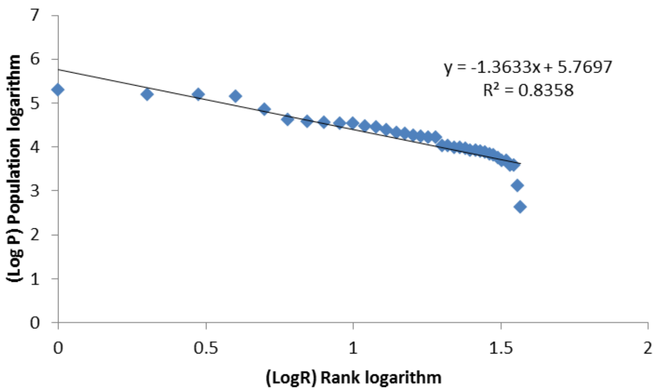


Figure 84 The logarithmic distribution of cities in the Mazandaran metropolitan area considering the rsults of Rank-Size Rule between 1986- 1996, Iran (by the author)

Best-fit values	
Slope	-1.363 ± 0.1021
Y-intercept	5.770 ± 0.1250
X-intercept	4.232
1/Slope	-0.7335
95% Confidence Intervals	
Slope	-1.571 to -1.156
Y-intercept	5.516 to 6.024
X-intercept	3.824 to 4.786
Goodness of Fit	
R square	0.8358
Sy.x	0.2309
Is slope significantly non-zero?	
F	178.2
DFn,DFd	1,35
P Value	< 0.0001
Deviation from horizontal?	Significant
Data	
Number of XY pairs	37
Equation	Y = -1.363*X + 5.770

Results of the model for this decade show a continuation of heterogeneity and imbalance that was started from the last decade or decades, without remarkable changes during this decade Table 22. The number and size of cities have grown numerically from 33 cities to 37, and population from 897667 to 1,223,326.

The expected urban population size for this decade, concerning the results of Zipf's law, is about 807307 dwellers Table 22. But in fact, statistics show that the cities were populated with 1,223,326 dwellers and faced a surplus of population. About 416019 people were settled over the capacities of these cities. According to the results, 54% of the population concentrated in class B2, 6% in class B1, and 40% in class A Figure 85.

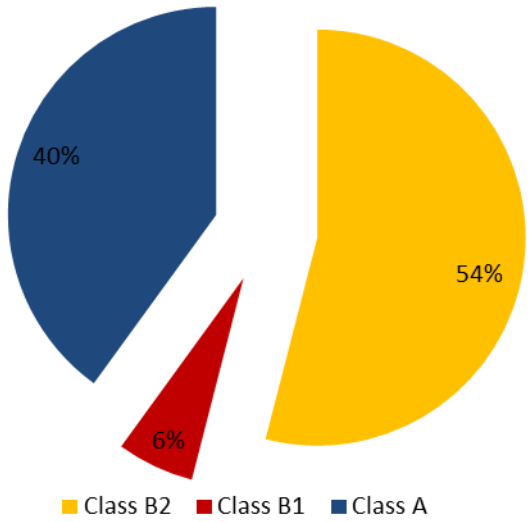


Figure 85 The percent of the spatial distribution of population in the cities of the Mazandaran metropolitan area (by the author)

As illustrated in graph Figure 83, there is substantial heterogeneity between the size of the population in the cities with ranks 1 to 4 compared to the results of Zipf's law. This problem imposed a big gap or distance between the two graphs on the column chart. Also, the imbalance for the cities with ranks between 5 to 19 is lower than the cities with upper ranks. Based on the results of the Regression Model, unfortunately, the slope rate for this decade is -1.363, a little bit more than before.

As shown in Figure 84, the logarithmic distribution of population is presented vertically, and the logarithmic distribution of the cities ranks horizontally. The direction of the slop line downward and distance between points for the first four larger cities is too much compared to the other cities. And for other ranks from 5 up to 21 is lower. Just for this size of cities with ranks between 22-52, the imbalance rate is less than other cities. Moreover, for the last two cities with ranks 147 and 462, the distance rate concerning the ranks has risen dramatically.

8.5. The results of Rank-Size Rule, Zipf's law for the decade 2006

Table 23 The result of the Rank-Size Rule, Zipf's law, and Regression Model for the cities of the Mazandaran metropolitan area between 1996- 2006, Iran (by the author)

Class Of Cities	Row	Cities	Real population	Rank	Zipf's law	Population surplus or decline	Regression Model LogR=x	Regression Model LogR=y
B2	1	**Sari**	261293	1	261293	0	0	5.417128
	2	**Amol**	201335	2	130647	70689	0.30103	5.303919
	3	**Babol**	199698	3	87098	112600	0.477121	5.300374
	4	**Ghaemshahr**	174768	4	65323	109445	0.60206	5.242462
B1	5	**Behshar**	84117	5	52259	31858	0.69897	4.924884
	6	**Babolsar**	50032	6	43549	6483	0.778151	4.699248
A	7	**Neka**	46291	7	37328	8963	0.845098	4.665497
	8	**Challos**	45625	8	32662	12963	0.90309	4.659203
	9	**Tonekabon**	43842	9	29033	14809	0.954243	4.64189
	10	**Nooshahr**	42175	10	26129	16046	1	4.625055
	11	**Freydonkenar**	34496	11	23754	10742	1.041393	4.537769
	12	**Ramsar**	32085	12	21774	10311	1.079181	4.506302
	13	**Mahmoodabad**	27748	13	20099	7649	1.113943	4.443232
	14	**Jouybar**	27211	14	18664	8547	1.146128	4.434745
	15	**Amirkolah**	25291	15	17420	7871	1.176091	4.402966
	16	**Noor**	22491	16	16331	6160	1.20412	4.352009
	17	**Galogah**	18727	17	15370	3357	1.230449	4.272468
	18	**Zirab**	18388	18	14516	3872	1.255273	4.264534
	19	**Katalem sadatshahr**	17955	19	13752	4203	1.278754	4.254185
	20	**Kelardasht**	11999	20	13065	-1066	1.30103	4.079145
	21	**Rostamkolah**	11408	21	12443	-1035	1.322219	4.05721
	22	**Abbasabad**	11278	22	11877	-599	1.342423	4.052232
	23	**Khalilshahr**	10126	23	11361	-1235	1.361728	4.005438
	24	**Khoramabad**	9945	24	10887	-942	1.380211	3.997605
	25	**Salmanshahr**	9664	25	10452	-788	1.39794	3.985157
	26	**Chamestan**	9499	26	10050	-551	1.414973	3.977678
	27	**Sorak**	8822	27	9678	-856	1.431364	3.945567

28	**Polsefeed**	8708	28	9332	-624	1.447158	3.939918
29	**Shirgah**	8611	29	9010	-399	1.462398	3.935054
30	**Keyahkolah**	7472	34	7685	-213	1.477121	3.873437
31	**Mazanabad**	7102	36	7258	-156	1.491362	3.851381
32	**Gatab**	6956	37	7062	-106	1.50515	3.84236
33	**Izadshahr**	6888	38	6876	12	1.518514	3.838093
34	**Bahnamir**	6848	39	6700	148	1.531479	3.835564
35	**Sorkhrood**	6620	40	6532	88	1.544068	3.820858
36	**Royan**	6351	41	6373	-22	1.556303	3.802842
37	**Nashtarood**	5967	44	5938	29	1.568202	3.775756
38	**Kelarabad**	5457	47	5559	-102	1.579784	3.736954
39	**Keyahsar**	3672	71	3680	-8	1.591065	3.564903
40	**Kallehbast**	3561	73	3579	-18	1.60206	3.551572
41	**Khoshroodpey**	3022	86	3038	-16	1.612784	3.480294
42	**Galogah-e-Babol**	2519	103	2537	-18	1.623249	3.401228
43	**Koheekheyl**	1950	134	1950	0	1.633468	3.290035
44	**Baladeh**	1340	195	1340	0	1.643453	3.127105
45	**Rineh-e-Larijan**	1213	215	1215	-2	1.653213	3.083861
46	**Dabodasht**	1096	238	1098	-2	1.662758	3.039811
47	**Alasht**	984	265	986	-2	1.672098	2.992995
48	**Marzikolah**	525	498	525	0	1.681241	2.720159
49	**Zargarmahalleh**	425	614	426	-1	1.690196	2.628389
50	**Gazanak**	362	722	362	0	1.69897	2.558709
51	**Farrim**	185	1412	185	0	1.70757	2.267172
	SUM	**1554143**		**1116058**	**438085**		

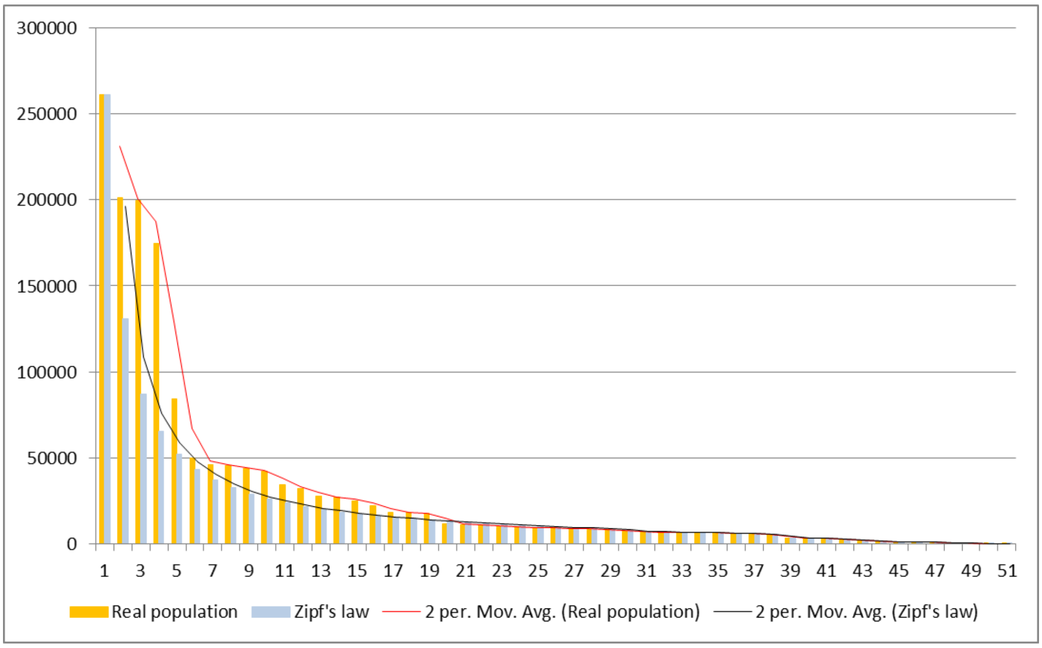


Figure 86 The imbalance between the actual size of the population with the ideal size of the population of cities in the Mazandaran metropolitan area considering the results of Zip's law; between 1996- 2006, Iran (by the author)

8.6. The results of Regression model for the decade 2006

The calculation of Rank-Size Rule using the Regression Model

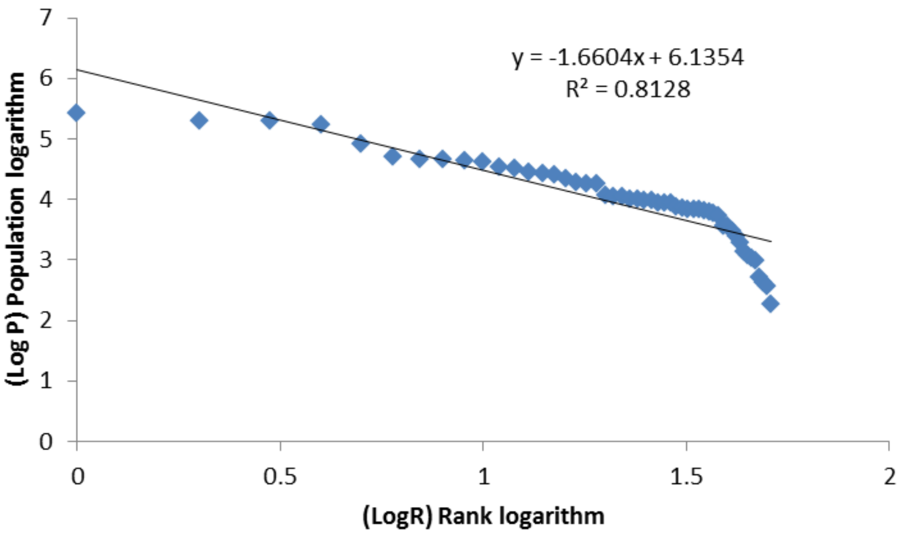


Figure 87 The logarithmic distribution of cities in the Mazandaran metropolitan area considering the rsults of Rank-Size Rule between 1996- 2006, Iran (by the author)

Best-fit values	
Slope	-1.660 ± 0.1138
Y-intercept	6.135 ± 0.1541
X-intercept	3.695
1/Slope	-0.6023
95% Confidence Intervals	
Slope	-1.889 to -1.431
Y-intercept	5.826 to 6.445
X-intercept	3.400 to 4.083
Goodness of Fit	
R square	0.8128
Sy.x	0.3113
Is slope significantly non-zero?	
F	212.7
DFn,DFd	1,49
P Value	< 0.0001
Deviation from horizontal?	Significant
Data	
Number of XY pairs	51
Equation	Y = -1.660*X + 6.135

That decade coincided with the entry into the 21st century, and the urban system of this metropolitan area faced dramatic changes in the number and size of cities and population. According to the model results, as shown in the above table Table 23, numbers of cities in the Mazandaran metropolitan area have increased from 37 to 51 significantly. The size of the population has been grown from 1,223,326 in 1996 to 1554143 in 2006. Results of models for this decade show the continuation of heterogeneity and imbalance that started from the last decades, accompanied by remarkable changes in Table 23. The numbers and size of cities have grown numerically from 33 cities to 51, and increasing population from 1,223,326 to 1,554,143.

Concerning the results of Zipf's law, the predicted urban population size for this decade is about 1,116,058 dwellers Table 23. But statistics indicate that the cities were populated with approximately 1,554,143 dwellers and faced a surplus of population. It means about 438085 dwellers over the capacities of the cities. According to the results, 53.86% of the population concentrated in class B2, 8.63% in class B1, and 37.71% in class A Figure 88. For the first time in this region, two cities have been placed in class B. The population size of class B2 has increased from 656606 in 1996 to 837094 in 2006.

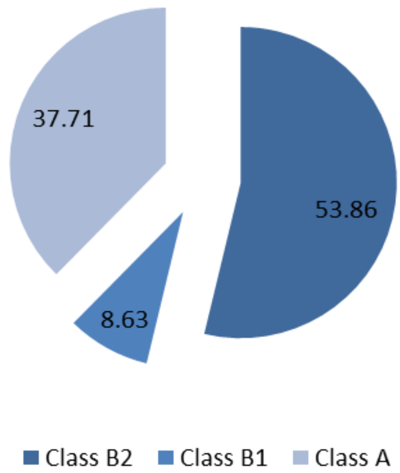


Figure 88 The percent of the spatial distribution of population in the cities of the Mazandaran metropolitan area (by the author)

As illustrated in Figure 86, the model shows the continuation of a sharp imbalance from the past decades between the size of population among the cities. Such heterogeneity has generated a big gap between the classes B2, B1, and A. Also, from the cities with ranks 5 to 19, we observed a continuation of this imbalance trend, but the distance between the graphs is closer than the cities with upper ranks 1 to 4.

According to the regression model results, in this decade, the rate of the slope line is -1.660, the highest rate that was never seen before.

Figure 8 presents a logarithmic distribution of the population vertically and a logarithmic distribution of the cities' ranks horizontally. The slope of the line is down, and the distance between points for the six superior cities is more than the cities with ranks 7 to 29. Just for these groups of cities with ranks 34 to 47, the imbalance rate is less than other cities. Moreover, the cities with ranks 71 to 1412 observed a dramatic imbalance.

8.7. The Rank-Size Rule, Zipf's law for the decade 2016

Table 24 The result of the Rank-Size Rule, Zipf's law, and Regression Model for the cities of the Mazandaran metropolitan area between 2006- 2016, Iran (by the author)

Class Of Cities	Row	Cities	Real population	Rank	Zipf's law	Population surplus or decline	Regression Model	
							LogR=x	LogR=y
C1	1	**Sari**	347402	1	347402	0	0	5.540832
	2	**Amol**	250217	2	173701	76516	0.30103	5.398317
B2	3	**Babol**	237528	3	115801	121727	0.477121	5.375715
	4	**Ghaemshahr**	204953	4	86851	118103	0.60206	5.311654
B1	5	**Behshar**	94702	5	69480	25222	0.69897	4.976359
	6	**Challos**	65196	6	57900	7296	0.778151	4.814221
	7	**Neka**	60991	7	49629	11362	0.845098	4.785266
	8	**Babolsar**	59966	8	43425	16541	0.90309	4.777905
	9	**Tonekabon**	55434	9	38600	16834	0.954243	4.743776
A	10	**Noshahr**	49403	10	34740	14663	1	4.693753
	11	**Freydonkenar**	38154	11	31582	6572	1.041393	4.58154
	12	**Ramsar**	35997	12	28950	7047	1.079181	4.556266
	13	**Juybar**	32924	13	26723	6201	1.113943	4.517513
	14	**Mahmoodabad**	31844	14	24814	7030	1.146128	4.503028
	15	**Amirkolah**	30478	15	23160	7318	1.176091	4.483986
	16	**Noor**	26947	16	21713	5234	1.20412	4.43051
	17	**Galogah**	21352	17	20435	917	1.230449	4.329439
	18	**Katalem Sadatshahr**	20716	18	19300	1416	1.255273	4.316306
	19	**Zirab**	16191	22	15791	400	1.278754	4.209274
	20	**Abbasabad**	13482	26	13362	120	1.30103	4.129754
	21	**Kelardasht**	13401	27	12867	534	1.322219	4.127137
	22	**Rostamkolah**	11686	30	11580	106	1.342423	4.067666
	23	**Khorramabad**	11542	31	11207	335	1.361728	4.062281
	24	**Shirood**	11377	31	11207	170	1.380211	4.056028
	25	**Chamestan**	11194	32	10856	338	1.39794	4.048985
	26	**Khalilshahr**	11032	33	10527	505	1.414973	4.042654
	27	**Hachirud**	10398	34	10218	180	1.431364	4.01695
	28	**Arrateh**	10327	35	9926	401	1.447158	4.013974
	29	**Salmanshahr**	9656	36	9650	6	1.462398	3.984797

30	**Sorrak**	9208	38	9142	66	1.477121	3.964165
31	**Shirgah**	8671	40	8685	-14	1.491362	3.938069
32	**Polsefeed**	8294	42	8271	23	1.50515	3.918764
33	**Keyahkolah**	8040	43	8079	-39	1.518514	3.905256
34	**Bahnamir**	7906	44	7896	11	1.531479	3.897957
35	**Hadishahr**	7889	45	7720	169	1.544068	3.897022
36	**Royan**	7731	45	7720	11	1.556303	3.888236
37	**Izadshahr**	7439	47	7392	47	1.568202	3.871515
38	**Gatab**	7374	48	7238	136	1.579784	3.867703
39	**Galogahbabol**	6908	50	6948	-40	1.591065	3.839352
40	**Sorkhrood**	6699	52	6681	18	1.60206	3.82601
41	**Marzanabad**	6698	53	6555	143	1.612784	3.825945
42	**Nashtarood**	6394	54	6433	-39	1.623249	3.805773
43	**Kelarabad**	6267	55	6316	-49	1.633468	3.79706
44	**Emamzadehabdollah**	5768	60	5790	-22	1.643453	3.761025
45	**Khoshroodpey**	5742	77	5695	47	1.662758	3.653116
46	**Ejbarkollah**	4499	81	4512	-13	1.653213	3.759063
47	**Zargarmahalleh**	3991	87	3993	-2	1.672098	3.601082
48	**Keyhsar**	3384	103	3373	11	1.681241	3.52943
49	**Pul**	3150	110	3158	-8	1.690196	3.498311
50	**Kojur**	3120	111	3130	-10	1.69897	3.494155
51	**Marzikolah**	2710	128	2714	-4	1.70757	3.432969
52	**Koheekheyl**	2242	155	2241	1	1.716003	3.350636
53	**Farahabad**	2217	157	2213	4	1.724276	3.345766
54	**Dabodasht**	1758	198	1755	3	1.732394	3.245019
55	**Alasht**	1193	291	1194	-1	1.740363	3.07664
56	**Rineh-e-Larijan**	982	354	981	1	1.748188	2.992111
57	**Baladeh**	970	358	970	0	1.755875	2.986772
58	**Paeenhollar**	956	363	957	-1	1.763428	2.980458
59	**Farim**	369	941	369	0	1.770852	2.567026
60	**Gazannak**	319	1089	319	0	1.778151	2.503791
	SUM	**1943378**		**1489837**	**453543**		

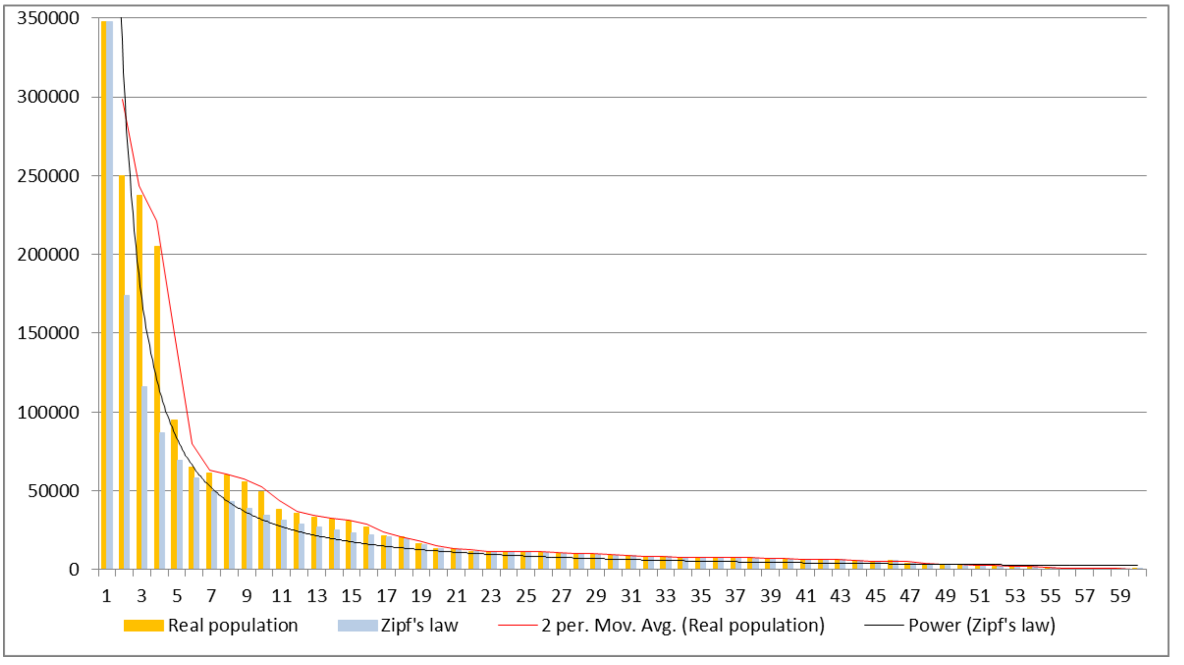


Figure 89 The imbalance between the actual size of the population with the ideal size of the population of cities in the Mazandaran metropolitan area considering the results of Zip's law; between 2006- 2016, Iran (by the author)

8.8. The Regression model for the decade 2016

The calculation of Rank-Size Rule using the Regression Model

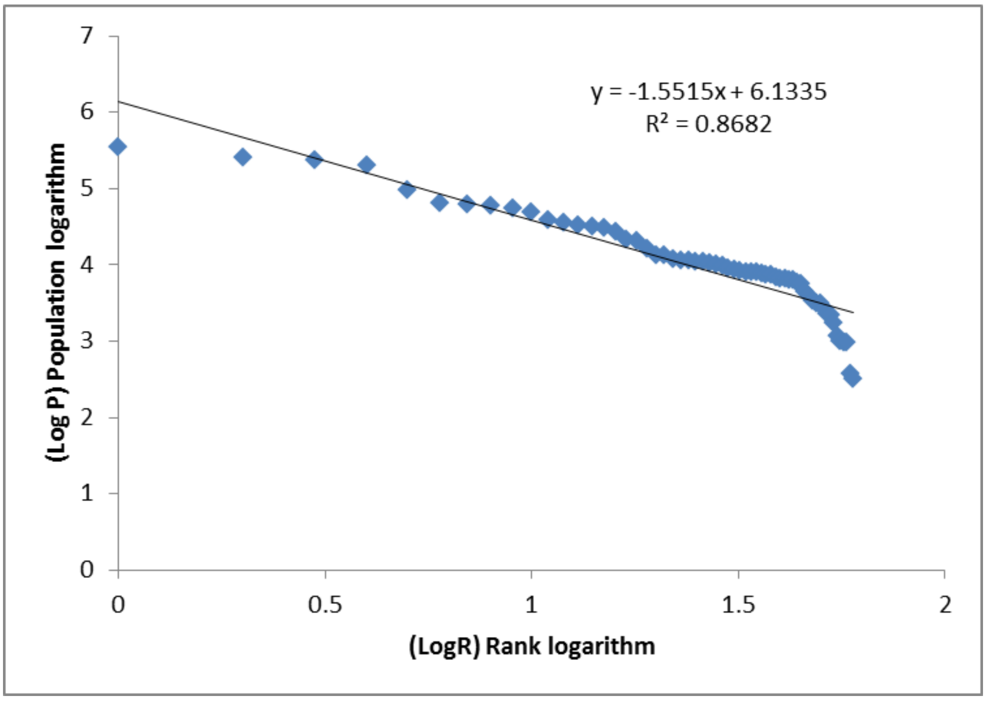


Figure 90 The logarithmic distribution of cities in the Mazandaran metropolitan area considering the rsults of Rank-Size Rule between 2006- 2016, Iran (by the author)

Best-fit values	
Slope	-1.551 ± 0.07939
Y-intercept	6.134 ± 0.1127
X-intercept	3.953
1/Slope	-0.6445
95% Confidence Intervals	
Slope	-1.710 to -1.393
Y-intercept	5.908 to 6.359
X-intercept	3.710 to 4.252
Goodness of Fit	
R square	0.8682
Sy.x	0.2386
Is slope significantly non-zero?	
F	381.9
DFn,DFd	1,58
P Value	< 0.0001
Deviation from horizontal?	Significant
Data	
Number of XY pairs	60
Equation	Y = -1.551*X + 6.134

The outcomes of data analysis represent this decade more distinctive than others. For the first time emerged two big cities, and the new class C1 added to the class of cities in this metropolitan area with remarkable population size. At the end of 2006 were four first cities in class B2, and today the cities of this class are divided into the two different classes B2 and C1 (Big Cities). Surprisingly, today we have five cities in class B2, which was never seen before Table 24.

According to the above model results, as shown in Table 24, the numbers of cities in this metropolitan area have increased from 51 at the beginning of the decade to 60 cities at the end of this decade significantly. The size of the population has risen rapidly from 1554143 in 2006 to 1,943,378 in 2016. The results show a continual growth of heterogeneity and imbalance in the size and rank of cities.

Concerning the results of Zipf's law, the urban population size for this decade is in this metropolitan area about 1,489,837 dwellers Table 24. But statistics show that the cities were populated with 1,943,378 dwellers and faced a surplus of population considerably. It means 453541 people were settled over the capacities of the cities. As shown in the pie chart Figure 91, 31% population of this metropolitan area dropped in the two first cities in class C1. And surprisingly, the second place belongs to the cities of class B2 with 23% of the population. Also, 17% of the population lives in class B1. The last place belongs to class A with 29% population of the Metropol.

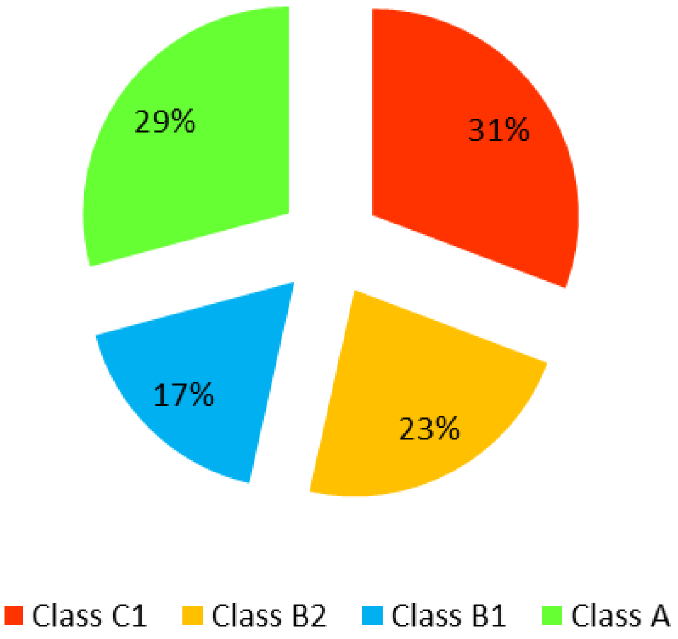


Figure 91 The percent of the spatial distribution of populations in the cities of the Mazandaran metropolitan area (by the author)

Table 25 Classifying the cities of the Mazandaran metropolitan area considering the population (by the author)

	Class C1	Class B2	Class B1	Class A	Sum
The population in percent	30.75%	22.77%	17.30%	29.18%	100
Numbers of Cities and Towns	2	2	5	51	60

As illustrated by the graphs on the column chart, Figure 89, we observe a gradual increase in the gap between the size of population and rank of cities concerning the results of Zipf's law compared with the statistical data.

As shown in the results, we face a polarized and centralized form of urbanization in this area, and urban hierarchies have no balance. 31% of the population live in the first two biggest cities of class C1, 23% live in two cities of class B2, 17% live in five cities from class B1, and 29% live in 51 cities of class A Table 25.

According to the results of the regression model, unfortunately, the rate of the line of the slope is -1.55for this decade, which is about 5% lower than the last decade, but it is not a considerable difference or a remarkable change (see Figure 90). This graph presents the logarithmic distribution of the size of the population vertically and also a logarithmic distribution of the rank of the cities horizontally. The slope of the line is sinking, and the distance between the points for the nine superior cities became more than the other cities, surprisingly. And for the cities in class A between the ranks 10 to 55, the imbalance degree is less than other cities. Moreover, for the cities with ranks 60 to 1089, the model shows a drastic difference in terms of size and status compared with the cities class C1.

Table 26 Number of cities in the Mazandaran metropolitan area from 1956 to 2016, Iran (by the author)

Decades	**1956**	**1966**	**1976**	**1986**	**1996**	**2006**	**2016**
Numbers of cities and towns	19	16	22	33	35	51	60
Numbers of added or decreased towns		-3	+6	+11	+2	+16	+9

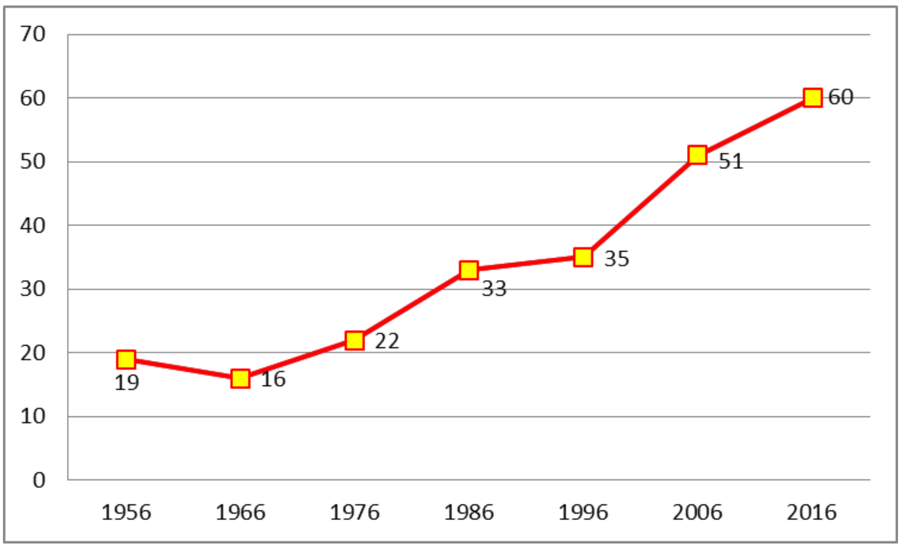


Figure 92 Numeric growth of cities in the Mazandaran metropolitan area from 1956 to 2016 (by the author)

Table 27 The proportion of the numbers of cities and size of the population to the total ratio, 1956-2016 (by the author)

Decades	1956	1966	1976	1986	1996	2006	2016	Sum
The proportion of the numbers of cities to the total proportion	19	16	22	33	35	51	60	60
The size of urban population to the total proportion	156329	301729	511787	897667	1223326	1554143	1943378	1943378
The proportion of the numbers of cities to the total proportion in %	32%	27%	37%	55%	58%	85%	100%	
The size of urban population to the total proportion in %	8%	16%	26%	46%	63%	80%	100%	

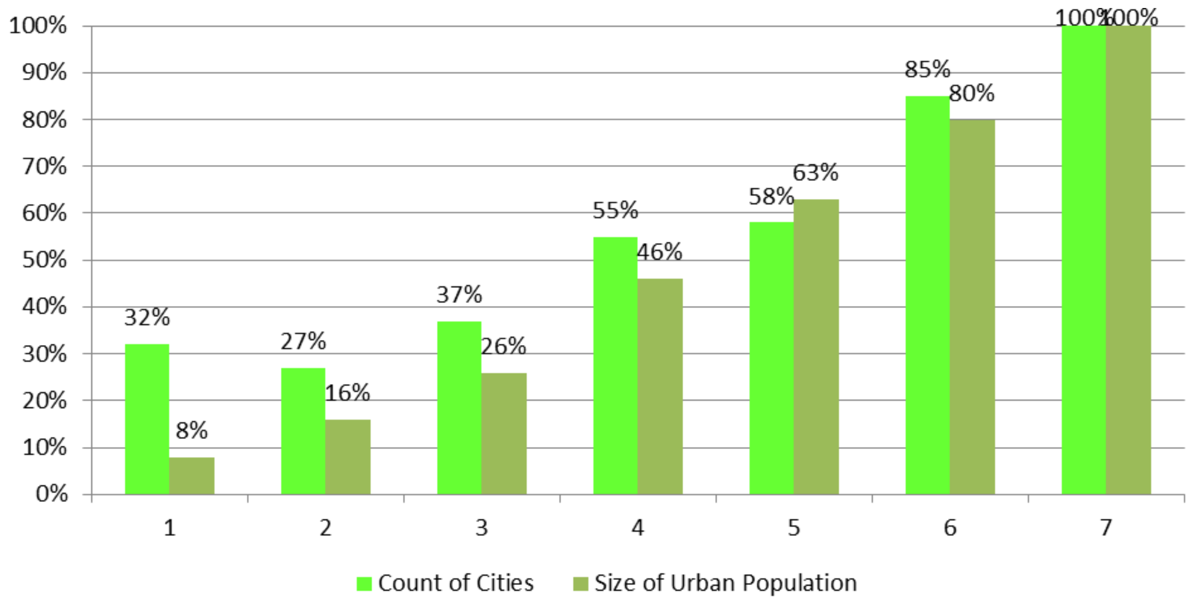


Figure 93 The proportion of the numbers of cities and size of the population to the total proportion in percent. The numbers between 1-7 horizontally refer to the decades in Table 27 (by the author)

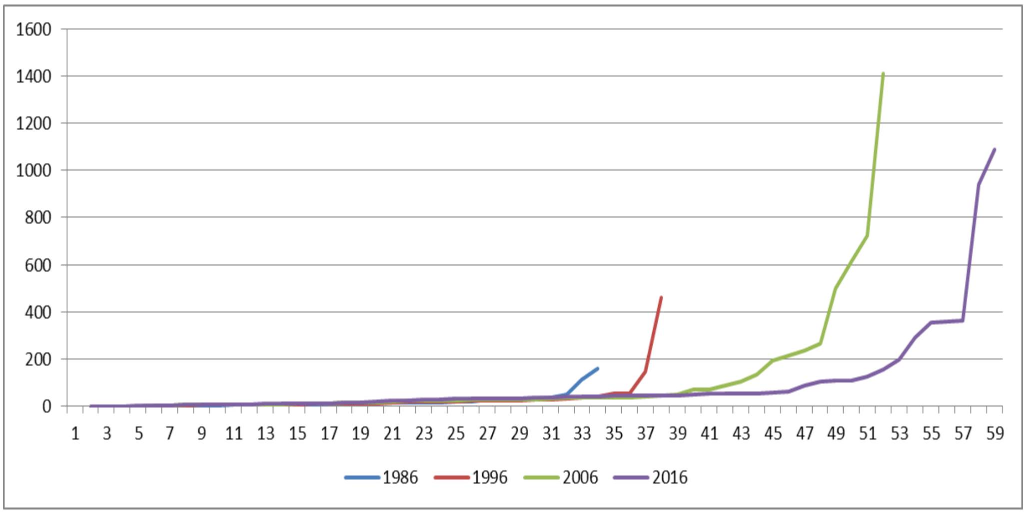


Figure 94 Increasingly difference between the size and rank of the first city with the smallest city according to the results of the Rank-Size roll (by the author)

By the 1956s were 19 cities in this metropolitan area but today has 60 cities in Table 26. The percentage of numerical growth of the cities relative to the total of cities by today has decreased in 1966s surprisingly compared with the rate of the decade 1956s that was 32% Table 27. The reason refers to the change of the political borders of this metropolitan area, separation of the major part of this region with urban and rural centers was added to the other provinces. Accordingly, the number of cities had decreased. As shown by the results of this research, before 1966s area of this region was about 14,758,918 hectares Figure 95, and today is about 2,261,555 hectares Figure 96. As a result, the number of cities had been decreased. It can be seen in the map Figure 97 that a large area of the region separated from the main body of this region and added to the other region. For that reason, the biggest changes of rural areas to the new towns happened between the decades 1986-2006 11 and 16 Table 25. Over the seven decades of urbanization processes in this region, the numerical growth of the cities and towns was more than the population growth of urban zones. This fact has faced this study with challenging questions! Why are Irans' Urban Development Ministry and regional administrations investing many times to change rural areas to new towns more important than solving urban problems, polarization, and unequal distribution of resources and infrastructures among the cities? Why is it difficult for them to understand, changing villages to a town increases regional imbalances?

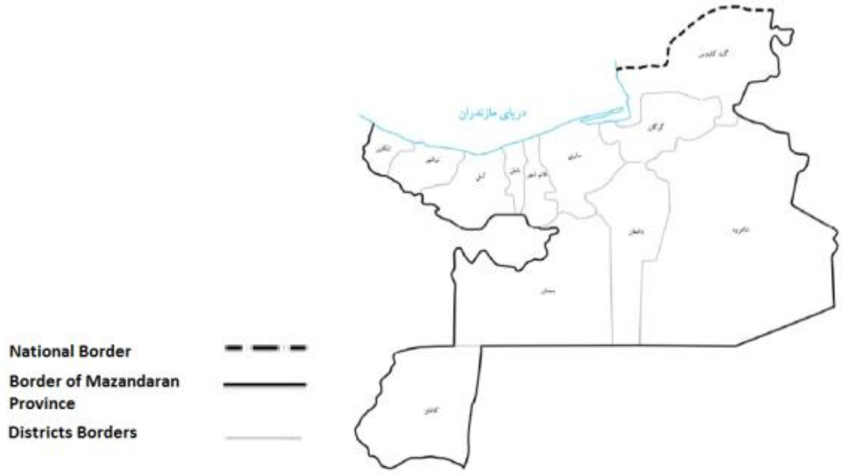


Figure 95 The geographical position and borders of the Mazandaran metropolitan area in the 1960s (by the author)

Figure 96 The geographical position and borders of the Mazandaran metropolitan area in 2020 (by the author)

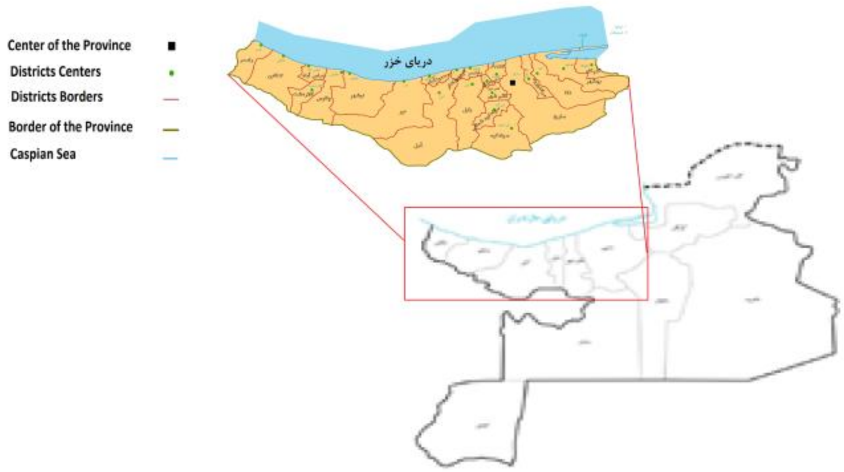


Figure 97 The visual comparison of the changed borders from 1960 to 2020, By author 2020 (by the author)

8.9. The results of Location Quotient model (L.Q)

The total share of Sari city in comparison with the total share at the national level

Table 28 The total share of the three basic economic activities at the city and national levels in the 1966s (by the author)

L.Q

	City	National
Agricultural	6649	3281125
Industry	4913	1856548
Servicing	8389	1833333
SUM	19951	6971006

Table 29 The rate of L.Q of Sari city at the national levels in the 1966s (by the author)

City	National	LQ National
33.326%	47.068%	0.708%
24.625%	26.632%	0.924%
42.048%	26.299%	1.598%
100	100	

Table 30 The total share of the three basic economic activities at the city and national levels in the 1976s (by the author)

L.Q

	City	National
Agricultural	8366	2991802
Industry	7002	3009401
Servicing	9257	2719020
SUM	24625	8720223

Table 31 The rate of L.Q of Sari city at the national levels in the 1976s (by the author)

City	National	LQ National
33.973%	34.308%	0.990%
28.434%	34.510%	0.823%
37.591%	31.180%	1.205%
100	100	

The total share of the city in comparison with the total share at the national, region, and county levels

Table 32 The total share of the three basic economic activities at the city, county, regional and national levels in the 1986s (by the author)

	Region	County	City	National
Agricultural	217056	38280	988	3190761
Industry	94929	6939	10341	2781008
Servicing	205857	25643	20736	5029766
SUM	5178 42	7086 2	3206 5	110015 35

Table 33 The percent of the activities of Sari city at the city, county, regional, and national levels in the 1986s (by the author)

Regional	County	City	National
41.915%	54.020%	3.081%	29.002%
18.331%	9.792%	32.250%	25.278%
40	36.187%	64.668%	45.718%
100	100	100	100

Table 34 The rate of L.Q of Sari city at the county, regional, and national levels in the 1986s (by the author)

LQ Regional	LQ County	LQ National
0.0735%	0.057%	0.106%
1.759%	3.293%	1.275%
1.626%	1.787%	1.414%

Table 35 The total share of the three basic economic activities at the city, county, regional and national levels in the 1996s (by the author)

L.Q

	Region	County	City	National
Agricultural	202278	28932	13339	3357263
Industry	153809	12618	11927	4472958
Servicing	278537	27597	21746	6484323
SUM	634624	69147	47012	14314544

Table 36 The percent of the activities of Sari city at the county, regional, city, and national levels in the 1996s (by the author)

Regional	County	City	National
31.873%	41.841%	28.373%	23.453%
24.236%	18.248%	25.370%	31.247%
43.890%	39.910%	46.256%	45.298%
100	100	100	100

Table 37 The rate of L.Q of Sari city at the county, regional, and national levels in the 1996s (by the author)

LQ Regional	LQ County	LQ National
0.890%	0.678%	1.209%
1.046%	1.390%	0.811%
1.053%	1.158%	1.021%

Table 38 The total share of the three basic activities at the city, county, regional and national levels in the 2006s (by the author)

L.Q

	Region	County	City	National
Agricultural	193565	32489	19283	3686747
Industry	268071	18389	24740	6493398
Servicing	443404	34094	45268	9808691
SUM	905040	84972	89291	19988836

Table 39 The percent of the activities of Sari city at the county, regional, and national levels in the 2006s (by the author)

Region Percent	County Percent	City Percent	National Percent
21.387%	38.234%	21.595%	18.444%
29.619%	21.641%	27.707%	32.485%
48.992%	40.123%	50.697%	49.070%
100	100	100	100

Table 40 The rate of L.Q of Sari city at the county, regional, and national levels in the 2006s (by the author)

LQ Regional	LQ County	LQ National
1.009%	0.564%	1.170%
0.935%	1.280%	0.852%
1.034%	1.263%	1.033%

Table 41 The total share of the three basic activities at the city, county, regional and national levels in the 2016s (by the author)

	Regional	County	City	National
Agricultural	188826	42803	20346	4621315
Industry	303638	22345	25421	7683721
Servicing	464946	32854	47543	12074964
SUM	957410	98002	93310	24380000

Table 42 The percent of the activities of Sari city at the city, county, regional, and national levels in the 2016s (by the author)

Regional Percent	County Percent	City Percent	National Percent
19.722%	43.675%	21.804%	18.955%
31.714%	22.800%	27.243%	31.516%
48.562%	33.523%	50.951%	49.528%
100	100	100	100

Table 43 The rate of L.Q of Sari city at the county, regional, and national levels in the 2016s (by the author)

LQ Regional	LQ County	LQ National
1.105%	0.499%	1.150%
0.859%	1.194%	0.864%
1.049%	1.519%	1.028%

The rate of L.Q of Sari city for all decades at the national level

Table 44 The rate of L.Q of the activities of Sari city at the national level, 1966-2016 (by the author)

Decades	1966	1976	1986	1996	2006	2016
Agricultural	0.708%	0.990%	0.106%	1.209%	1.170%	1.150%
Industry	0.924%	0.823%	1.275%	0.811%	0.852%	0.864%
Servicing	1.598%	1.205%	1.414%	1.0211%	1.033%	1.028%

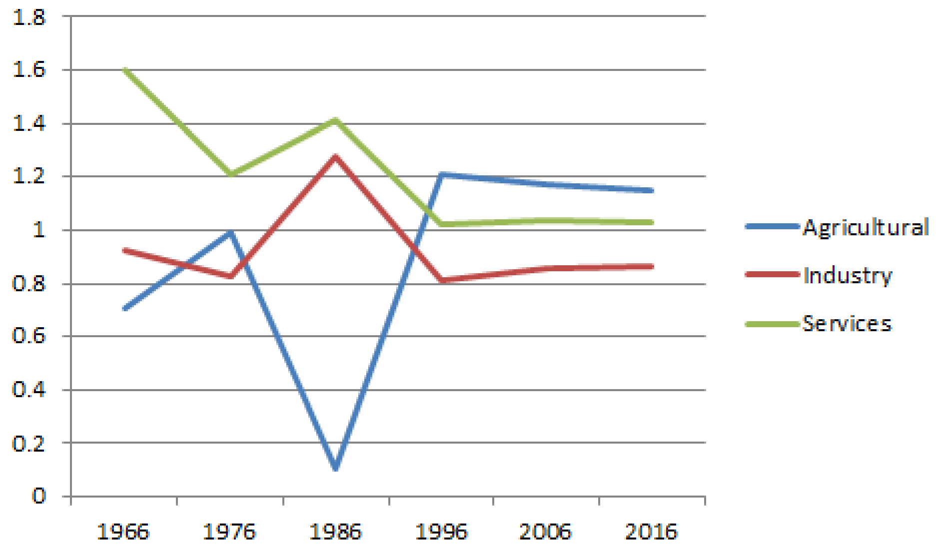


Figure 98 The L.Q of the activities of Sari city at the national level, 1966-2016 (by the author)

The final results for the agricultural sector show the development and independence of the sari city in the share of farm goods at the national level from 1966 to today. In 1966 the rate of the L.Q model was lower than 1 (0.708<1), and it means that time the city was of importer of agricultural goods. In 1976, the rate of L.Q had considerably increased and was (0.990). On the one hand, the rate is lower than 1, but on the other hand, if the rate L.Q is equal with 1 (L.Q = 1), it means the city in the mentioned part is independent. Accordingly, it is not false if we argue that this city in 1976 would be independent rather than an importer of goods. Because, based on the results, the rate of L.Q in the following decades is more than 1, and the cities from this decade are independent and are the exporter of agricultural goods at the national levels. In 2006 the city experienced the highest export rate, and in the next decade faced with a 0.2%

decrease. But this reduction is not limited to the mentioned sector also the industry and servicing activities faced with a declination.

The other considerable change happened in the agricultural sector in 1986, and the value of the share of agricultural goods for this city had decreased dramatically. Because, in addition to the unwelcome revolution in 1979, one year later, Iran faced the war that was started by the country Iraq in the 1980s. So, basic economic sectors were under negative consequences of revolution and war at the national level, and as a result, the city experienced a decrease in production. But after the war, concerning the result as shown in Figure 98, the share of this city has increased rapidly and by today has the first place than other sectors. One of the main reasons referred to geographical location and particular climatic condition of this metropolitan area than the other regions in Iran. This region is the wettest region and always recorded the highest rainfall rate than the other regions in Iran. So, such perfect conditions have developed agricultural activities in this region, and most people are working in this sector.

The rate of L.Q of Sari city for all decades in the Mazandaran metropolitan area

Table 45 The rate of L.Q of the activities of Sari city at the regional level, 1986-2016 (by the author)

Decades	L.Q Sari 1986	L.Q Sari 1996	L.Q Sari 2006	L.Q Sari 2016
Agricultural	0.073%	0.890%	1.009%	1.105%
Industry	1.759%	1.046%	0.935%	0.859%
Servicing	1.626%	1.053%	1.034%	1.049%

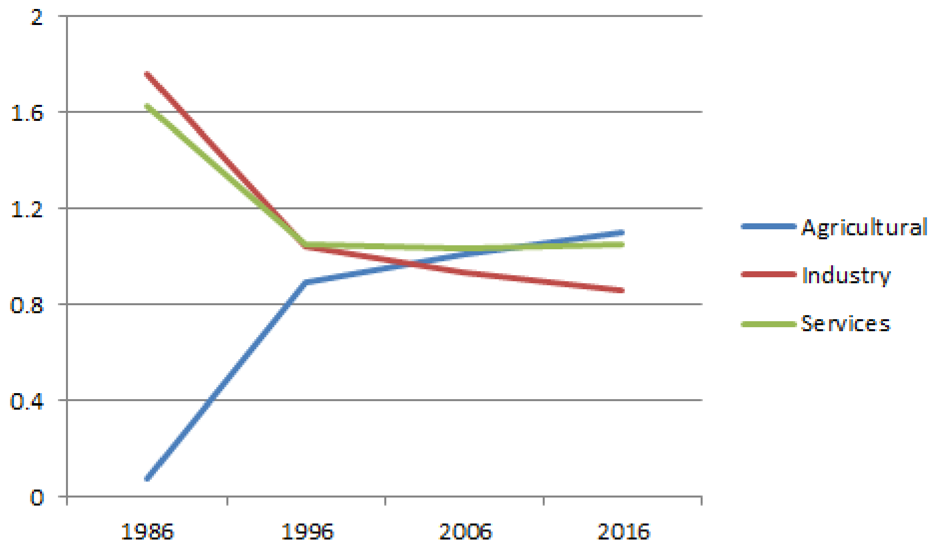


Figure 99 The L.Q of the economic activities of Sari city at the regional level, 1986-2016 (by the author)

Unfortunately, there is no statistical data around the above sectors before 1986 at the regional level. Concerning the model results, agricultural activities ranked above the other sectors on the graph and tables. And then servicing and industry parts placed in the second and third places.

In the agricultural sector, the rates of share of the city at the regional level except the last decade are more than the national level. There are considerable differences between the values of agricultural and servicing activities with the industrial sector. For the service sector, there are no remarkable differences between the decades and rates of share.

The rate of L.Q of Sari city for all decades at the county level

Table 46 The rate of L.Q of the activities of Sari city at the county level, 1986-2016 (by the author)

Decades	L.Q Sari 1986	L.Q Sari 1996	L.Q Sari 2006	L.Q Sari 2016
Agricultural	0.05%	0.678%	0.564%	0.499%
Industry	3.293%	1.390%	1.280%	1.194%
Servicing	1.787%	1.158%	1.263%	1.519%

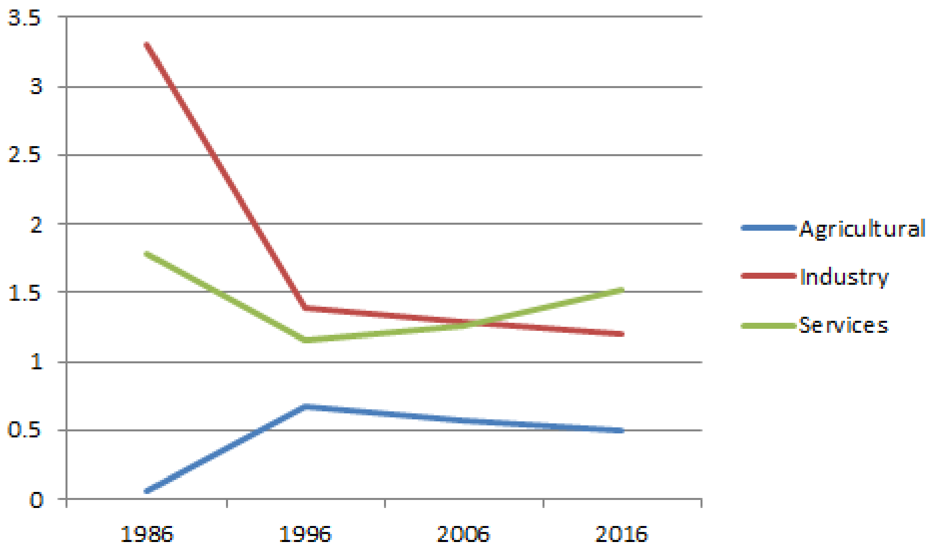


Figure 100 The L.Q of the activities of Sari city at the regional level, 1986-2016 (by the author)

According to the results of the L.Q model, the place of share of the city has changed surprisingly. The city at the county level has played its dominant role in servicing activities while agricultural servicing at the regional and national levels. As shown in Figure 100, in the servicing sector, after the 1996s, the graph has moved upward and shown a slight growth for the 2016s. And the towns and non-urban places around the city tend to meet their needs and receive services from the capital. After that, the industry and agricultural sectors got the second and the third places.

8.10. The results of Isard's longitudinal and transverse model

The proportion of the activities of Sari compared at the national level 1966-1976

Table 47 The proportion of the activities of Sari city compared at the national level between 1966-1976 (by the author)

	National	City
Agriculture	91.18	125.82
Industry	162.09	142.51
Servicing	148.31	110.34
Average Economic Growth	**125.09**	**176.51**

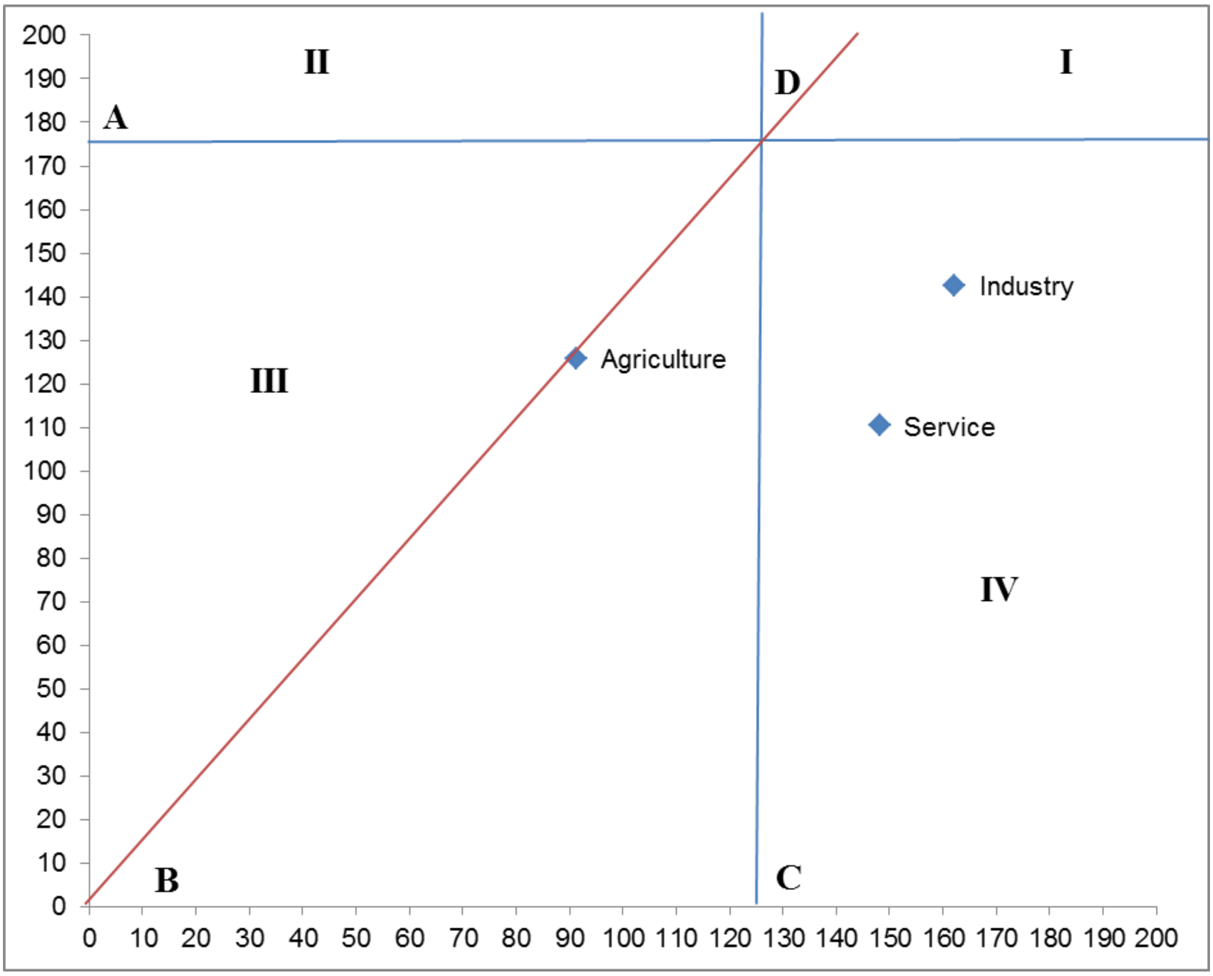


Figure 101 The matrix of the activities of Sari city at the national level between 1966-1976 (by the author)

According to the results of the Isard model in Figure 101, the agricultural sector has been placed in part III of the matrix. The rate of this activity between 1966s-1976s for the city is 125.82%, near the average economic growth at the national level 125.09%, but 50.68% lower than the average economic growth rate of the city that was 176.51%.

But both industry and service sectors have been placed in part IV of the matrix. For the industry sector, the activity rate was 33.99%, actually lower than the average growth rate of the city but 17.42% more than the national level. For the service sector, the rate of this activity was lower than the average economic growth; the rates of both sectors, respectively, are 66.16% and 14.74%.

The proportion of the activities of Sari city compared at the national level between 1976-1986

Table 48 The proportion of the activities of Sari city compared at the national level between 1976-1986 (by the author)

	National	City
Agriculture	106.65	119.38
Industry	92.41	147.68
Servicing	184.98	224.00
Average Economic Growth	**126.16**	**166.76**

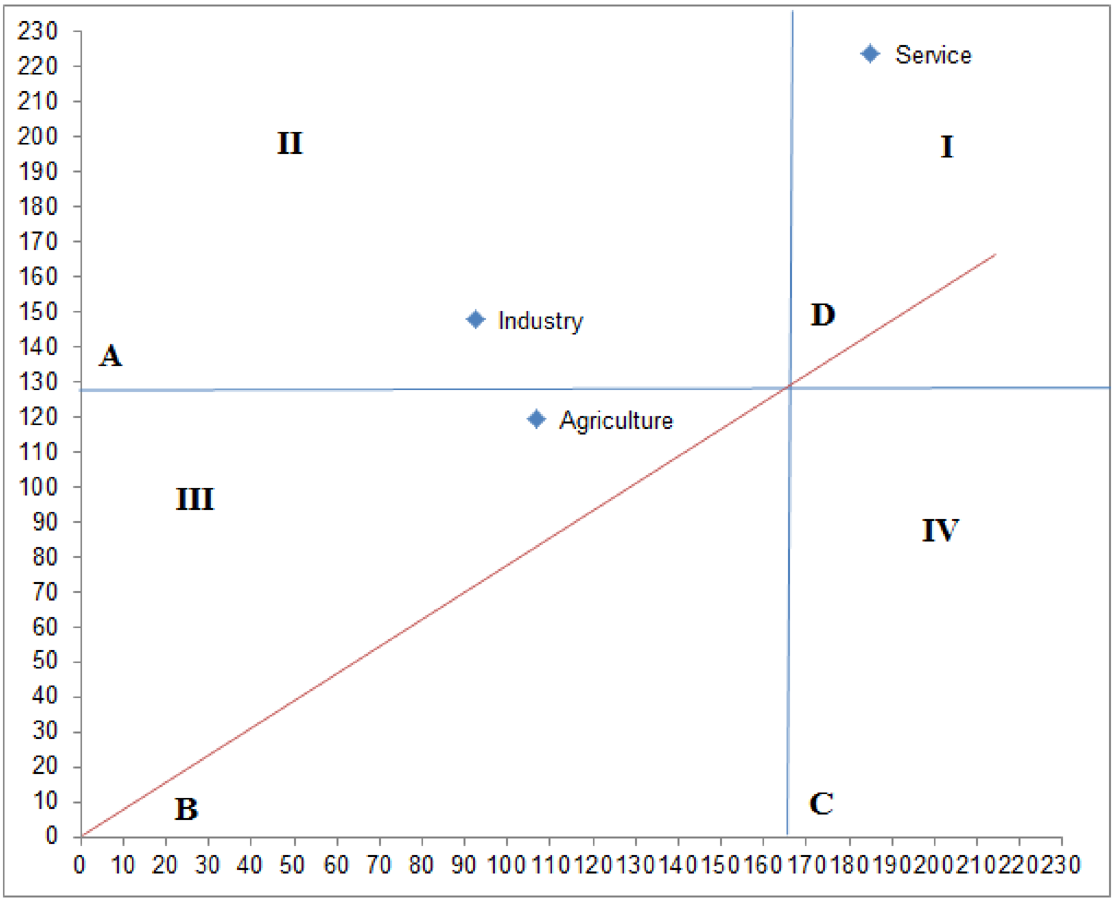


Figure 102 The matrix of the activities of Sari city at the national level between 1976-1986 (by the author)

During the decades 1976s-1986s, the situation and rank for basic economic activities have changed. With a 224% rate, the city's service sector has placed in part I of the matrix above the other sectors. It means the rate of this activity is about 57.24% more than the average economic growth of the city and about 97.84% more than national levels. In this phase, the spatial economic organization of the city has changed, and the service sector became the highest primary economic activity. The city became a supplier of services to the other cities and non-urban areas at the regional and national levels.

In the industry sector, the activity rate at the city level is about 19.07% lower than the average economic growth rate and lower than the average economic growth rate at the national level. As shown in Figure 102, the industry sector has been placed in part II of the matrix.

Unfortunately, for the agricultural sector, the activity rate is lower than the average economic growth rate at both city and national levels. Also, this rate has reduced in comparison with the last decade.

The proportion of the activities of Sari city compared at the national level between 1986-1996

Table 49 The proportion of the activities of Sari city compared at the national level 1986-1996 (by the author)

	National	City
Agriculture	105.21	133.55
Industry	160.83	115.33
Servicing	128.91	104.87
Average Economic Growth	**130.11**	**114.48**

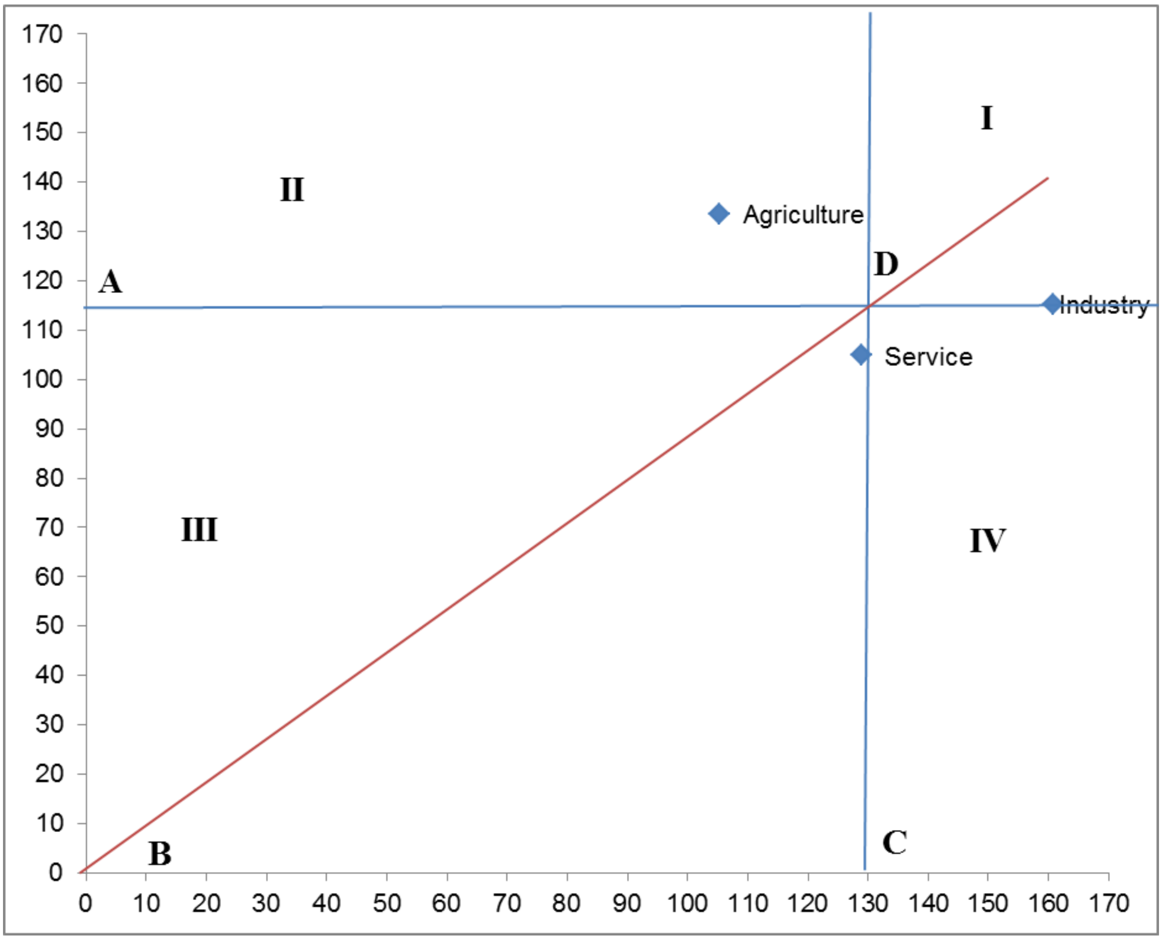


Figure 103 The matrix of the activities of Sari city at the national level between 1986-1996 (by the author)

According to the results, the position of the three sectors has changed on the matrix dramatically. In this decade for this city except for agricultural industry that has experienced positive growth, rate of the other activities has been decreased significantly about -52.27% compared to the last decade.

The agricultural sector experienced sizeable growth, about 19.06% more than the average economic growth at the city and national levels. As illustrated on the matrix, this sector has moved from part III to part II. The activity rate has increased at the local level for the industry sector but was lower than the average economic growth rate at the national level. Compared to the last decade, this sector has moved from part II to part IV on the matrix but placed on the border.

For the service sector, unfortunately, the rate of decrease is considerably much, about -119.12%. In this decade, the activity rates are remarkably lower than the average economic growth for both city and national levels. At the national, about -56.06% rate of this servicing activities had decreased, and in comparison with last decade, its position has changed from part I to part III on the matrix.

The proportion of the activities of Sari city compared at the national level between 1996-2006

Table 50 The proportion of the activities of Sari city compared at the national level 1996-2006 (by the author)

	National	City
Agriculture	109.81	144.56
Industry	145.17	207.42
Servicing	151.26	208.16
Average Economic Growth	**139.64**	**189.93**

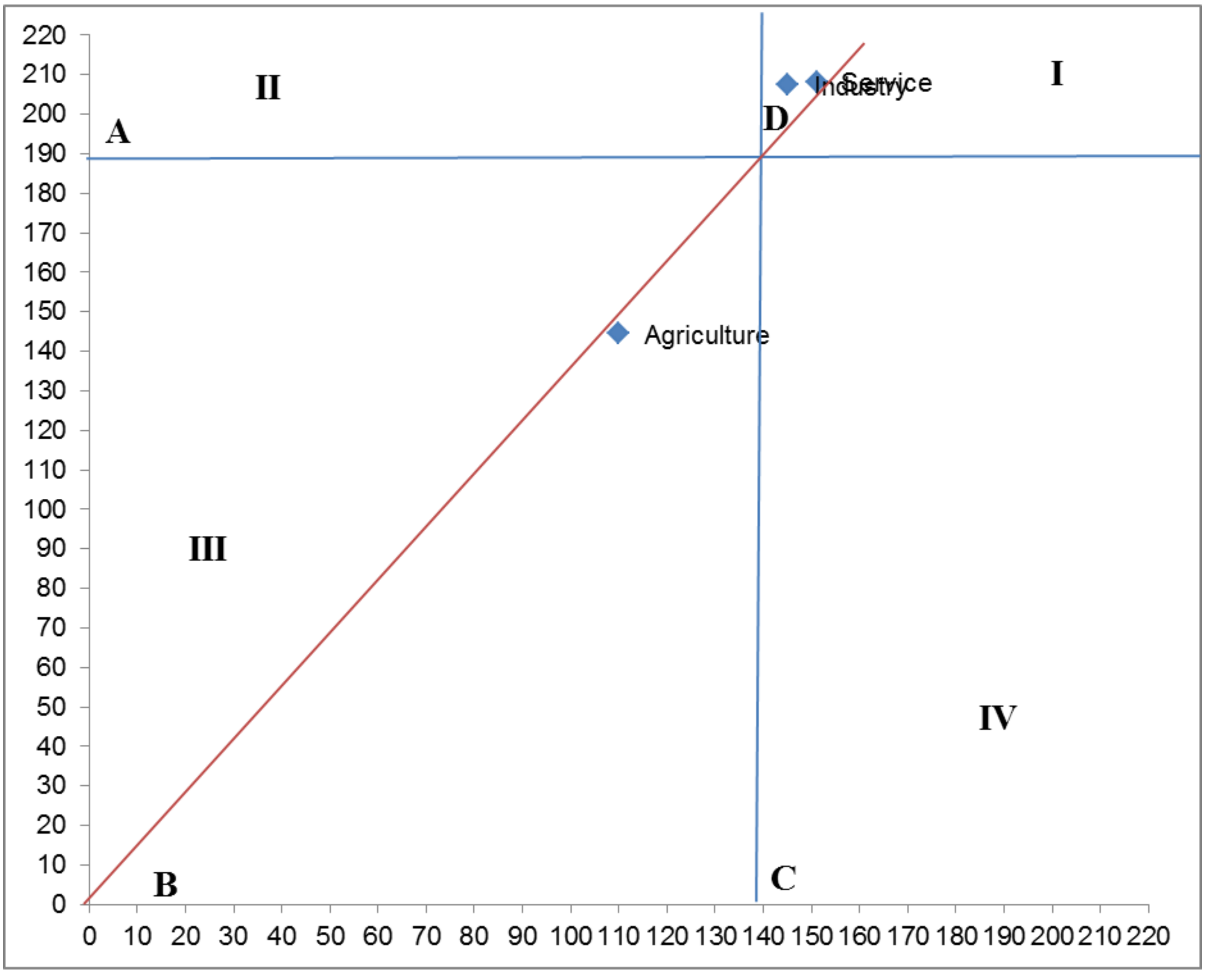


Figure 104 The matrix of the activities of Sari city at the national level between 1996-2006 (by the author)

Concerning the results of this decade, both city and national levels have experienced positive average economic growth, respectively 189.93% and 139.64%. Also, industry and service sectors have been faced with substantial growth and, in comparison with the last decade, displaced their positions from parts III and IV to part

I, as shown in the above matrix. It means the industry and service sector activities have grown up more than average economic growth at both city and national levels.

For the agricultural sector, the activity rate was lower than the average economic growth at the city level and more than the national level and located in part III of the matrix.

The proportion of the activities of Sari city compared at the national level between 2006-2016

Table 51 The proportion of the activities of Sari city compared at the national level 2006-2016 (by the author)

2006-2016	National	City
Agriculture	125.34	105.51
Industry	118.33	102.75
Servicing	123.10	105.02
Average Economic Growth	**121.96**	**104.50**

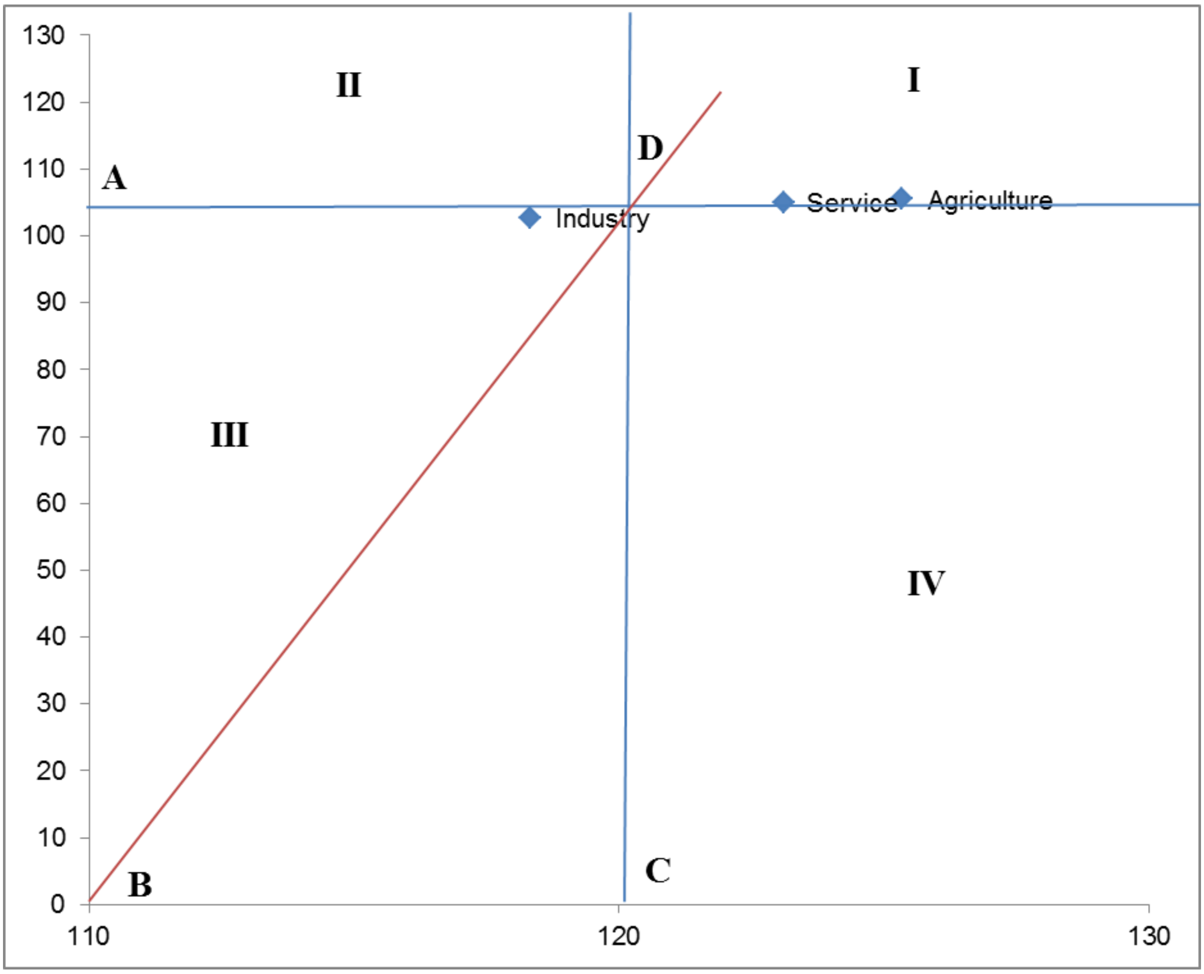


Figure 105 The matrix of the activities of Sari city at the national level between 2006-2016 (by the author)

In this decade, all three basic economic sectors at the city level have been faced with a dramatic decrease rate of activities and the national sectors except the agricultural activities. It means the country has experienced a downturn, and the average economic growth rate has considerably decreased Table 51.

As illustrated in the above matrix, the industry sector has been placed in part III., so it means the activities rates at both levels are lower than the rate of average economic growth. Servicing and agricultural parts are located in part I but closed to the line. It means the growth rate is hopeful and better than other parts in terms of activity. The activity rate for the agricultural sector at the local level is1.01, and for the service sector is about 0.52 %. Also, at the national level, respectively, 3.39% and 1.14% were more than the average economic rates.

8.11. The results of Lorenz Curve and calculating Gini Coefficient

The results of Lorenz Curve for the decade 1986

The spatial distribution of cities in the Mazandaran metropolitan area considering the factors population and rank for the 1986s

Table 52 The spatial distribution of cities in the Mazandaran metropolitan area considering the factors population and rank in the 1986s (by the author)

Groups	Ranks	Cities	The population	Number of cities	The population of the classes	The simple rank	The simple distribution of cities in %	The ranks of density	The cumulative percent of cities	The simple population	The simple distribution of the population in %	The density of population	The cumulative percent of the population in %
100000-250000	1	Sari	141020	4	483870	0.03030303	12.12%	1	95.45%	0.157096117	53.90%	1	78.42%
	2	Amol	118242			0.03030303		0.96969697		0.131721451		0.842903883	
	3	Babol	115320			0.03030303		0.939393939		0.128466347		0.711182432	
	4	Ghaemshahr	109288			0.03030303		0.909090909		0.121746706		0.582716085	
50000-99999	5	Behshahr	52461	1	52461	0.03030303	3.03%	0.878787879	87.88%	0.058441493	5.84%	0.46096938	46.10%
25000-49999	6	Tonekabon	29380	5	140845	0.03030303	15.15%	0.848484848	78.79%	0.032729286	15.69%	0.402527886	33.77%
	7	Challos	29308			0.03030303		0.818181818		0.032649078		0.3697986	
	8	Babolsar	28589			0.03030303		0.787878788		0.031848113		0.337149522	
	9	Nooshahr	28216			0.03030303		0.757575758		0.031432591		0.305301409	
	10	Ramsar	25352			0.03030303		0.727272727		0.028242099		0.273868818	
10000-24999	11	Neka	23604	8	138331	0.03030303	24.24%	0.696969697	59.09%	0.026294829	15.41%	0.245626719	16.86%
	12	Freydonkenar	20997			0.03030303		0.666666667		0.023390634		0.21933189	
	13	Juybar	18942			0.03030303		0.636363636		0.021101366		0.195941257	
	14	Amirkolah	18295			0.03030303		0.606060606		0.020380609		0.174839891	
	15	Galogah	18073			0.03030303		0.575757576		0.020133301		0.154459282	
	16	Katalem Sadatshahr	13509			0.03030303		0.545454545		0.01504901		0.134325981	
	17	Nor	13055			0.03030303		0.515151515		0.014543255		0.11927697	
	18	Mahmoodabad	11856			0.03030303		0.484848485		0.01320757		0.104733715	
5000-9999	19	Zirab	9595	7	56100	0.03030303	21.21%	0.454545455	36.36%	0.010688819	6.25%	0.091526145	6.24%
	20	Rostamkolah	9220			0.03030303		0.424242424		0.010271069		0.080837326	
	21	Abbasabad	8169			0.03030303		0.393939394		0.009100257		0.070566257	
	22	Khoramabad	8154			0.03030303		0.363636364		0.009083547		0.061466	
	23	Shirgah	7452			0.03030303		0.333333333		0.008301519		0.052382454	
	24	Salmanshahr	7087			0.03030303		0.303030303		0.00789491		0.044080934	
	25	Polsefeed	6423			0.03030303		0.272727273		0.007155215		0.036186024	
Under 5000	26	Nashtarood	4760	8	26060	0.03030303	24.24%	0.242424242	13.64%	0.005302634	2.90%	0.02903081	1.32%
	27	Kelarabad	4267			0.03030303		0.212121212		0.004753433		0.023728175	
	28	Royan	4035			0.03030303		0.181818182		0.004494985		0.018974742	
	29	Kelardasht	4030			0.03030303		0.151515152		0.004489415		0.014479757	
	30	Marzanabad	3889			0.03030303		0.121212121		0.004332342		0.009990342	
	31	Keeyakolah	2964			0.03030303		0.090909091		0.003301893		0.005658	
	32	Rineh-e-Larijan	1225			0.03030303		0.060606061		0.001364649		0.002356108	
	33	Alasht	890			0.03030303		0.03030303		0.000991459		0.000991459	
		SUM	897667	33	897667		100.00%				100.00%		

The final curve considering the results of Lorenz model (Table 52) and calculating Gini Coefficient for the decade 1986.

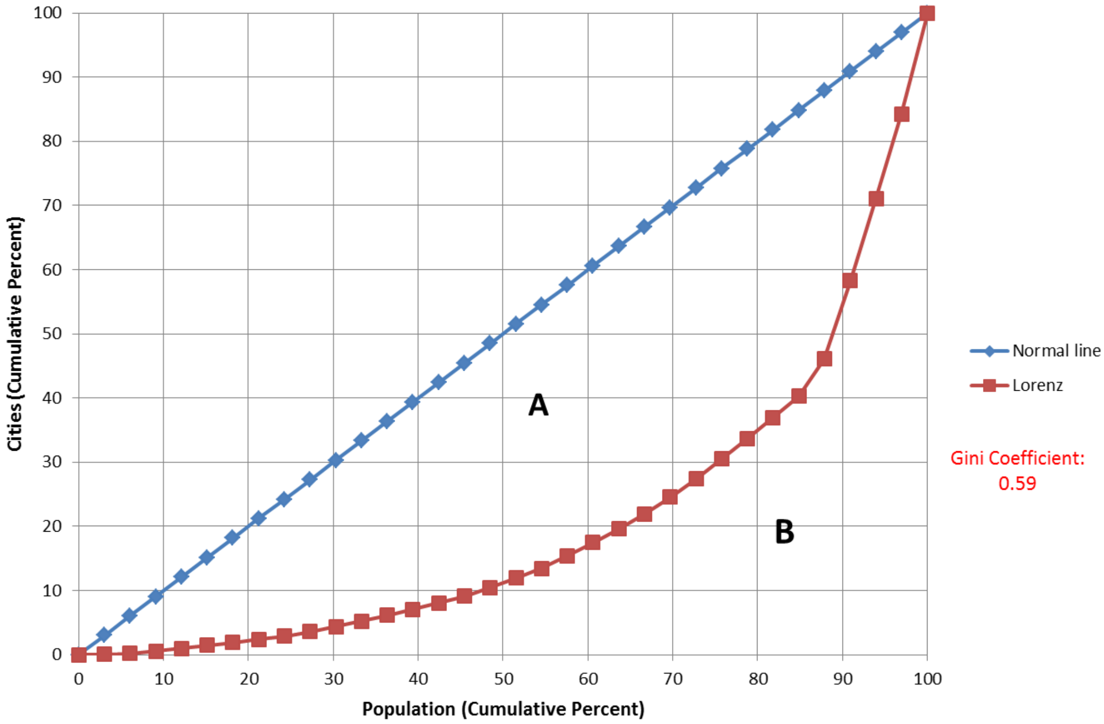


Figure 106 the results of the Lorenz Curve and Gini Coefficient for the decade 1986 (by the author)

Concerning the results of the Lorenz model, this Metropol had 33 cities with 897667 populations in 1986s. According to the showed results in Table 52, the listed cities have been placed in the six subgroups and ranked according to the size of the population. The results represent centralization in the urban system, an unbalance in the urban hierarchies, the polarization of population, and urban growth, particularly in the big and medium-sized cities. Surprisingly, more than 53.90% of the population has concentrated just in the four medium-sized cities (big-class). And in the second group, just one city placed with 5.84% of the population of the Metropol, and the rest are small urban areas. It means about 59.75% of the population, about 536331 people, have been concentrated in the first five cities, and 40,25% of the population, about 361336 people, lived in 28 towns. While, simple distribution of the medium-sized cities for the first group is 12,12% and the second group is 3,03, but they have

124,52% of the cumulative population. For the other groups, the simple distribution of the small urban area is 84.85%, but the cumulative percent of the population is about 58,19.

According to the illustrated results on the Lorenz curve Figure 106, the distance between the Lorenz curve and the normal line is considerable. And distribution of cities in the small-sized cities is more than bigger groups of cities. Especially for the ranges between 80-100, the space between points is more and not normal. These ranges refer to both medium-classed size cities (small and big).

Based on the Gini coefficient, if G=0 means complete equality, G>0 and up to 0.25, means relative unequal. If the result is between 0 .25 – 0.5 expresses Unequal; if between 0.5 – 0.75 means more unequal, and if between 0.75 – 100 says total inequality (Critical situation). As is shown in Figure 106, the Gini coefficient for this decade is 0.59, so it means an unequal distribution of population concerning the size of the cities.

The results of Lorenz Curve for the decade 1996:

The spatial distribution of cities in the Mazandaran metropolitan area considering the factors population and rank in the 1996s

Table 53 The spatial distribution of cities in the Mazandaran metropolitan area considering the factors population and rank in the 1996s (by the author)

Groups	Ranks	New cities	Cities	The population	Number of cities	The population of the classes	The simple rank	The simple distribution of cities in %	The ranks of density	The cumulative percent of cities	The simple population	The simple distribution of the population in %	The density of population	The cumulative percent of the population in %
100000-250000	1		Sari	195882	4	656606	0.027027027	10.81%	1	95.95%	0.160122486	53.67%	1	78.25%
	2		Amol	159092			0.027027027		0.972972973		0.130048736		0.839877514	
	3		Babol	158346			0.027027027		0.945945946		0.129438923		0.709828778	
	4		Ghaemshahr	143286			0.027027027		0.918918919		0.117128223		0.580389855	
50000-99999	5		Behshahr	72067	1	72067	0.027027027	2.70%	0.891891892	89.19%	0.058910707	5.89%	0.463261633	46.33%
25000-49999	6		Challos	41403	7	240968	0.027027027	18.92%	0.864864865	78.38%	0.033844617	19.70%	0.404350925	31.28%
	7		Babolsar	38644			0.027027027		0.837837838		0.03158929		0.370506308	
	8		Neka	35208			0.027027027		0.810810811		0.028780554		0.338917018	
	9		Nooshahr	35133			0.027027027		0.783783784		0.028719246		0.310136464	
	10		Tonekabon	33650			0.027027027		0.756756757		0.027506977		0.281417218	
	11		Ramsar	28954			0.027027027		0.72972973		0.023668262		0.253910241	
	12		Freydonkenar	27976			0.027027027		0.702702703		0.022868802		0.23024198	
10000-24999	13		Juybar	23909	9	154814	0.027027027	24.32%	0.675675676	56.76%	0.019544259	12.66%	0.207373178	14.26%
	14		Amirkolah	21280			0.027027027		0.648648649		0.0173952		0.187828919	
	15		Mahmoodabad	20054			0.027027027		0.621621622		0.016393014		0.170433719	
	16		Galogah	18073			0.027027027		0.594594595		0.014773658		0.154040705	
	17		Zirab	17196			0.027027027		0.567567568		0.01405676		0.139267047	
	18		Nor	16808			0.027027027		0.540540541		0.013739592		0.125210287	
	19		Katalem Sadatshahr	16239			0.027027027		0.513513514		0.013274466		0.111470695	
	20		Rostamkolah	10773			0.027027027		0.486486486		0.00880632		0.098196229	
	21		Kelardasht	10482			0.027027027		0.459459459		0.008568444		0.089389909	
5000-9999	22		Khoramabad	9881	10	79813	0.027027027	27.03%	0.432432432	31.08%	0.00807716	6.52%	0.080821465	4.84%
	23		Shirgah	9546			0.027027027		0.405405405		0.007803317		0.072744305	
	24		Abbasabad	9384			0.027027027		0.378378378		0.007670891		0.064940989	
	25		Salmanshahr	8302			0.027027027		0.351351351		0.006786417		0.057270098	
	26	+	Sorrak	8236			0.027027027		0.324324324		0.006732465		0.050483681	
	27	+	Chamestan	7926			0.027027027		0.297297297		0.006479058		0.043751216	
	28		Polsefeed	7648			0.027027027		0.27027027		0.006251809		0.037272158	
	29		Keeyakolah	6810			0.027027027		0.243243243		0.005566791		0.031020349	
	30		Marzanabad	6488			0.027027027		0.216216216		0.005303574		0.025453559	
	31		Royan	5592			0.027027027		0.189189189		0.004571145		0.020149985	
Under 5000	32		Kelarabad	4973	6	19058	0.027027027	16.22%	0.162162162	9.46%	0.004065147	1.56%	0.01557884	0.68%
	33		Nashtarood	4770			0.027027027		0.135135135		0.003899206		0.011513693	
	34	+	Kiyahsar	3782			0.027027027		0.108108108		0.003091572		0.007614487	
	35	+	Sorhkrood	3772			0.027027027		0.081081081		0.003083397		0.004522915	
	36		Rineh-e-Larijan	1337			0.027027027		0.054054054		0.001092922		0.001439518	
	37		Alasht	424			0.027027027		0.027027027		0.000346596		0.000346596	
			SUM	1223326		1223326	1	100.00%			1	100.00%		

The final curve considering the results of Lorenz model (Table 53) and calculating Gini Coefficient for the decade 1996.

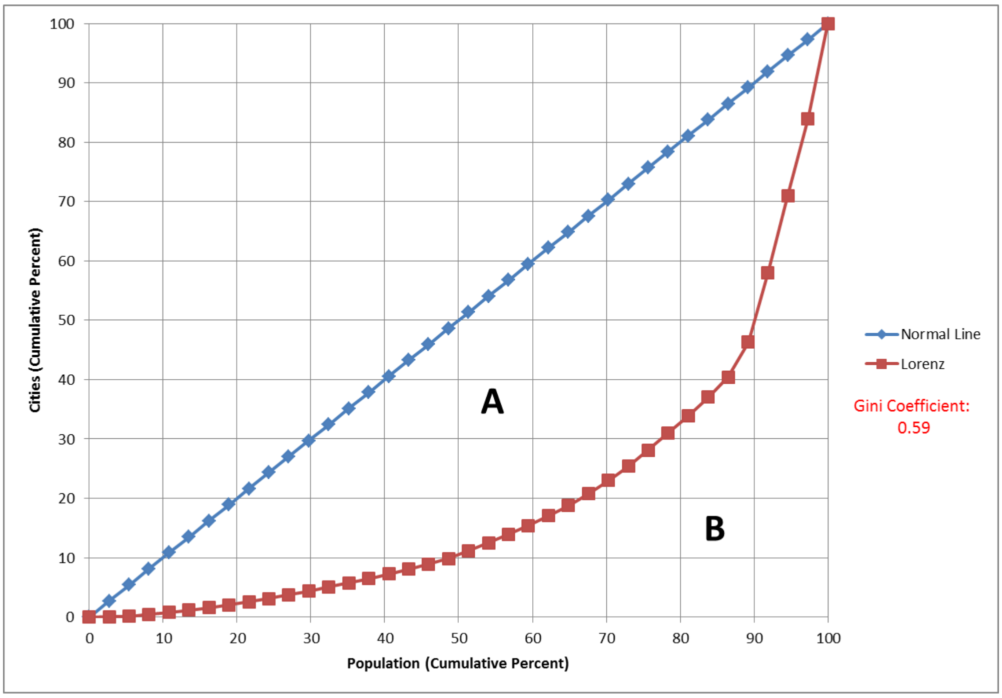


Figure 107 the results of the Lorenz Curve and Gini Coefficient for the decade 1996 (by the author)

Concerning the final results of the Lorenz model, the numbers of the cities were 37 with 1223326 dwellers in 1996s. There are no considerable changes in comparison with the last decade. According to Table 53, the results represented a continuation of imbalance and centralization in the urban hierarchies, which were started in the past. More than 53.67% of the population, like before, is concentrated just in the four medium-sized cities (big-class). And just one city has placed in the second group with 5.89% of the total urban population of the region, and the rest are small urban areas. It means 59.56% of the population, about 728673 people, have been concentrated in the five cities, and 40,44% of the population, about 494653 people, have been placed in the 32 small cities. The simple distribution of the medium-sized cities for the first group is 10.81%, and the second group is 2.70, but they have 124,58% of the cumulative population. For the other groups, the simple distribution of the small urban area is 86.49%, but the cuamulative percent of the population is 51,06. As a result, the is drastic contrast between the size of population accumulation and the growth of the cities in this region.

Concerning the illustrated results on the Lorenz curve Figure 107, the distance between the Lorenz curve and the normal line is like before did not happen positive changes in the share of the population between the cities and towns. As shown in Figure 107, the Gini coefficient for this decade is 0.59, and it means an unequal distribution of population concerning the size of cities.

The results of Lorenz Curve for the decade 2006:

The spatial distribution of cities in the Mazandaran metropolitan area considering the factors population and rank in the 2006s

Table 54 The spatial distribution of cities in the Mazandaran metropolitan area considering the factors population and rank in the 2006s (by the author)

Groups	Rank	New cities	Cities	The population	Number of cities	The population of the classes	The simple rank	The simple distribution of cities in %	The ranks of density	The cumulative percent of cities	The simple population	The simple distribution of the population in %	The density of population	The cumulative percent of the population in %
100000-250000	1		**Sari**	261293	4	837094	0.019607843	7.84%	1	97.06%	0.168126743	53.86%	1	77.70%
	2		**Babol**	201335			0.019607843		0.980392157		0.129547281		0.831873257	
	3		**Amol**	199698			0.019607843		0.960784314		0.128493967		0.702325976	
	4		**Ghaemshahr**	174768			0.019607843		0.941176471		0.112452972		0.573832009	
50000-99999	5		**Behshahr**	84117	2	134149	0.019607843	3.92%	0.921568627	91.18%	0.054124363	8.63%	0.461379037	43.43%
	6		**Babolsar**	50032			0.019607843		0.901960784		0.032192662		0.407254673	
25000-49999	7		**Neka**	46291	9	324764	0.019607843	17.65%	0.882352941	80.39%	0.029785547	20.90%	0.375062012	26.92%
	8		**Challos**	45625			0.019607843		0.862745098		0.029357015		0.345276464	
	9		**Tonekabon**	43842			0.019607843		0.843137255		0.028209759		0.315919449	
	10		**Nooshahr**	42175			0.019607843		0.823529412		0.027137142		0.28770969	
	11		**Freydonkenar**	34496			0.019607843		0.803921569		0.022196156		0.260572547	
	12		**Ramsar**	32085			0.019607843		0.784313725		0.020644818		0.238376391	
	13		**Mahmoodabad**	27748			0.019607843		0.764705882		0.017854213		0.217731573	
	14		**Juybar**	27211			0.019607843		0.745098039		0.017508685		0.19987736	
	15		**Amirkolah**	25291			0.019607843		0.725490196		0.016273277		0.182368675	
10000-24999	16		**Nor**	22491	8	122372	0.019607843	15.69%	0.705882353	63.73%	0.014471641	7.87%	0.166095398	12.56%
	17		**Galogah**	18727			0.019607843		0.68627451		0.012049728		0.151623757	
	18		**Zirab**	18388			0.019607843		0.666666667		0.011831601		0.139574029	
	19		**Katalem Sadatshahr**	17955			0.019607843		0.647058824		0.011552991		0.127742428	
	20		**Kelardasht**	11999			0.019607843		0.62745098		0.007720654		0.116189437	
	21		**Rostamkolah**	11408			0.019607843		0.607843137		0.00734038		0.108468783	
	22		**Abbasabad**	11278			0.019607843		0.588235294		0.007256732		0.101128403	
	23	+	**Khalilshar**	10126			0.019607843		0.568627451		0.006515488		0.093871671	
5000-9999	24		**Khoramabad**	9945	15	114910	0.019607843	29.41%	0.549019608	41.18%	0.006399025	7.39%	0.087356183	4.91%
	25		**Salmanshahr**	9664			0.019607843		0.529411765		0.006218218		0.080957158	
	26		**Chamestan**	9499			0.019607843		0.509803922		0.00611205		0.07473894	
	27		**Sorrak**	8822			0.019607843		0.490196078		0.00567644		0.06862689	
	28		**Polsefeed**	8708			0.019607843		0.470588235		0.005603088		0.062950449	
	29		**Shirgah**	8611			0.019607843		0.450980392		0.005540674		0.057347361	
	30		**Keeyakolah**	7472			0.019607843		0.431372549		0.004807794		0.051806687	
	31		**Marzanabad**	7102			0.019607843		0.411764706		0.004569721		0.046998893	
	32	+	**Gatab**	6956			0.019607843		0.392156863		0.004475779		0.042429172	
	33	+	**Izadshahr**	6888			0.019607843		0.37254902		0.004432025		0.037953393	
	34	+	**Bahnamir**	6848			0.019607843		0.352941176		0.004406287		0.033521368	
	35		**Sorhkrood**	6620			0.019607843		0.333333333		0.004259582		0.029115081	
	36		**Royan**	6351			0.019607843		0.31372549		0.004086497		0.024855499	
	37		**Nashtarood**	5967			0.019607843		0.294117647		0.003839415		0.020769003	
	38		**Kelarabad**	5457			0.019607843		0.274509804		0.00351126		0.016929588	
Under 5000	39		**Kiyahsar**	3672	13	20854	0.019607843	25.49%	0.254901961	13.73%	0.002362717	1.34%	0.013418328	0.45%
	40	+	**Kalehbast**	3561			0.019607843		0.235294118		0.002291295		0.011055611	
	41	+	**Khoshrodpey**	3022			0.019607843		0.215686275		0.00194448		0.008764316	
	42	+	**Galogahe Babol**	2519			0.019607843		0.196078431		0.001620829		0.006819836	
	43	+	**Kohekheyl**	1950			0.019607843		0.176470588		0.001254711		0.005199007	
	44		**Baladeh**	1340			0.019607843		0.156862745		0.000862212		0.003944296	
	45		**Rineh-e-Larijan**	1213			0.019607843		0.137254902		0.000780494		0.003082084	
	46	+	**Dabodasht**	1096			0.019607843		0.117647059		0.000705212		0.00230159	
	47		**Alasht**	984			0.019607843		0.098039216		0.000633146		0.001596378	
	48	+	**Marzikolah**	525			0.019607843		0.078431373		0.000337807		0.000963232	
	49	+	**Zargarmahaleh**	425			0.019607843		0.058823529		0.000273463		0.000625425	
	50	+	**Gazanak**	362			0.019607843		0.039215686		0.000232926		0.000351962	
	51	+	**Farim**	185			0.019607843		0.019607843		0.000119037		0.000119037	
			SUM	**1554143**		**1554143**		**100.00%**		**387.25%**		**100.00%**		**165.97%**

The final curve considering the results of Lorenz model (Table 54) and calculating Gini Coefficient for the decade 2006.

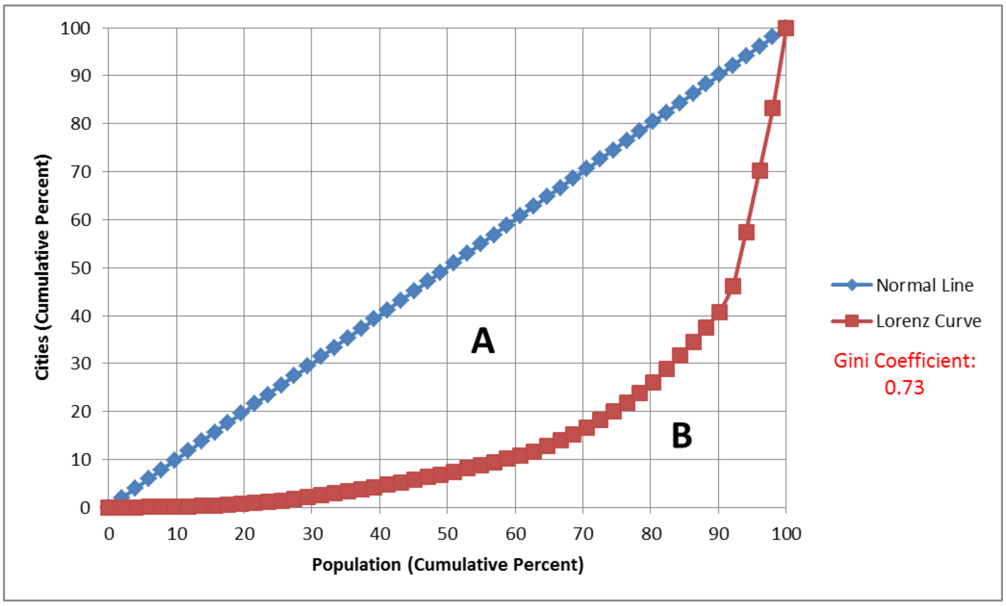


Figure 108 the results of the Lorenz Curve and Gini Coefficient for the decade 2006 (by the author)

With respect to the results of the Lorenz model, the number of cities has substantially has grown up to 51 cities with 1554143 dwellers in 2006s. According to Table 54, the results represented drastic changes in the rank and number of cities but not the population size. How is it possible such emerge of many new towns during a decade! The number of small cities has been increased surprisingly, especially in the groups under 10000 dwellers. In this decade, for the first time, we are witnessing emerge of the Sari as the first city that has been placed in class C1 of the urban hierarchies of this metropolitan area **Table 54**. This numerical increase of cities, neglecting providing needed infrastructures to meet people's basic needs such as jobs, homes, entertainment, and recreation, has increased the imbalance and centralization in the urban hierarchies. According to the results, on the one hand, we are witnessing a numerical increase of new small cities, but on the other hand, seeing physical growth and agglomeration of the population in the big cities. It should be clear for the administrations, and they have to learn; changing villages to small cities is contrary to the migration controlling policies. More than 53.86% of the population is concentrated just in the four cities of the big-class (medium-sized). And then in the second group, medium-sized (small-class) for the first time two cities have been placed in this group and encompassed 8.63% of the total urban population. Accordingly, 70.70 % of the cumulative population, 837094 people, have been concentrated in the first four cities, and 43.43% of the population, 134149 people, in the second group, and 44.84% of the people in the 45 small cities. Concerning the illustrated results on the Lorenz curve Figure 108, the distance between the Lorenz curve and the normal line has increased more than the last decades and represented the highest rate of inequality. As shown in Figure 108, the Gini coefficient for this decade is 0.73 and expresses the continuation of unequal distribution of population regarding the size of cities.

The results of Lorenz Curve for the decade 2016:

The spatial distribution of cities in the Mazandaran metropolitan area considering the factors population and rank in the 2016s

Table 55 The spatial distribution of cities in the Mazandaran metropolitan area considering the factors population and rank in the 2016s (by the author)

Groups	Rank	New cities	Cities	The population	Number of cities	The population of the classes	The simple rank	The simple distribution of cities in %	The ranks of density	The cumulative percent of cities	The simple population	The simple distribution of the population in %	The density of population	The cumulative percent of the population in %
250000-499999	1		Sari	347402	2	597619	0.016666667	6.67%	0.966666667	94.17%	0.178761929	53.52%	0.996544162	76.75%
	2		Babol	250217			0.016666667		0.95		0.128753644		0.817782233	
100000-249999	3		Amol	237528	2	442481	0.016666667		0.933333333		0.122224292		0.689028588	
	4		Ghaemshahr	204953			0.016666667		0.916666667		0.105462242		0.566804296	
50000-99999	5		Behshahr	94702	5	336289	0.016666667	8.33%	0.9	87.33%	0.048730612	17.30%	0.461342055	38.35%
	6		Challos	65196			0.016666667		0.883333333		0.033547771		0.412611443	
	7		Neka	60991			0.016666667		0.866666667		0.031384013		0.379063672	
	8		Babolsar	59966			0.016666667		0.866666667		0.030856581		0.347679659	
	9		Tonekabon	55434			0.016666667		0.85		0.028524559		0.316823078	
25000-49999	10		Nooshahr	49403	7	245747	0.016666667	11.67%	0.833333333	78.81%	0.0254212	12.65%	0.288298519	22.77%
	11		Freydonkenar	38154			0.016666667		0.816666667		0.019632825		0.26287732	
	12		Ramsar	35997			0.016666667		0.8		0.018522902		0.243244495	
	13		Juybar	32924			0.016666667		0.783333333		0.016941635		0.224721593	
	14		Mahmoodabad	31844			0.016666667		0.766666667		0.016385901		0.207779958	
	15		Amirkolah	30478			0.016666667		0.766666667		0.015683001		0.191394057	
	16		Nor	26947			0.016666667		0.75		0.013866062		0.175711056	
10000-24999	17		Galogah	21352	12	162698	0.016666667	20.00%	0.733333333	64.17%	0.010987054	8.37%	0.161844994	11.77%
	18		Katalem Sadatshahr	20716			0.016666667		0.716666667		0.010659789		0.150857939	
	19		Zirab	16191			0.016666667		0.7		0.008331369		0.14019815	
	20		Abbasabad	13482			0.016666667		0.683333333		0.006937405		0.13186678	
	21		Kelardasht	13401			0.016666667		0.666666667		0.006895725		0.124929376	
	22		Rostamkolah	11686			0.016666667		0.65		0.006013241		0.118033651	
	23		Khoramabad	11542			0.016666667		0.633333333		0.005939143		0.11202041	
	24		Shirood	11377			0.016666667		0.616666667		0.005854239		0.106081267	
	25		Chamestan	11194			0.016666667		0.6		0.005760073		0.100227027	
	26		Khalilshar	11032			0.016666667		0.583333333		0.005676713		0.094466954	
	27		Hachirood	10398			0.016666667		0.566666667		0.005350477		0.08879024	
	28		Arateh	10327			0.016666667		0.55		0.005313943		0.083439763	
5000-9999	29		Salmanshahr	9656	17	126684	0.016666667	28.33%	0.533333333	40.00%	0.004968668	6.52%	0.07812582	4.47%
	30		Sorrak	9208			0.016666667		0.516666667		0.004738142		0.073157152	
	31		Shirgah	8671			0.016666667		0.5		0.004461819		0.068419011	
	32		Polsefeed	8294			0.016666667		0.483333333		0.004267826		0.063957192	
	33		Keeyakolah	8040			0.016666667		0.466666667		0.004137126		0.059689366	
	34		Bahnamir	7906			0.016666667		0.45		0.004068174		0.055552239	
	35	+	Hadishahr	7889			0.016666667		0.433333333		0.004059426		0.051484065	
	36		Royan	7731			0.016666667		0.416666667		0.003978125		0.047424639	
	37		Izadshahr	7439			0.016666667		0.4		0.003827871		0.043446514	
	38		Gatab	7374			0.016666667		0.383333333		0.003794424		0.039618643	
	39		Galogahe Babol	6908			0.016666667		0.366666667		0.003554635		0.035824219	
	40		Sorhkrood	6699			0.016666667		0.35		0.003447091		0.032269584	
	41		Marzanabad	6698			0.016666667		0.333333333		0.003446576		0.028822494	

	42		**Nashtarood**	6394			0.016666667		0.316666667		0.003290147		0.025375918	
	43	+	**Kelarabad**	6267			0.016666667		0.3		0.003224797		0.02208577	
	44	+	**Emamzadehabdollah**	5768			0.016666667		0.283333333		0.002968028		0.018860973	
	45		**Khoshrodpey**	5742			0.016666667		0.266666667		0.002954649		0.015892945	
	46	+	**Ejbarkollah**	4499			0.016666667		0.25		0.002315041		0.015253337	
	47	+	**Zargarmahaleh**	3991			0.016666667		0.233333333		0.002053641		0.012938296	
	48		**Kiyahsar**	3384			0.016666667		0.216666667		0.001741298		0.010884655	
	49	+	**Pool**	3150			0.016666667		0.2		0.001620889		0.009143358	
	50		**Kelarabad**	3120			0.016666667		0.183333333		0.001605452		0.007522469	
	51	+	**Marzikolah**	2710			0.016666667		0.166666667		0.001394479		0.005917017	
	52		**Kohekheyl**	2242			0.016666667		0.15		0.001153661		0.004522538	
Under 5000	53	+	**Farahabad**	2217	13	31860	0.016666667	25.00%	0.133333333	15.38%	0.001140797	1.64%	0.004509673	0.62%
	54		**Dabodasht**	1758			0.016666667		0.116666667		0.00090461		0.003368876	
	55		**Alasht**	1193			0.016666667		0.1		0.00061388		0.002464266	
	56		**Rineh-e-Larijan**	982			0.016666667		0.083333333		0.000505306		0.001850386	
	57		**Baladeh**	970			0.016666667		0.066666667		0.000499131		0.001345081	
	58		**PaeenHolar**	956			0.016666667		0.05		0.000491927		0.00084595	
	59		**Farim**	369			0.016666667		0.033333333		0.000189876		0.000354023	
	60		**Gazanak**	319			0.016666667		0.016666667		0.000164147		0.000164147	
			SUM	**1943378**		**1943378**		**100.00%**		**379.86%**		**100.00%**		**154.74%**

The final curve considering the results of Lorenz model (Table 55) and calculating Gini Coefficient for the decade 2016.

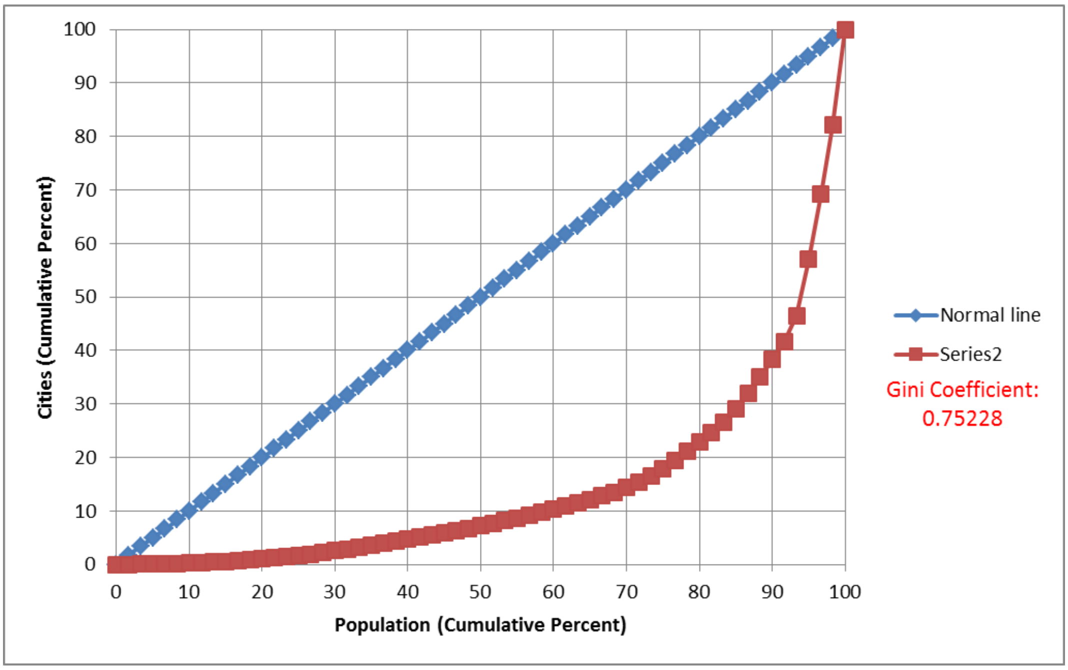


Figure 109 the results of the Lorenz Curve and Gini Coefficient for the decade 2016 (by the author)

Concerning the results of the Lorenz model, the number of the cities substantially has grown up to 60 cities with about 1943378 dwellers in 2016. According to Table 55, the results represent substantial changes in the rank and number of cities, especially in the first, second, third, and seventh groups of the big and small cities. Growth of big cities more than ever has been increased and continued agglomeration of cities. In this decade, for the first time, two big cities (medium-class) have emerged. The number of cities in the third group has surprisingly increased, and now there are five cities in the medium-sized. Consequently, have been eight new small cities emerged in the last groups. Today there are 60 cities and small towns in this region, and the first city has 347402 dwellers; meanwhile, the last town has 319 dwellers, which means the population size of the first city is 1089 times bigger than the last town.

According to the illustrated results in Figure 109, the distance between the normal line (line of equality) and the Lorenz Curve is more than ever happened. And the Gini coefficient is > 0.75, as shown on the graph 0.75228, so it means the balance and equality between the size of cities and distribution of population in this region are in the worst condition., and it's going to be more dramatic than before. These problematic conditions are consequences of uncontrolled urbanization, which was started in the last decades.

8.12. The results of Entropy Index

The results of Entropy Index for the decade 1986:

The rate of entropy of the spatial distribution of population and size of cities in the Mazandaran metropolitan area considering the actual population for the decade 1986.

Table 56 The rate of entropy of the spatial distribution of population and size of cities according to the actual population for the decade 1986s (by the author)

Groups	The real population	Pi	Ln(Pi)	Pi*Ln(Pi)	
100000-250000	483870	0.53903	-0.618	-0.3331	
50000-99999	52461	0.05844	-2.8397	-0.166	**K=6**
25000-49999	140845	0.1569	-1.8521	-0.2906	**Ln (k6)=**
10000-24999	138331	0.1541	-1.8701	-0.2882	**1.7917595**
5000-9999	56100	0.0625	-2.7727	-0.1733	**H=1.353894**
Under 5000	26060	0.02903	-3.5394	-0.1028	**G=0.755623**
SUM	**897667**	**1**		**1.3539**	

The rate of entropy of the spatial distribution of population and size of cities in the Mazandaran metropolitan area considering the caculated optimal size of population by Zipf's law (Table 20) for the decade 1986.

Table 57 The rate of entropy of the spatial distribution of population and size of cities according to the population of Zipf's law for the decade 1986 (by the author)

Groups	The real population	Pi	Ln(Pi)	Pi*Ln(Pi)	
100000-250000	141020	0.24985	-1.3869	-0.3465	**K=6**
50000-99999	70510	0.12493	-2.08	-0.2599	**Ln (k6)=**
25000-49999	110466	0.19572	-1.6311	-0.3192	**1.7917595**
10000-24999	136540	0.24191	-1.4192	-0.3433	**H=1.687979**
5000-9999	79591	0.14102	-1.9589	-0.2762	**G=0.942079**
Under 5000	26287	0.04657	-3.0667	-0.1428	
SUM	**564413.2355**	**1**		**1.688**	

The results of Entropy Index for the decade 1996:

The rate of entropy of the spatial distribution of population and size of cities in the Mazandaran metropolitan area considering the actual population for the decade 1996.

Table 58 The rate of entropy of the spatial distribution of population and size of cities according to the actual population for the decade 1996s (by the author)

Groups	The real population	Pi	Ln(Pi)	Pi*Ln(Pi)	
100000-250000	656606	0.5367384	-0.622245	-0.333982505	
50000-99999	72067	0.0589107	-2.831732	-0.16681936	**k=6**
25000-49999	240968	0.1969777	-1.624665	-0.320022756	**Ln (k6)=**
10000-24999	154814	0.1265517	-2.067104	-0.261595584	**1.791759469**
5000-9999	79813	0.0652426	-2.729642	-0.178089027	**H=1.325345898**
Under 5000	19058	0.0155788	-4.161842	-0.064836666	**G=0.73968963**
SUM	**1223326**	**1**	**-14.03723**	**1.3253**	

The rate of entropy of the spatial distribution of population and size of cities in the Mazandaran metropolitan area considering the caculated optimal size of population by Zipf's law (Table 22) for the decade 1996.

Table 59 The rate of entropy of the spatial distribution of population and size of cities according to the population of Zipf's law for the decade 1996 (by the author)

Groups	The population	Pi	Ln(Pi)	Pi*Ln(Pi)	
100000-250000	195882	0.2380054	-1.435462	-0.34164768	
50000-99999	163235	0.1983378	-1.617784	-0.32086766	**k=5**
25000-49999	148777	0.1807708	-1.710526	-0.309213004	**Ln (k5)=**
10000-24999	187044	0.2272672	-1.481629	-0.336725632	**1.609437912**
5000-9999	128077	0.155619	-1.860345	-0.289504963	**H=1.597958939**
SUM	**823015.1127**			**1.5979**	**G=0.992867713**

The results of Entropy Index for the decade 2006:

The rate of entropy of the spatial distribution of population and size of cities in the Mazandaran metropolitan area considering the actual population for the decade 2006.

Table 60 The rate of entropy of the spatial distribution of population and size of cities according to the actual population for the decade 2006s (by the author)

Groups	The real population	Pi	Ln(Pi)	Pi*Ln(Pi)	
250000-500000	261293	0.168126743	-1.783037164	-0.29977623	**k=7 Ln (k7)= 1.945910149 H=1.656800065 G=0.851426807**
100000-249999	575801	0.370494221	-0.992917432	-0.367870171	
50000-99999	134149	0.086317025	-2.449728425	-0.211453269	
25000-49999	324764	0.208966614	-1.565580783	-0.327154115	
10000-24999	122372	0.078739215	-2.541613962	-0.200124688	
5000-9999	114910	0.073937855	-2.604530334	-0.192573387	
Under 5000	20854	0.013418328	-4.311133771	-0.057848206	
SUM	**1554143**	**1**		**1.6568**	

The rate of entropy of the spatial distribution of population and size of cities in the Mazandaran metropolitan area considering the caculated optimal size of population by Zipf's law (Table 23) for the decade 2006.

Table 61 The rate of entropy of the spatial distribution of population and size of cities according to the population of Zipf's law for the decade 2006 (by the author)

Groups	The population	Pi	Ln(Pi)	Pi*Ln(Pi)	
250000-500000	261293	0.221297091	-1.508249175	-0.333771156	**k=6 Ln (k6)= 1.791759469 H=1.765772001 G=0.985496118**
100000-249999	130647	0.110648546	-2.201396355	-0.243581305	
50000-99999	204680	0.173349388	-1.752446135	-0.303785466	
25000-49999	168700	0.14287713	-1.945770248	-0.278006069	
10000-24999	241814	0.204799717	-1.585722768	-0.324755574	
5000-9999	173601	0.147028341	-1.917129912	-0.281872431	
SUM	**1180734**	**1**		**1.7657**	

The results of Entropy Index for the decade 2016:

The rate of entropy of the spatial distribution of population and size of cities in the Mazandaran metropolitan area considering the actual population for the decade 2016.

Table 62 The rate of entropy of the spatial distribution of population and size of cities according to the actual population for the decade 2016s (by the author)

Groups	The real population	Pi	Ln(Pi)	Pi*Ln(Pi)	
250000-500000	597619	0.308581983	-1.175767724	-0.362820736	
100000-249999	442481	0.22847611	-1.476323626	-0.337304679	
50000-99999	336289	0.17364362	-1.750750242	-0.304006609	k=7 Ln (k7)= 1.945910149 H=1.708951863 G=0.87822753
25000-49999	245747	0.126892044	-2.0644186	-0.261958296	
10000-24999	162698	0.084009497	-2.47682543	-0.208076858	
5000-9999	126684	0.065413583	-2.727025355	-0.178384499	
Under 5000	25144	0.012983164	-4.344101852	-0.056400186	
SUM	**1936662**	**1**	**-16.01521283**	**1.7089**	

The rate of entropy of the spatial distribution of population and size of cities in the Mazandaran metropolitan area considering the caculated optimal size of population by Zipf's law (Table 24) for the decade 2016.

Table 63 The rate of entropy of the spatial distribution of population and size of cities according to the population of Zipf's law for the decade 2016 (by the author)

Group	The population	Pi	Ln(Pi)	Pi*Ln(Pi)	
250000-500000	347402	0.21522714	-1.536061346	-0.33060209	
100000-249999	289502	0.17935595	-1.718382902	-0.308202197	
50000-99999	214231	0.132723403	-2.019487995	-0.268033318	k=6 Ln (k6)= 1.791759469 H=1.767830194 G=0.986644817
25000-49999	253650	0.1571446	-1.850588881	-0.290810049	
10000-24999	325890	0.201899465	-1.599985405	-0.323036197	
5000-9999	183444	0.11364953	-2.174635869	-0.247146343	
SUM	**1614118**	**1**		**1.7678**	

According to the principles of the Entropy Index, (G) is the value of entropy. If the rate tends toward the value (0), it means intensifying population agglomeration and imbalance in the population distribution. Suppose the value tends towards (1) or even more, so it means normal distribution of population and establishing a balance among the cities in an urban area. This study has tried to provide two levels of analysis to understand better what happened, how the current condition is, and how the population should be distributed concerning the size of urban area in the ideal form based on the results of Zipf's law.

In Table 37, the cities are classified into different groups based on the population size in the first column. The second column showed the quantity of population and then calculated rate of [Pi: frequency, Ln (Pi) Ln Pi: Nehprii frequency logarithm, Pi*Ln (Pi)], and finally in the last column is showed the following information:

These regulations and orders are applied to the other tables up to Table 63, which are analyzed based on Zipf's low. The classification of big and small cities and the population is based on the results of the Rank-Size role, which is accompanied by Zipf's analysis.

In the 1986s, according to the presented results in Table 56, the amount of entropy is G= 0.755%, while according to the results of Zipf's law, it must be G=0.94%. It means there is no balance between the size of big, medium, and small cities and relative population agglomeration. The amount of Ln (Pi) for the cities with more population is lower than small cities and represents a concentration of population in the big cities.

In the 1996s, the amount of entropy has decreased and was G=0.74% but mot considerably. According to the results, this decade continued the entropy trend, which started in the last decade with no considerable changes. Based on Zipf's law, the rate of entropy must be G=0.99%. In the 2006s, the rate of entropy has increased about G=0.85%, which should ostensibly show a few positive changes in the population distribution of this metropolitan area, but it is not valid in reality. What has made this result wrong is the increase of immigration to the first big city, which changed the number of groups from 6 to 7 (K=7). It has a little normalized the final value of the entropy model. Because if we add the population of the first group to the second and fixed all changes that happened in the other groups, the rate of entropy would be like last decade G=738. In other words, all changes that have been occurred in the other groups of cities don't show considerable positive changes. But in this decade, for the first time, primary positive changes in this regard have happened in Medium-sized cities. And by the continuation of that, will be expected emerge of positive changes in the population mobility and redirection of migration follow instead of big cities to the Medium-sized cities. With respect to the results of the Ranke-Size Role, there is a substantial gap between the rank and size of the last small city with the first city. In comparison with the last decade, not only the rate of inequality has increased, even the population size of the first city became 1412 times bigger than the last city Table 60 and Table 61.

In the 2016s, as illustrated in Table 62 and Table 63, the amount of entropy is G=0.88, but unfortunately, this value, like the last decade, is not real and in accordance with the changes that happened in the other urban groups perfectly. Of course, in this decade, some positive changes started since the last decade in the size of populations in the Medium-sized cities. For the first time, five cities ranked in class B1, and it represented changes of movements to the other class of cities, what used to be one-sided and in favor of big cities (cities in class C1) Table 24. Also, the results of the Rank-Size Role have confirmed a reduction of the gap between the rank and size of the population in the small cities with fewer than 25000 dwellers compared to the big cities.

Chapter Nine

Urbanization, development policies, and twelve decades planning practice, conflicts and lessons for Iranian cities

9.1. Introduction

This research has studied the urbanization and urban development process between 1908-2021 to figure out the reasons for today's non-sustainable and polarized form of urban development in Iran. And the preliminary results of this study have shwon many obstacles and problems in urban areas that are structurally and refer to Iran's planning system, and in some cases, triggered by particular unwelcome social-economic and political changes.

In Iran, urban governance has a significant dependency on the political system. Revolution and structural-functional changes in the political and social systems reformed urban management in Iran.

Therefore, city management and urban governance of a place represent dominated political system, either open or closed, centralized or decentralized (Farzali Salari Sardari, Akbar Kiani, 2017). And for this case, urban management has a comprehensive linkage to Iran's centralized political system and structure. Such a centralized political-administrational structure has established a linear-vertical relationship between the cities and state, which made the urban management inefficient and faced with many social-economic problems. In other words, centralization has intensified the presence of the government in the development and management of cities (A. Kiani, G. Fazelniya, F. Salari Sardari, 2013). Today, in Iran, several government ministries and agencies (at the regional and national levels) are the leading and influential directors of urban management and development Figure 110.

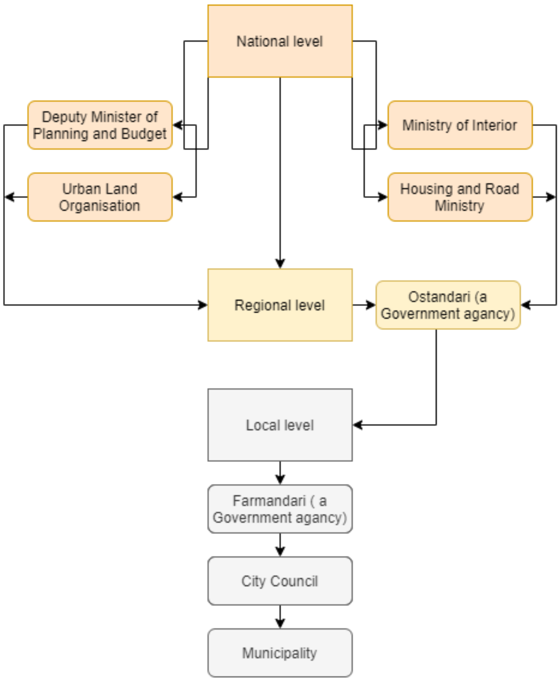


Figure 110 The conceptual model of the levels of urban management in Iran (by the author)

Many structure problems in management and planning sectors have caused a systematic disintegration, especially in macro and micro levels of urban management. And inefficiency in urban management refers to the lack of appropriate political, social, financial, and legal bases, which has negatively affected public participation and declined citizens' role and rights in the decision-making process (Farnak Seyfoaldini, Mossa Panahandekhah, 2010). In Iran, the urban dwellers have never been questioned about their opinion during the planning and executing process.

For this country, many institutional and instructional problems have increased an unstable state of growth and unsustainable development, especially in the urban area, while declining polarization, the unequal form of urban growth, and urban development were defined as main goals in many national and regional development plans. It means the plans were not effective and successful. Also, polarized growth has intensified unbalanced demographic changes, and big cities have become bigger and bigger than medium and small-sized cities. Also, the development gaps between urban and rural areas became bigger and bigger (Hataminejad, Hossain, Zahra Zamani, Sadegh Hagineghad, Mohammad Ghazaee, 2010).

According to the Iranian researcher, structural changes and corrections in the management and planning system are necessary to establish a decentralized system to enhance the role and power of urban dwellers in decision-making to solve or decrease urban problems (Mohammad Mirehei, Hossain Kalantarikhalilabad, 2011). Managing cities and organizing urban issues considering urban population growth and citizens' daily needs, especially in the big cities, is not more possible considering inefficient administration structures in Iran (Akbar Parhisgar, Ali Firozbakht, 2011, 8, 32).

Generally, the political system and, of course, ideology, view, and politicians' attitudes play considerable roles in the planning, decision, or strategy-making process.

Iran's municipalities are under the control of government agencies because of the centralized political structure. And the municipalities have no place in the urban decision-making process, and they are just executors of the government's policies. In Iran, the Interior Ministry, the Housing, Road, Urban Development Ministry, and also the Supreme Urban Development Council are the leading urban affairs directors (Elyaszazadehmoghadam, 2011). Additionally, more than six ministers, six presidents, and vice-presidents from other national organizations are directly and indirectly involved in the urban planning and decision-making process (Saeed Amanpor, Mahyar Sajadiyan, 2016). And municipalities must implement the desired plan and enacted by the responsible ministry (top-down view). It means municipalities are implementers of policies, providers of services, and not more.

This research has tried under a comprehensive analysis of Iran's urban management system and structure answers to the following questions: What changes happened in this country's planning and management structures, especially in urban planning between1908-2021? What factors and forces have accelerated emerging modern and contemporary urbanization in Iran? What forces have maximized centralization, and what consequences happened, especially for urban development? How can we realize a decentralized form of planning and management system in Iran, and why?

9.2. The big bang of Iran's cities

Iranian cities have faced substantial changes and transformations structurally, socially, also in content, rule, function, and population size over the past 120 years. And the Persian cities have been facing many problems, either natural and artificial environments, on a large scale. It is no exaggeration if say Iran's contemporary cities are like a package of urban problems in a showcase. The following table shows the changes in the political structure and administrational system, regulations, legislation regarding the urban discipline, and social-economic changes between 1908-2021.

Table 64 The trajectory of urban development in Iran and the main changes that happened between 1908 to 2021 (by the author)

Types of Iran's political structure	**What have been taken place for the development of Iranian cities**	**Types of implemented urban development plans**	**Time**
Persian Constitutional Revolution	-Enacting the first urban legislations -Foundation of Balladdieh as the first local government with limited tasks that was responsible for: 1- Urban management 2- Increasing urban security and safty 3- Maintenance and repair of urban roads 4- Water management	-	1908
Reza Shah, the first Pahlavi (Father Of Modern Iran)	- Restructuring the national administration system - Development and amendment of urban laws - Fundation of Shardari as a new local government that was responsible for urban management in urban areas but with more tasks than Balladdieh - Start of the first urban development plans at the national level - Start of the modernization of cities for the first time in Iran and stablishment of new and modern urban structures including publich transportation, health and education centers, making new roads and asphalt	- Urban Road Development (Planning, Design, and Constructing)	1922-1942
Mohamad Reza Shah, the second Pahlavi	-Infrastructural Development - Preparation of Urban Development Plan -Foundation Various Organizations Responsible for Planning and Control of Urban Development	-Comprehensive Plan -Detailed Plan	1942-1978
After the revolution 1979 to the year 2021	- Abolition of land ownership - Urban Land Organization - Reducing the role of the municipality - Selling surplus building density	-	1978-2021

	- Looking at the people at the lowest level - Enacted the law of the Cities Council - Add urban areas to big cities - Attention to the physical aspects of regional projects and lack of social participation		

Entrance to the new era of urbanization after the Persian constitutional revolution

In this study, considering the trajectory of urbanization in Iran, this thesis has regarded happening the "Persian Constitutional Revolution" (Enghelab-e Mashruteh) as a Big Bang point and entering a new era of urbanization between 1905-1911 (Ahmad Poorahmad, Hossein Hatamineghad, Seyed Hadi Hosseini, 2006). Because during the Qajar dynasty, this revolution had reformed the political structure and led to the establishment of the first Parliament in Persia[7] in 1906. After the revolution, new changes had been emerged in all aspects (political, social, cultural, and economic) at the national levels, particularly in the cities.

This study has regarded this revolution as a significant milestone in Iran's social, political, and economic history during the last century. The social, political, and economic elements and forces of the revolution had reformed Persian cities' patterns and structures (Dr. Ali Shamaei, Mohammad Mehdi Abrari, 2013). This time is regarded as a transition phase for the cities from urbanization with Persian orient to new urbanization with new characteristics. Accordingly, the pace of urban changes and development had accelerated surprisingly. After the revolution, many implemented policies and actions regarded as a base model for developing Iranian cities (Emamali Shabani, Jamal Kamalyab, 2012). For example, after the revolution, members of the first parliament enacted the first urban laws for providing better

7 In the Western world, Persia (or one of its cognates) was historically the common name for Iran. In 1935, Reza Shah Pahlavi asked foreign delegates to use the term Iran, the endonym of the country, in formal correspondence.

services to urban dwellers, such as health services and water supply, by using a water tank Figure 112. In June 1907, enacting new urban laws led to the foundation of Balladdieh in the major cities (an organization that is responsible for urban affairs). Balladdieh was the first independent or self-government urban organization. But unfortunately, the coup of 1920 had restricted the power of Balladdieh and must work under the power and control of the new government (Saeed Amanpor, Mahyar Sajadiyan, 2016).

Figure 111 Members of the first Iranian Parliament[8] (Library W. D., 1906)

8 This photograph shows the representatives of the first Iranian Majles (parliament) in front of the military academy, which served as the first parliament building. In the 1870s–early 20th century, leading political figures in Iran concluded that the only way

Figure 112 Supplying water using water tanks (Najafzadeh, 2021)

to save the country from government corruption and foreign manipulation was to make a written code of laws, an attitude that laid the foundation for the Iranian Constitutional Revolution of 1905–7. The movement for a constitution bore fruit during the reign of Muẓaffar ad-Dīn Shah of the Qajar dynasty, who ascended to the throne in June 1896. Under relentless pressure from the proponents of constitutional rule, Muẓaffar ad-Din Shah was forced to issue, on August 5, 1906, the decree for the constitution and creation of the elected Majles (National Consultative Assembly). On August 18, 1906, the first legislative assembly, the Supreme National Assembly, gathered in the national military academy to prepare for the opening of the first term of the National Consultative Assembly and to draft a parliamentary electoral law. On October 7, 1906, the shah inaugurated the first session of the Majles (October 7, 1906–June 23, 1908). The most important task undertaken by the first Majles was to draft and ratify the constitution, which was completed on December 30, 1906. This session also established the internal procedures for the Majles and drafted and ratified, on October 17, 1907, the constitutional amendments

Figure 113 Lalehzar Street, Tehran in 1926s. (Gheissari, 2011)

Figure 114 Persian Shops, 1905. A peep into the bazaar of Isfahan. In these open shops, all goods are exposed to view, and the passer-by is invited to take a seat and inspect (Mary Hume-Griffith, Dr. Albert Hume-Griffith, 1909)

Figure 115 A Street in Kerman, in 1907 leading into the long covered bazaar (Mary Hume-Griffith, Dr. Albert Hume-Griffith, 1909)

Figure 116 A bazaar in the city of Mashhad (Sykes, 1921)

Figure 117 A house-building project in Persia, 1904s, (Mary Hume-Griffith, Dr. Albert Hume-Griffith, 1909)

As the above picture shows, the house was built normally from sun-dried earth bricks and chopped straw and then plastered. The bricks were generally made on-site.

The main urban policies implemented by the Persian constitutional revolution:

1. Control and management of urban market
2. Collection of public tax and rents
3. Legitimizing the property rights of landowners and feudal in the cities to transfer added value of the agriculture sector to the cities and commercialization of agricultural products in the cities (base of the rent-capitalism and unequal development theory from Hans Bobek) (Bobek, 1974)
4. Accumulation of capital in the cities through the auctions
5. Legitimizing cities and their functions rather the non-urbanized areas and supporting cities through the urban laws (Ehlers, 1978)

6. Outsourcing and handing over control of public services to private enterprises and people; such as supply water, fuel, education, and healthcare (Balladdieh was irresponsible in the provision of the above services)
7. Construction of public buildings such as Ab-Anbar[9], Mosque, and Public baths
8. Renovation of towers, city gates, and roads (Library N. P., 1905)

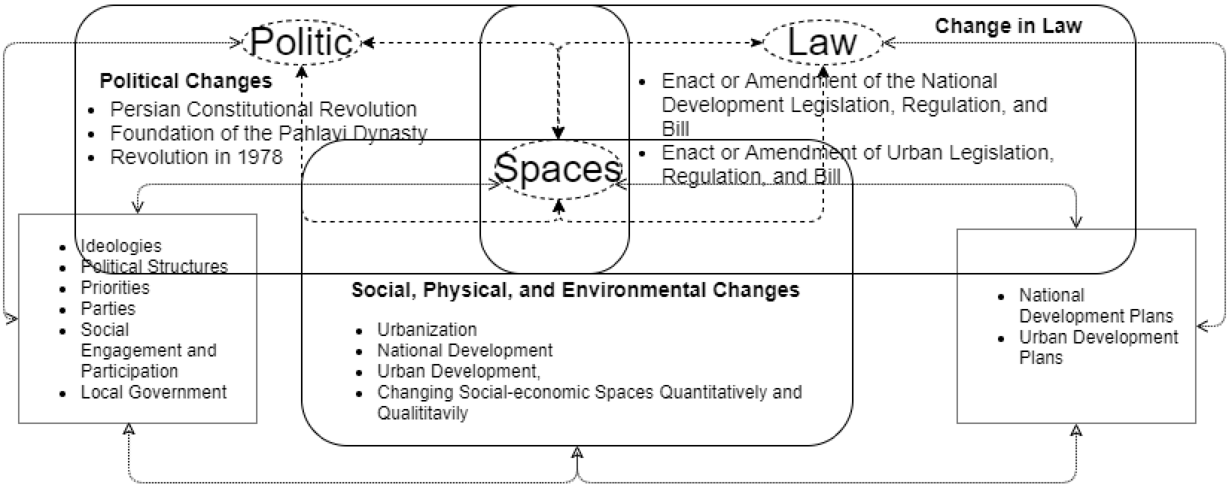


Figure 118: The interactions between politics, law, and spaces (by the author)

New urban evolution after the foundation of the Pahlavi dynasty

Reza Shah[10], the founder of modern Iran

The new political structure was established by the Persian constitutional revolution but was stabilized after the foundation of the Pahlavi monarchy by Reza Shah Pahlavi. He is the "Father of Modern Iran" and has tried to develop and apply a new form of city-building through his modernist and reformist ideas and policies (Alireza Seyfzadeh, Mansor Badrifar, 2008). Iranian modernized and reformed cities resulted

9 Ab-Anbar (Persian: آب انبار, literally "water reservoir") is a traditional reservoir or cistern of drinking water in Greater Iran in antiquity.

10 (Reza Shah the First Pahlavi and her son Mohammad Reza Shah the Second Pahlavi)

from the modernist and reformist ideas of Reza Shah Pahlavi. The structure, form, pattern, and system of today's Iranian cities follow a trend and policies that he had launched for the first time in 1933 (Eckart Ehlers, Willem Floor, 1993).

As mentioned above, owing to the coup of 1920, which had once powered centralization and Balladieh was not more independent. But Reza Shah has tried to increase the power of Balladieh by giving new tasks to work more efficiently. He has changed the name of Balladieh to Shahrdari and ordered to enact new urban legislations and develop urban laws. The "Law of Balladdieh" was abolished and replaced by enacting "New Municipal law" In 1930. On the one hand, for the first time, this law helped to establish "Shahrdari" (municipality) for the first time in the cities and towns in the whole of the country (Emamali Shaban, 2012).

At that time, Iran was faced many problems as follows:

- In terms of political power, Iran was unstable and under the control of colonial powers. Southern Iran was in the hands of the British, and northern Iran was in the hands of the Russians, and they had exploited the country's resources
- Iran's economy had collapsed entirely, and poverty had spread throughout the country
- Cities and villages had no health facilities and other basic infrastructures and facilities.

Tehran of the 1890s is a prime example of the unsanitary condition observable throughout urban centers in the Qajar era Figure 119. For example, Iran was faced infectious diseases such as plague and cholera, and hundreds of thousands of people were dead. Dirty streets, stagnant and contaminated pools of water, and a suffocating atmosphere characterized its scorching summer months (A.Afkhami, 1998). Or, in 1918, in the province of Khorasan, for example, the city of Mashhad had two-thirds of its 100,000 citizens sick with the flu. The epidemic killed about 3,500 people in that area: a 5% mortality rate within city limits and 7% in outlying villages (Afkhami, 2003).

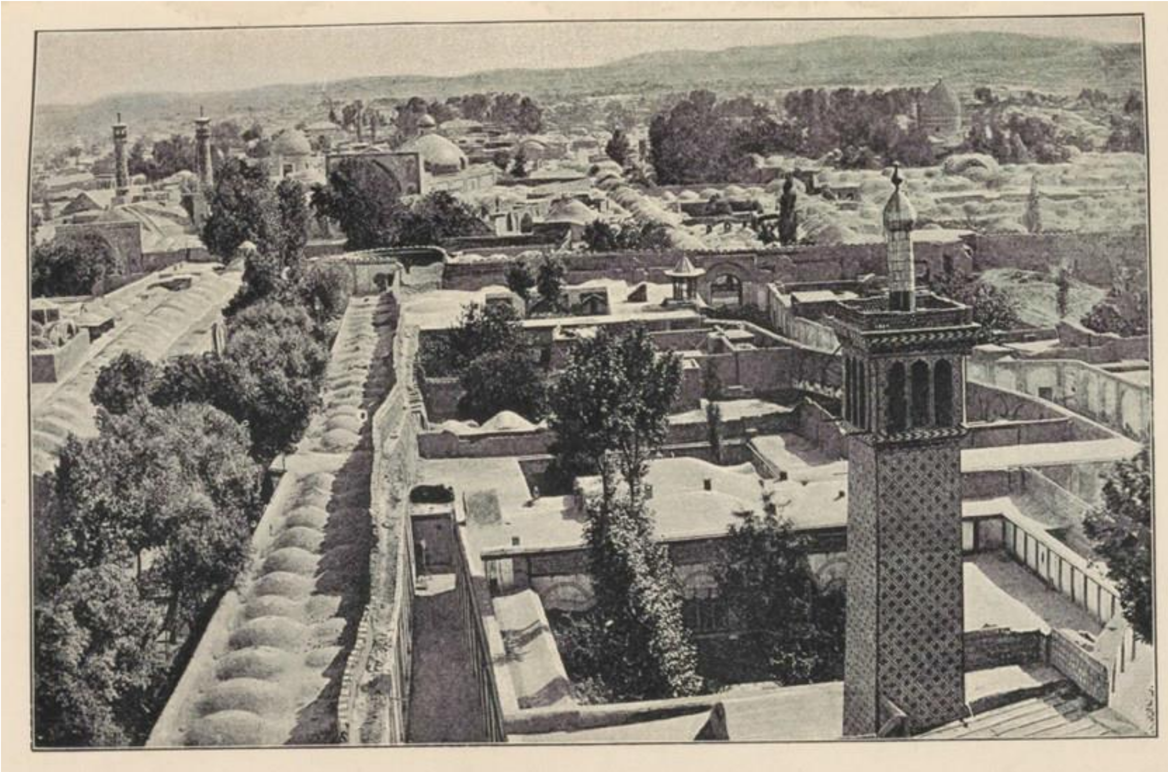


Figure 119, Panorama of Tehran, in 1892s, (Curzon, 1892)

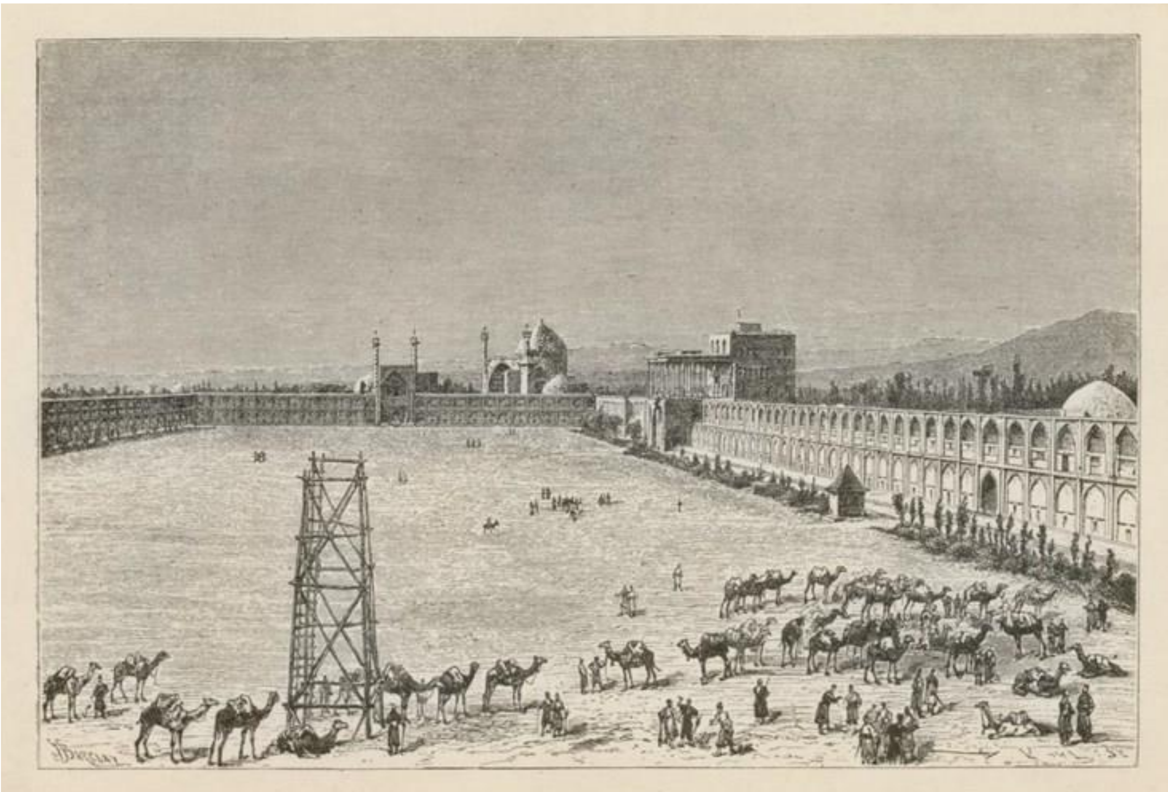


Figure 120 Royal square at Isfahan, in 1909s, (Mary Hume-Griffith, Dr. Albert Hume-Griffith, 1909)

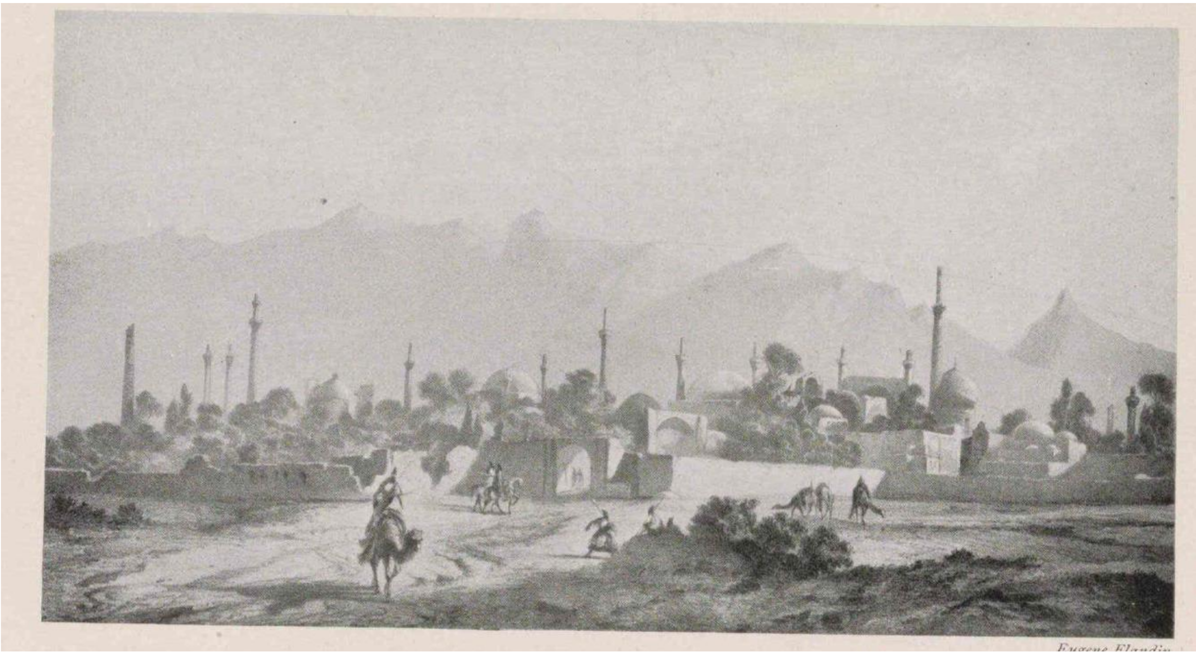


Figure 121 The city of Isfahan from the north side (Sykes, 1921)

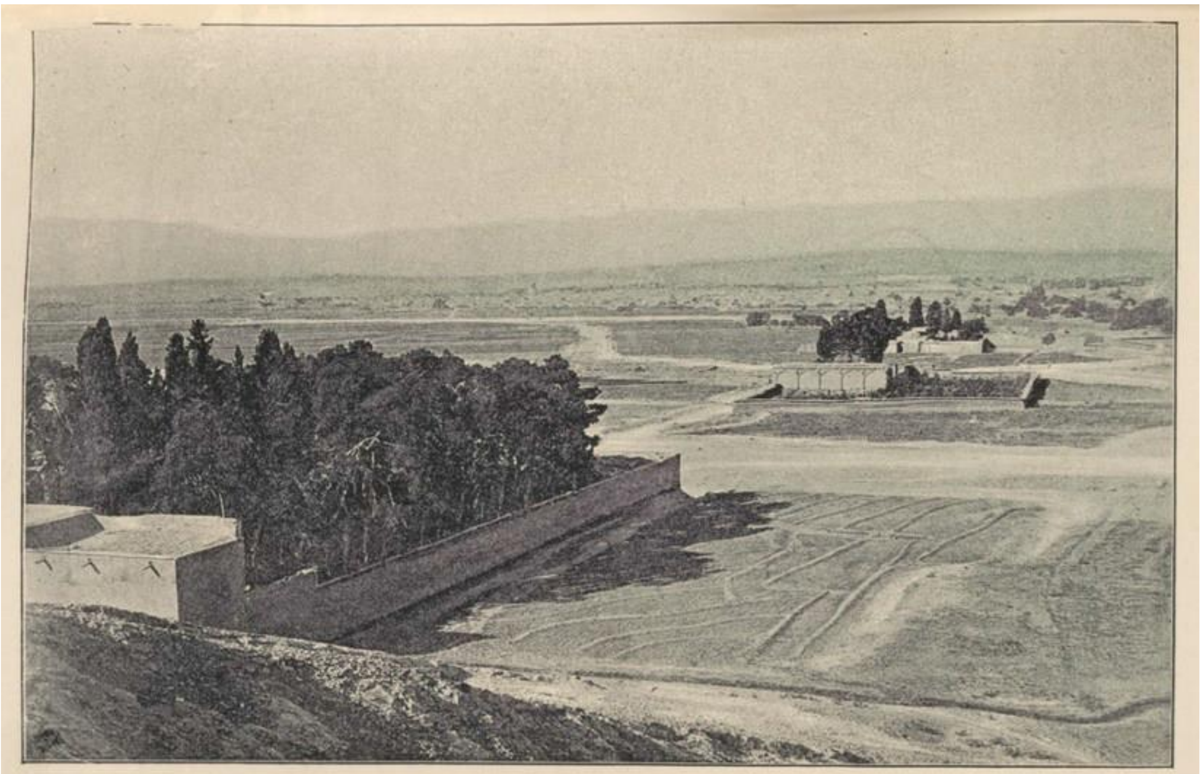


Figure 122 Panorama of Shiraz, in 1909s. (Mary Hume-Griffith, Dr. Albert Hume-Griffith, 1909)

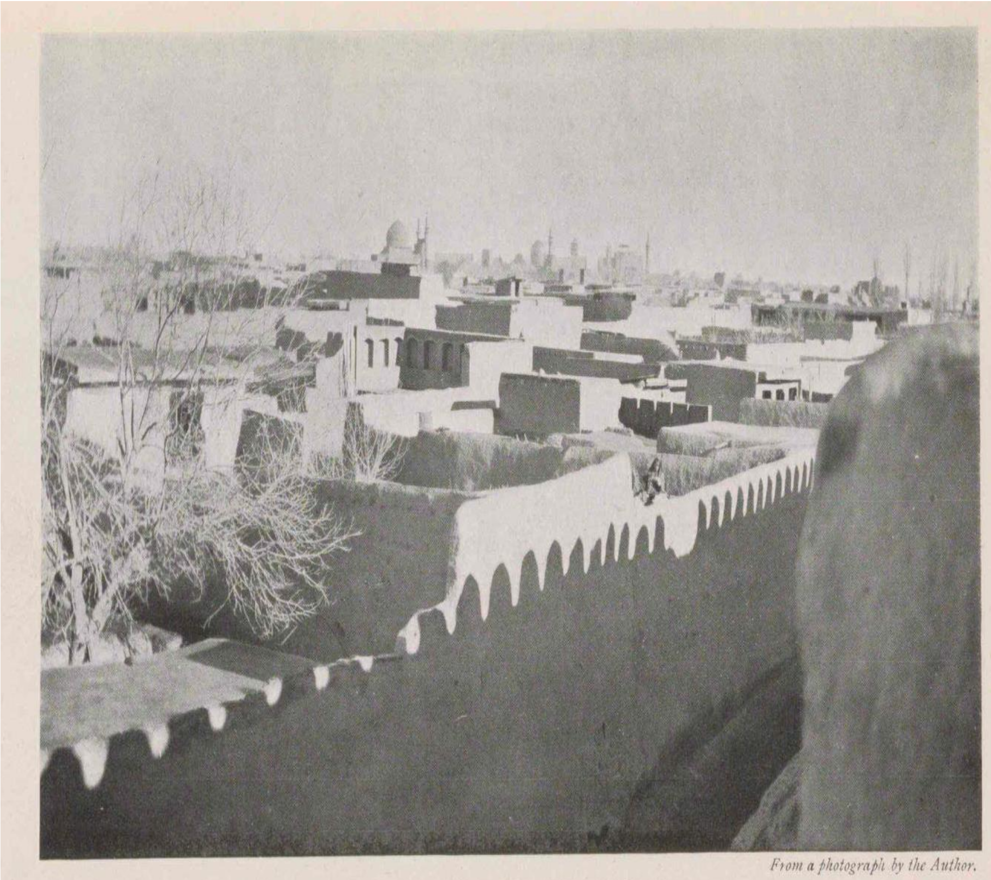


Figure 123 Mashhad, the sacred city of Persia. The picture was taken from the city wall and shows the mosque of Gauharshad (left), and the golden dome (center) in the background (Sykes, 1921)

Figure 124 The Amirchakhmagh square in Yazd city (Sykes, 1921)

Figure 125 Tabriz city (Sykes, 1921)

So, that was a supportive plan from Reza Shah to construct health infrastructures in the urban area to give service to urban and even rural. The new law had increased the government's role in the urban development process. In this regard, the government officially delegated the management of cities to the "Shahrdari" (municipalities) but under the authority of the interior ministry.

In the Persian urban dictionary, the word "Shahrdari" is equivalent to "Municipality" and is a modern organization to direct and control urban growth and development. Emerge of "Shahrdari / Municipality" is also resulted from Reza Shah's modernist ideas.

His first reform for urban development plan included the following actions:

- the foundation of needed urban organizations to better management, control, planning, and direction of urban development,
- new and modern city building beside historical textures (broader and longer streets, asphalt roads, and railroads)
- substantial changes in the roads and transportation system,
- providing safer and faster accessibility between cities through the construction of asphalt roads and railroad at the local, regional and national levels
- provision of new services and urban infrastructures.
- Supporting industrial activities and building new and mother industries around the cities at the local, regional and national levels
- improving the education system and constructing public and free universities for all people

Figure 126 Constructing new roads in the city of Tehran by Reza Shah in 1946 (Mohammad Reza Pourzargar, Parichehr Moafi Ghaffari, Maryam Amjadi, 2018)

Figure 127 Providing water infrastructures in the city of Tehran city by Reza Shah in 1945 (Mohammad Reza Pourzargar, Parichehr Moafi Ghaffari, Maryam Amjadi, 2018)

The modernization and reconstruction of Iranian cities were started in 1931 broadly. The enactment of the new law of "Urban Road Development (Planning, Design, and Construction)" in November 1933 had provided a legal base for the government to apply new revolutionary city design in the oriental structure of Persian cities. Constructing new streets and roads has developed transportation networks and promoted the use of cars in the cities substantially. Furthermore, constructing big squares accompanied by massive office buildings were regarded as symbols of a new powerful empire and presented Iranian cities in a new and unique landscape and identity.

Before the Pahlavi era, most Iranian cities were surrounded by enormous walls, defense tools, and city gates. However, modernization and reform ideas transformed the Persian city from a closed-form to an open-form. Modernization had destroyed the cities' defense walls and gates, expanded city borders, and contributed the people to buildup and living outside of the destructed borders.

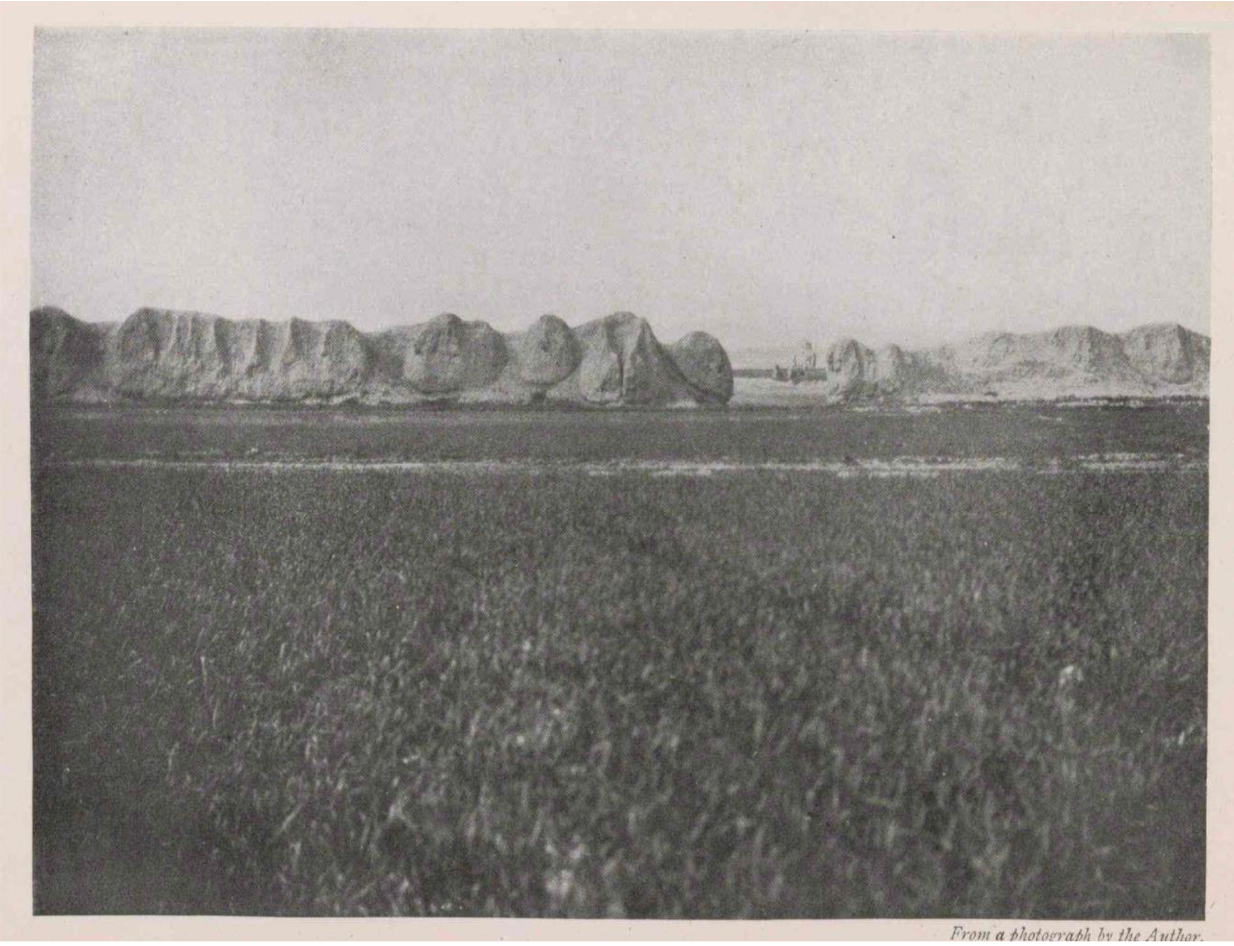


Figure 128 The walls of Tus city (Sykes, 1921)

Figure 129 Dowlet gate, Tehran 1902 (Mary Hume-Griffith, Dr. Albert Hume-Griffith, 1909)

Figure 130 The Mosque gate, City of Kerman (Sykes, 1921)

In cities, they were constructed and provided modern service systems and facilities for the first time, including a new transportation system such as Bus, Taxi, and tramway. New facilities included: piped water, electric lighting, Telephone, sanitation, drainage, and consequently, these actions increased new job opportunities and population growth.

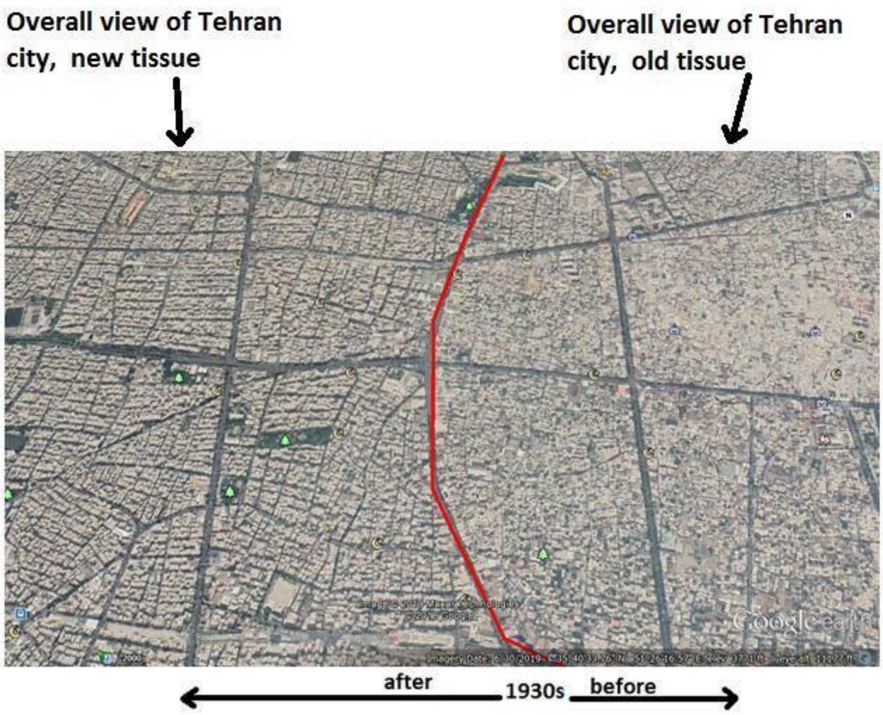


Figure 131 City Building in a new and modern form (left), under Pahlavi Dynasty, city of Tehran (by the author)

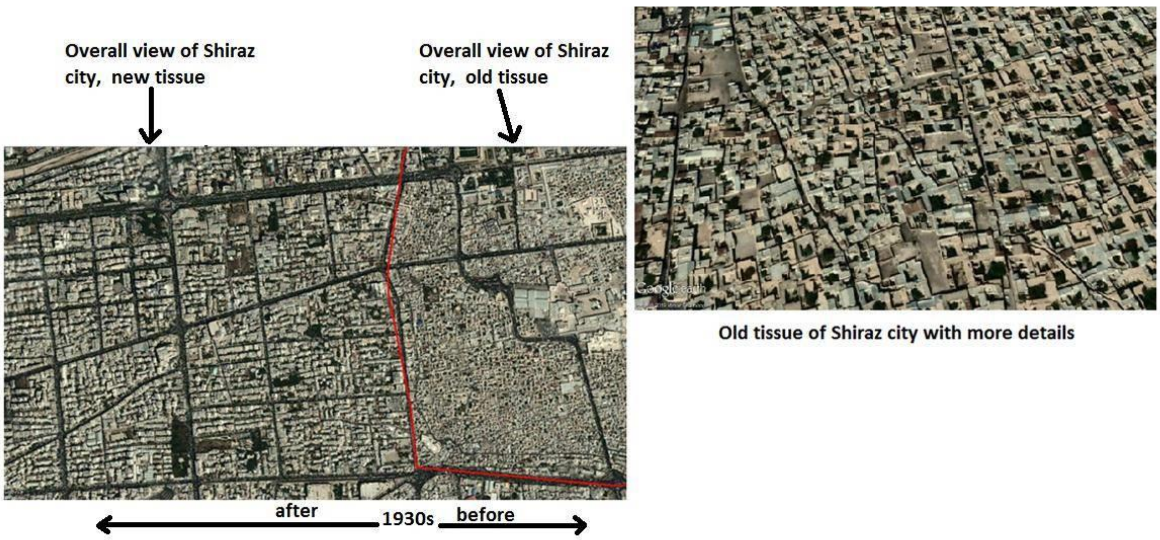


Figure 132 City Building in a new and modern form (left), during Pahlavi Dynasty, the city of Shiraz (by the author)

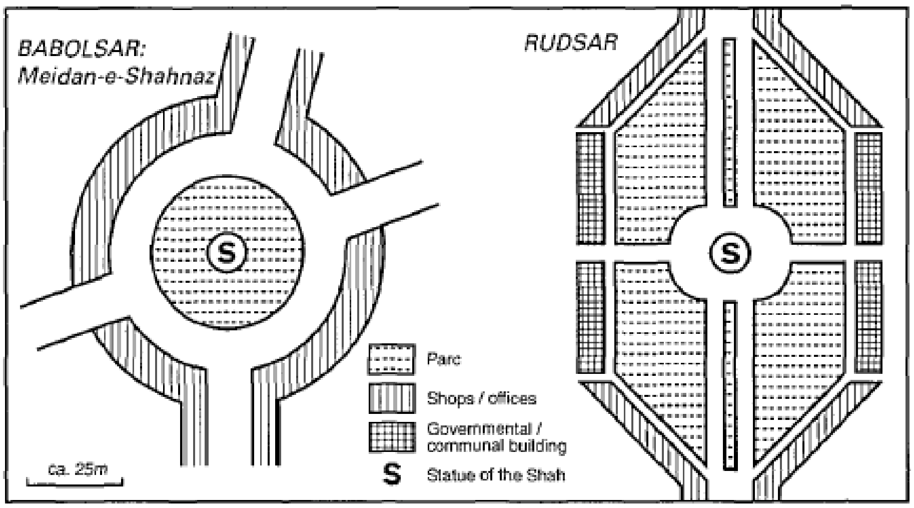


Figure 133 Design and layout of public squares in new towns during Reza Shah Pahlavi (Eckart Ehlers, Willem Floor, 1993)

However, the planning system's structural change was in its primary stages of forming and needed time to fix the unpredicted shortcomings. There were no systematic coordination and task divisions among the organizations to perfectly direct and implement urban development projects. So, it was required to provide new structures to realize coordination between the organizations and activities substantially. Between 1935-1936 talk about providing a national development plan has increased in the parliament. The parliament had stressed restructuring the current traditional administration and planning system to a modern and efficient form. This trend led to the "Economic Council," founded in 1937, responsible for providing the first National Development Plan. But in this process, some significant factors had prolonged the planning process and included: 1) lack of experienced people, 2) lack of stable political power and sovereignty, 3) the start of the second world war and its shadow on Iran (National Bank of Iran, 1948).

Most implemented urban development strategies between 1920-1941 focused on the public spaces and sidewalks in terms of content and physical. However, constructing new sidewalks, health centers, public buildings, providing urban furniture, and many other new services was considered as one of the most critical actions and positive aspects of urban design accomplished by municipalities for the following reasons: 1) Social-economic developments 2) to develop living conditions 3) Industrialization and consequently migration (National Parliament Library, 1949).

The "Law of Urban Roads Development" was amended in July 1941 to accelerate urban development. But, implementing the newly amended law coincided with the Second World War and Iran's occupation. And this problem stopped the implementation of relevant urban development policies regarding the new law for several years. Anglo-Soviet invasion of Iran faced the country with a dramatic condition insofar as led to Reza Shah's abdication and was forced into exile by the invading British. The king's son Mohammad Reza Pahlavi came to the throne.

After the war, the second king was resolute to allocate needed requirements for providing a National Development Plan, which encompassed urban and rural development strategies, in 1946. For this purpose, a national centralized and comprehensive planning system was structured and organized many economic and planning teams that included Iranian and foreign experts' "Harvard Group." In December 1946, signed a contract between Iran and "Morrison-Knudsen International Company" from the USA with the incorporation of "Overseas Consultant" to prepare the first national development plan on "Seven-Year Development Plan for the Plan Organization of The Imperial Government of Iran."

Studying and analyzing these plans became necessary for this research. And it helped to understand what goals the government was pursuing in these plans, what social-economic strategies were implemented, and how these policies affected the cities.

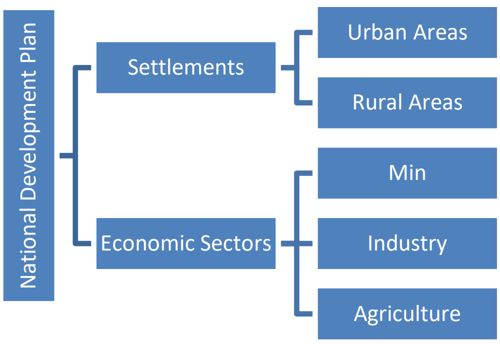


Figure 134 The sectors that are under effects of the national development plans directly and indirectly (by the author)

In the 1946s, Iran was in the preliminary stages of social-economic development planning. All urban development strategies and policies were integrated into the national development plans from the first to the third. And in the third and fourth national development plans emphasized preparing an especial development plan for the urban areas as a goal. In this regard, gathering and creating needed data and maps for providing development plans particular for cities was started in the third national development plan. As a result, the first Comprehensive Plans for some Iranian cities were provided during the fourth national development plan.

Table 65 The main national implemented urban development policies between 1947 to 1987 (by the author)

Plan Name	status	Development periods	Goals and strategies of urban development during the Pahlavi Dynasty
The first national development plan: "Seven-Year Development Plan for the Plan Organization of The Imperial Government of Iran"	Implemented	From 1947 to the middle of 1955	- Urban and Social reforms - Constructing cheap homes and apartments - Credits to the cities for supply piped water, use of mineral waters, and establishment of new electric generators systems - Profligacy actions and public health improvement - Increasing citizens' skills and ability, growth of education among the citizens, and supporting technical institutions in training skilled staff - Increase of new job opportunities - Giving advice and increasing technical knowledge of agricultures and Industrialists - Mapping and providing base maps for urban development planning - Creating the first local, regional and national senses data bank - And the other development projects
The Second National Development Plan	Implemented	From the second half of 1955 to 1962	- Developing urban areas for support and rise of production and export through building new factories - Developing public health service and accessibility to healthcare and sanitation - Social-cultural Development

			- Increasing income levels and improve the well-being of urban dwellers - Priority over urban development projects, improvement, and development of urban infrastructures such as asphalt - Growing transportation alternatives and developing transportation networks - Coordination between the urban organizations and activities - Implementing the Urban Road Network Design and City Networking Plan
The third national development plan	Implemented	From the second half of 1962 to 1967	- Priority over the non-development regions facing climatic and geographical difficulties and providing needed infrastructures, services, and facilities included: piped water supply system, electric network, telecommunication network, sanitation, technical and non-technical supports and s housing supply - Credits to the not complicated development projects that were allocated from the second development plan - Providing and creating maps for urban planning - Providing Comprehensive Plan for cities
The fourth national development plan	Implemented	From 1968 to 1972	- Decentralization and share of development at the national level - Priority over the non-development area and providing infrastructures, services, and facilities - Education and urban management improvement - Building and providing cities infrastructures - Financial and non-financial supports to the municipalities to implement development projects - Providing Comprehensive Plan for 46 cities - Providing needed maps by mapping for comprehensive plans - Education and urban studies - Help and support of municipalities in the urban management process - Analyzing and monitoring urban development plans

The fifth national development plan	Not implemented completely	From 1973 to 1978	- The increasing rate of income - Mobilizing Army Science Board to provide opportunities for all people, even for people that are living in the most remote areas - Developing education and communication systems for both urban-rural areas - Developing health networks, especially among the low-income families - Family planning, increasing public awareness about new methods to do that effectively - Increasing public awareness about an order, perseverance, professional conscience, and drawing public attention to have active participation, especially among young groups in the development projects. Also inviting all associations at the local and regional levels to mobilize the public for this aim - Organizational development and developing service in both urban-rural areas - Providing new modern technical and logistical support for the municipalities

9.3. Pervasiveness systemized and principled urbanization

Consolidation of the second Pahlavi's monarchy king, "Mohammad Reza Shah," had accelerated urban planning activities; hence, amendment and enactment of urban law became necessary (Mojtahedzadeh G. , 2019). And the parliament, in 1960, had enacted a new legal bill on "Land Tenure" to remove legal barriers and accelerate urban development projects such as constructing new infrastructures and revitalizing old quarters in the cities. The legal bill was reenacted with a new title on "Urban Road Network Design and City Networking" in 1962. Accordingly, Iran's interior ministry had signed a contract with an American consulting firm. Then the first team of American experts under the title "Peace Group" came to Iran. They have planned and designed urban road networks for most Iranian cities and towns (Shieh, 2003).

Figure 135 Modern Tehran during Pahlavi Dynasty (Siyavosh, 2013)

These applied novel ideas for developing Iranian cities coincided with the growth of technocrat and modernist thoughts in western countries. Capitalism and industrialization trends have conquered Orient urbanism's spirit and physics and reformed Iranian cities' traditional construction (Habibi, 2018).

Hence, the Comprehensive Plan was gradually applied to the Iranian cities. While this plan initially was provided for western cities, especially for American cities, and was supplied according to the western countries' urban design patterns and rules (Dehaghani, 1994). It should be noted that today both the "Comprehensive Plan" and "Detailed Plan" are two main plans for directing Iranian cities' growth and development. Still, these plans are reviewed every ten years, while this plan in western countries is not more effective and replaced by "Strategic Planning" or other plans that increase public participation (Behzad Malekporasl, Millad Alimohammadi, Sadegh Katoziyan, 2014).

During the second development plan (1955-1962), for the cities, Isfahan, Sanandaj, Bijar, and Oromieh, were provided the Comprehensive Plan based on the "Point Four Program" by the American experts. Furthermore, during the third national development plan, they had provided the Comprehensive Plan for 17 cities (Rahnamaei, 2017).

Figure 136 Iran's annual economic growth rate 1960-2019, (worldbank.org, 2021)

According to this study, during the third development plans' planning, the government had tried to decentralize and reduce the top-down dominance in the decision-making process (Ali Shamaee, Mohammadmehdi Abrari, 2015). For the first time, the government had enacted a new bill, which allowed the regions' authorities to provide development plans independently under supports of the national "Plan Organization." It has provided possibilities for implementing development projects independently at the regional level according to the principles of the Plan Organization. Such as constructing new roads, institutions, health centers, economic-social development projects, etc. In my regard, it should be regarded as the first official action towards a decentralized planning system after the coup of 1920 in Iran (Naser Barati, Mina Barati, 2011) .

In this era, while the new and young form of urban development was still in the formation and realization process, simultaneously, the government tried to change and develop the urban municipal legislation and regulations. For instance, the "Low of Amendment of Some Articles and Add Some New Paragraphs to the Municipal Legislation" was passed in 1334 to attain the following selected goals: a) providing needed regulations and legislations to enhance effectivity and efficiency of urban development plans, b) providing new principles, guidelines, and standards for urban development plans, c) determining jurisdiction and municipal boundaries of cities, d) Monitoring and controlling buildings according to the Building permit and Blueprints (Shieh, 2003) (Zanouz, 2016).

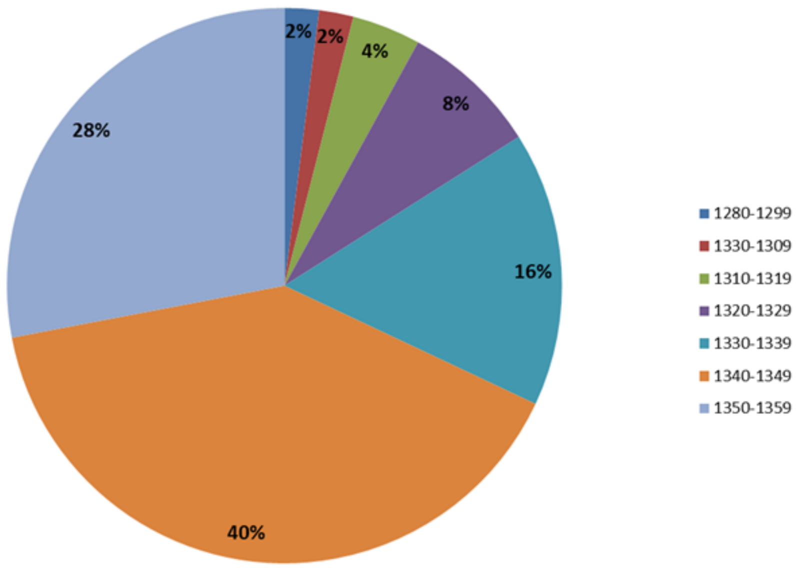


Figure 137 The percent of amendments or enacted urban development legislation and regulations between 1280-1359 (by the author)

The above actions had accelerated the pace of growth in the agricultural, industrial, economic, and service sectors and caused substantial changes in the urban-rural networks and interactions. The economy's dependency on the single-product "Oil" and revenue by selling crude oil had played a significant role in this trend. Single-product economics reformed the traditional spatial interactions between cities and the rural at the regional and national levels and tremendously accelerated these changes. Because had decreased dependency of cities on the rural products, consequently reduced the trade rate between the cities and rural areas (Nazarian, 1994). The government received millions of dollars of money every day by selling crude oil. At that time, the country faced financial problems and negative consequences of the Second World

War; the oil revenue had injected millions of dollars into the economy to start the engines of growth and execution of big development projects. And cities with more population, educated people, and other potentials became the places that could play a considerable role to help the government for realizing development projects. The cities became the main hotspot zones of economic activities. So, the government had started to reconstruct the Persian cities by the oil revenue. Finally, the era of contemporary Persian cities emerged in a modern form, contrasting with the old Persian cities' nature and texture.

Some main factors, such as the a) nationalization of the Iranian oil industry, b) the White Revolution (Enqelab-e Sefid), which led to the land reform, and c) rise of oil price have increased the rate of investments in the urban area and by growing infrastructure projects in the cities and strengthening the urban economy emerged a deep gap between the urban and rural areas (Shokouei H. , 1992).

After the Revolution of 1978 to Today

In the early years of the revolution in 1978, the new government couldn't control and manage the market. It had turned the management and development of urban areas, especially the cities, into chaos and grown a form of city-building under a new policy Maskan-e enghelabi (Revolutionary Housing), immethodical and contrary to the rules (Zanouz, 2016). This revolution had fundamentally transformed the monarchy system and structure into a centralized republic system. The interior ministry and the Housing and Urban Development ministries dictate all urban development policies to the municipalities. The municipalities have no power to do everything without permission from the ministries (top/down or hierarchical relationship) (Asghar Nazarian, 2008).

And today, all organizations involved in urban development and management couldn't plan and implement an urban development plan perfectly. Also unable to establish an integrated urban management system. As a result, today's cities have experienced a few corrective measures but temporary and scattered accompanied by turbulence, test, and failure (Mahnaz Hosseyni Siahgoli, Mostafa Ghadami, 2016). In

1984 the parliament enacted the new law on "Urban Development, Spheres of Influence and Detailed Plans" to apply some changes in the guiding principles of urban design and planning and the approval process. Furthermore, a new organization of Building New Cities and Satellite Towns was founded to settle the surplus population of big cities, like bedroom communities (Ziari K. , Principles and Methods of Regional Planning, 2008).

The post-war[11] era, regarded as a turning point to start privatizing municipal services. The country was facing a financial crisis and had not enough budgets to support urban areas. So, the cities themself have to care to find new financial resources to implement development projects. That was a big shock that time for municipalities that had always been supported financially by the state. They had no experience and didn't know what to do at that time? or how to find new financial resources?

According to the previous studies, the government's actions after the revolution concentrated more on using all mechanisms to increase the control and dominance of the government's body over the local and regional authorities and organizations. So, the urban development policies of the new government included:

1. Control and accumulation of wealth and capital in the center by the governmental organizations
2. Providing new facilities for commercializing the agricultural and industrial goods in the cities but irregularly
3. Foundation and growth of government-owned banks through the commercialization of capitals in cities

11 Iraq was starter of the war and invaded Iran in 1980. The war had damaged the economic sectors of Iran, destroyed the infrastructures in large scale and imposed many problems to the social sectors. After eight years the war ended in 1988.

4. An unequal competition between the government-owned organization and the private sectors in the field of urban economy and mainly concentrated on the following sectors: distribution of goods, speculation in the land market, and housing.
5. Delivering some public services by the semi-government organizations or affiliated with the government have increased their dominance over the market and imposed additional costs to the families
6. Imposing exorbitant costs to citizens for providing infrastructure facilities
7. Privatizing some significant services, including public education, health, and insurance and imposing high costs to the families
8. Expansion of the bureaucratic organization's framework and supplying new government job opportunities to the job seekers in the cities
9. More attention to the urban development than the rural areas and consequently a) growth of migration from rural to cities b) decreased potentials of rural productivity c) and promoting consumerism in the rural area. In the past, the villagers were the producer of agricultural goods, and today they are more consumers of goods of urban areas that are most of them importing every day from other countries.
10. Supporting the services and intermediation activities in cities as an easy solution for money circulation by the governmental agencies
11. Inattention to provide new job opportunities in the rural area
12. The concentration of cultural, social, and economic centers in the cities and increasing dependency of the rural to the cities to meet the above needs (Sarrafi, 2010) (Mojtahedzadeh G. , 2019) (Asghar Nazarian, 2008) (Habibi, 2018) (Shokouei H. , 1992) (Ziari K. , Principles and Methods of Regional Planning, 2008) (Shieh, 2003) (Hadiyani, 2001).

Today, the relationship between government and cities is interest-oriented and is not sensible. Because in some cases, changing a village into a new town is usually requested from some persons and groups with considerable influence in the government's executive organizations, and not from most of the villagers (Zanganehsharaki, 2013). Today, statistics show that about 766 places have emerged as new towns after the revolution. Just about 25 cases of the total were constructed as a new city, and the rest resulted from the change of villages to new towns (Seyed Shamsoaldin Sadeghi, Loghman Ghanbari, 2017).

Table 66 Number of rural areas that have changed into towns (National Statistics Centers, 2019) (by the author)

Decades	**1956 - 1966**	**1966 - 1976**	**1976 - 1986**	**1986 - 1996**	**1996-2006**	**2006 - 2016**	**SUM**
Number of rural settlements changed into town	73	101	123	116	400	319	**1132**
The average rate of changing the rural settlements into the city	%7.3	%10.1	%12.3	%11.6	%40	%31.9	**100**

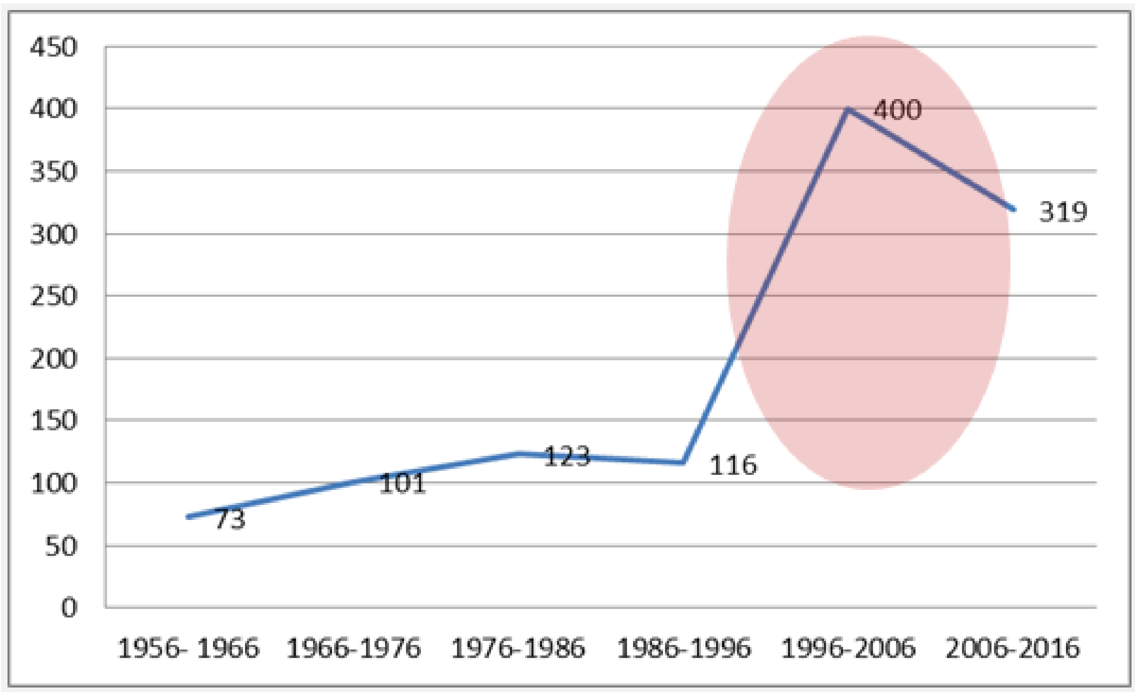


Figure 138 Number of rural areas that have changed into towns (by the author)

Table 67 Growth of cities and towns with considering the implemented development plans before and after the revolution 1978 (by the author)

Decades	**Before 1956**	**1956 - 1966**	**1966 - 1976**	**1976 - 1986**	**1986 - 1996**	**1996 - 2006**	**2006 - 2016**	**2016 - today**
TNC at the national level	191	271	373	496	617	1012	1345	-
TNC and towns		+80	+101	+123	+121	+395	+333	-
Implemented development plans	The first national development plan (1949-1955)	The second national development plan (1955-1962) & The third national development plan (1962-1967)	The fourth national development plan (1968-72) & The fifth national development plan (1973-1978)	About one decade without development plans	The first national development plan 1989-1993 & The second national development plan (1995-1999)	The third national development plan (2000-2004) & The fourth national development plan (2005-2009)	The fifth national development plan (2011-2015)	The sixth national development plan (2017-2021)
Type of governments	Mohammad Reza Shah Pahlavi[12] Period (1941-1979) (38 years)			After the revolution and emerge of the Islamic Republic of Iran (1979- Today) (40 years)				

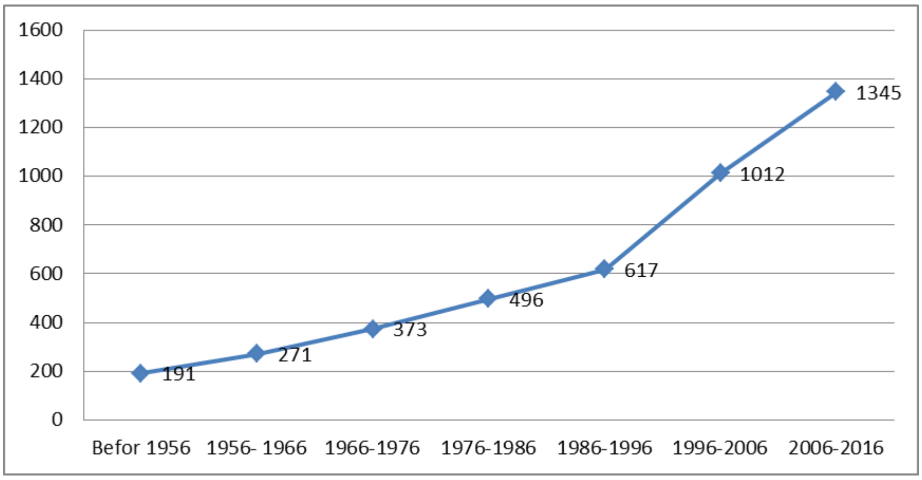


Figure 139 Numerical growth of cities and towns in Iran from Pahlavi dynasty between (1956-1976), to the republic Iran between (1976-2016) (by the author)

12 He was the second and last monarch of the House of Pahlavi (Pahlavi dynasty).

During such a trend, the government has performed the role of the central employer directly. And the cities are the main operational bases for engineering the government's social and economic interests. The centralized government is now city-oriented, and their political and economic interests have an organic linkage to the cities. Hence, the government doesn't like to stop the numerical growth of new towns and urban-rural migration, and using this trend helps to have more control over the markets and activities (Mozafar Sarrafi, Jamileh Tavakollimiya, Mehdi Chamanimoghadam, 2015). Over decades the job market is not good, and most of the job offers are short time and, in some cases, without pension. So, there is no job security. And in this condition, the government offers hundreds of official jobs every four years for election campaigns. And people for taking these jobs have to accept and follow the government's actions and policies. And for symbolic political events and anniversaries, they force millions of them to attend these events and be on the street. So, this is engineering, controlling, and reforming social behaviors according to the government's desires. That is one of the main reasons the government likes the growth of the urban population and emerged polarised urban-rural societies and has shared development resources between places unequal.

The following issues had established an ineffective form of urban management and governance:

- The collapse of Iran's traditional production system,
- The influx of foreign goods and capital over the country,
- The inflow of oil revenue as the primary source of the central government's income has played a significant role in the urban development process, economic activities, banks, employees' salaries, pensions, etc. (Nazarian, 1994) (Shokouei H. , 1992).

The second and third national development plans' social, cultural, and economic policies between 1995 – 2004 have intensified urban changes. In this period, the government agencies tried to expand their ideologies over the country (Plan Organization, 1961) (Plan Organization, 1955).

For example, the parliament in 1998 changed the name "City Council," which was founded in the Pahlavi dynasty, into the "Islamic City Council" and applied new amendments (Latifi, 1376). Unfortunately, these recent amendments had limited the tasks and power of the municipalities. For example, in paragraph five, public participation in the development plans is allowed once central government agencies agree. In the new amendment, they have removed paragraph 30 from the primary law, which allowed the interior ministry annually to send abroad the employees at the whole the country to study and obtain information on urban planning and administration for a maximum of two years. That was a positive rule to give a chance to the employees to develop their knowledge and skills for urban issues, but this matter had no place in the amended law.

An Analysis on the Planning Processes and Actions after the Revolution 1978

Planning system as a constructer of the planning frameworks, director of the development process, depending on the type of political system can be centralized, semi-centralized, or decentralized. Planning frameworks determines hierarchies, functions, and roles in a planning system. Iran's centralized planning system has disturbed the inter-organizational connections and activities between public and private organizations. Hence, analysis of the planning system helps answer the reasons for the fail and inefficiency of urban development plans in Iran. But, it is required to know how the structure of Iran's planning system is? What organization and groups are involved in the planning and executing processes? And what problems hinder Iran's planning system?

Generally, in urban planning, it is necessary to study the interactions of a city to other places considering the economic and non-economic forces at the regional, national, and even international levels. And in this study, these forces are studied at both local and national levels. Iran's national development plan encompasses general attitudes, policies, and defined budgets for projects. From one side, the national development plans have been played a considerable role in urbanization. And from the other side, due to Iran's centralized administration system, so government plays a central role in the development planning process. Hence, studying Iran's planning system at the national level helps better understand the government's role in urban development.

According to the structuralism theory, a system structurally is not apart from its subsystems, and all parts effort for a common goal. Accordingly, urban planning is a subsystem of the national planning system. So, local urban development policies follow national urban development policies, and the forces and decisions at the macro-level for this case (Shokouei H. , 2009).

According to the results, one of the other structural problems is the diversity and multiplicity of involved organizations in the planning process. It has generated many challenges and obstacles during urban development planning. So, it is required to solve this problem for realizing urban sustainability. Rapid urban population growth through the dramatic interregional migrations from rural to the big cities, and negative consequences of an unstable political-administrative system on the economic sector, financial crisis, multiple economic structures (traditional, semi-industrial, and modern just in mother industries), and fail of the planning organizations have been affected negatively on urban development. In other words, the city is not an independent variable in this sense and has an extreme dependency on spatial, physical, social, and economic factors. This complex national issue, which has been surrounded the urban areas, doesn't give any chance to the Persian cities to solve the obstacles charged by the national political and planning organizations.

To continue is provided pathology on Iran's planning framework and included the following sectors:

- Pathology of the planning system
- Pathology of the goals
- Pathology of the enacting process of development plans
- Pathology of the program monitoring and evaluation process

Pathology of the planning system

The results have shown that Iran's planning system has no precise definition for the concept, dimension, and character of the word "Development" with a broad consensus to apply in any development plans. In most of Iran's development plans, "Economic Growth" was defined as a goal (Barmaki, 2014). However, if we consider "Plan" as a regulator and organizer tool to achieve specified purposes, employing the word "Economic Growth" as a plan's goal cannot be a clear and comprehensive definition in Iran's development planning. As a result, different understandings and interpretations for the word "Development" happened in the different periods. And still, it is a significant challenge for planners and authorities.

This fact shows we cannot be optimistic about successfully implementing development plans until we reach a consensus on the principles and paradigms of development among the planners, authorities, private sectors, and NGOs.

The other point is that the planning system always has been defined with a high degree of centralization. Thus, all general social, political, and economic policies have been defined by the central government's leaders, while they have the lowest interaction with experts in the planning process. And this behavior is in contrast with the planning act's nature. Coordination among all involved organizations and persons is required for planning, enacting, and executing development plans successfully. Researchers believe that decentralization and effective "mutual interaction" between public and private sectors increases resiliency and capacities in the urban development process locally and nationally. Unfortunately, centralization is continually promoted by the mains leaders to the national planning organization and then to the regions and locals authorities in the urban management act. Such behaviors and actions are contrary to what planners and economists have always pointed out on the necessity of decentralization in Iran's planning system.

Lack of a "Futuristic approach" and long-term strategies are the other main shortages. This problem deflected these plans from its straight course. That's why the executives are impotent to provide all required applications for new imposed and spontaneous changes from parties and finally unsuccessful planning (Mohammad Taghi Rahnamaei, Parvaneh Shah Hossaini, 2009).

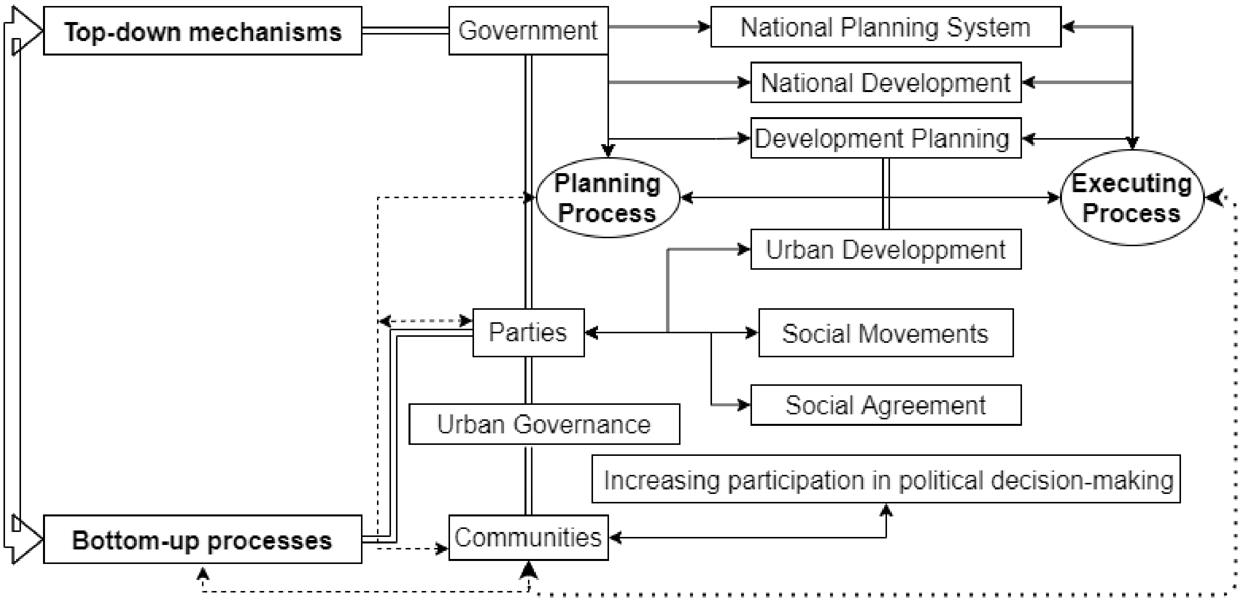


Figure 140 Interactions between organizations, authorities, and planners during planning practice in a centralized system (by the author)

Pathology of the development plans' goals

Analyzing the damages in Iran's planning system shows a conflict between the planners and authorities in the planning process on planning and executing concepts and disciplines. And this is one of the main difficulties that have played a considerable role in the fail of development plans. On the one hand, the Iranian planners have always tried to find and develop new development strategies for the socio-economic sectors. But, on the other hand, political factors like disagreements between parties have restricted the circle of supports for the proposed strategies planners. And these different opinions resulted in the change of the priorities of plans or postponed enacting or executing time.

The centralized political and administrational structure has increased the presence of military organizations or closed to the government in the economic activities and monopolized the production cycle and market. And of course, urban areas, with the highest contribution in the economic activities, were affected substantially. Also, this problem has decreased the presence of private sectors in the economic activities and, as a result, has impaired the urban economic forces and performance. Therefore, the cities in such polarized markets have no chance to realize development plans' goals. Because they have no power in organizing the market and urban economic activities, today, the nature of the economic structure is determined by the government agencies and some political groups close to the government.

In continue, the government has started the privatization policies in 2005. As a result, the political groups close to the government have seized most of the mother industries and main financial companies (Atashbar, 2011). This unwelcome event had intensified centralization and increased the government's power, presence, and dominance in all social-economic sectors.

Inattention to the economic sectors and social organizations like NGOs in the planning process is a significant shortage in Iran's planning and development politics. The other reason referred to the government's role in changing policies, strategies, and planning and governing manners. So, if they do not tend to the defined development strategies by planners; as a result, such contrasts will be affected on the plan implementation negatively.

Moreover, the results have shown that the plans' goals did not define clearly. And the word "Goal" or "Goals" were employed in different forms in the development plans. For example, in a development plan, they have written "General Goals," in another one, "Contents or General Orientation," etc. Regardless this disagreement is between the planners or else, that's like the personalization of development plans or applying personal favors over such plans (Barmaki, 2014). Different approaches between planners and politicians permanently have blocked achieving a consonance to define the plan's goals. Because of parties' conflicts, each winner party that comes to power will not follow another party's plan or policies. That is like a circular rotation and without any aim.

In some cases, heightened tension during the planning act resulted in some organizations being suppressed unfairly from the planning team, but the deprived organization was officially responsible for monitoring and provide development plans. For example, after the revolution in 1978, the urban development ministry decided to use the Comprehensive Plan for development planning over the country (Nazarian, 1994). And according to the law, the Economic Council was responsible for providing these plans. But because of the above problems, oppositions have deprived the Economic Council of the planning team. It should be noted that this council was founded in 1937 as the first planning core in Iran. And this council was the founder of the new planning culture and provider of its knowledge and principles for the first time in Iran. And today, there is no organization like the Economic Council to take this responsibility and realize coordination among the policies, plans, and actions (Barmaki, 2014). Instead, the foremost leaders and politicians determine what plan must implement and what organizations must execute without respect to the plans' goals and priorities. Such behaviors and views made development plans ineffective and meaningless.

Pathology of the enacting process of the development plans (Structural)

Unfortunately, based on the results, the parliament could not enact the most national development plans according to the time plan. Surprisingly, in some years, there was no plan to implement. In other words, the country had no plan. Please take a look at Table 68.

Table 68 The enacted development plans after the revolution 1979 (by the author)

Number of Development Plans	The last deadline for Send the plan to the parliament	Sent to the Parliament	Enacted and ordered to the administration
After the revolution up to 1990 the country was without development plan	No Plan	No Plan	No Plan
The First Plan	1988-09-22	*1988-06-16*	*1990-03-01*
The Second Plan	*1993-08-23*	*1993-12-21*	*1994-12-11*
The Thierd Plan	*1999-09-22*	*1999-09-15*	*2000-04-05*
The Fourth Plan	*2004-09-21*	*2004-01-12*	*2004-10-07*
The Fifth Plan	*2009-09-22*	*2010-01-10*	*2011-01-10*
The Sixth Plan	*2015-09-17*	*2016-01-16*	*2017-03-04*

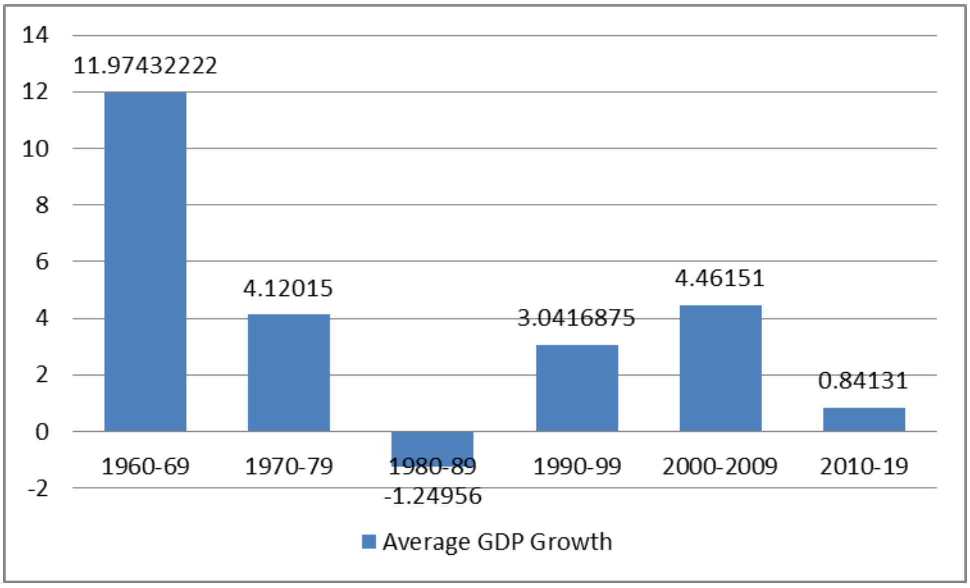


Figure 141 Iran's GDP growth by decades 1960-2019, the graph provided by the author, and the data from (worldbank.org, 2021)

The other problem is that the executive and legislative branches' scope of activities and tasks are not defined clearly. Because the scope of legal actions of the parliament about the change of development plans draft or bills is not defined clearly (Hamed Samarghandi, Seyed Mohammad Moosavi Tabatabaei, Pouria Taabayan, Ahmad Mir Hashemi, and Keith Willoughby, 2016). On the one hand, according to the law, the executive sector is responsible for providing development plans (Barmaki, 2014). And on the other hand, according to the law, the parliament has the right to apply "minor changes" in the development plans. But it is a general definition and not clear. As a result, in many cases, the parliament applied many changes in the content of plans beyond minor changes and regarded as **replanning** and **interference** in the executive branches' duties.

Pathology of the plans implementation process

When the oil export exposes to an external shock, the oil revenue will decrease. So, reducing the government's revenue means facing reducing financial resources to execute development plans or projects. The single product economy and heavy dependency on crude oil revenue led to incomplete and unsuccessful development plans. In continue, this problem is explained in more detail.

Also, the other factor with substantial adverse effects on the financial resources referred to Iran's political behaviors, foreign policies, and how to communicate with the other countries at the international level. Ideological differentiation has always negatively affected the safety of the middle east and Iran's political stability. And as a result, countries or investors don't want to invest their money in an unsafe place. International sanctions on Iran to change the government's behavior are one of the prominent pieces of evidence for this claim.

Please consider, Iran is ranked as one of the top leading countries based on the value of natural resources and has fifth place globally. But, unfortunately, these innate potentials never have been used efficiently for urban-regional or national development due to the a) lack of domestic financial resources, b) unstable market and political-economic system, and c) lack of safe investment space for foreign investors.

The other factors that have increased urban problems' inefficiency referred to the politicians' dialogs and the government's significant leaders (Barmaki, 2014). Their orders and guidelines have always strongly influenced the development plans' policies and strategies. They determine how and when such plans have to implement (at the macro level), while they have never participated in the planning process (at the local level). Unfortunately, the political conflict between parties is not limited to the parliament and law, even in implementing plans. Analysis of Iran's urban management has shown that urban management's structure and manner have permanently changed by changes in the political sector and the change of leaders and authorities.

After establishing a new administration, the new state doesn't want to follow the action plans, policies, and strategies that were done during the last four years by the previous party in power. Instead, they want to implement new development plans and projects according to their party's interests. So, parties don't take care of the public interest. Such conflictual behavior means unaccountability, waste of time, public resources, opportunities, and threatening the future of the current and next generations. This is a dominant political culture and behavior generalized in all management and execution parts.

Pathology of the plans monitoring and assessment process

After analyzing the development plans' determined legal frameworks, the results show that these acts haven't been taken seriously. For instance, after providing a development plan and formal notification to implement the plan, then the executive sectors from the Government body are responsible for implementing the plans. But these organizations, Instead of concentrating on the contents of development plans and providing requirements before executing, have always tried to speculate in the parliament about allocating more financial resources to implement selected projects from the annual budget (Barmaki, 2014).

The other problem is that the Economic Council was suppressed from some official tasks, particularly planning. According to the law, the Economic Council was the leading organization responsible for planning, assessing, and monitoring all development plans' implementation processes (National Parliament Library, 1949). In 2009 the government changed the composition of members, and tasks were restructured ineffectively, and the tasks were assigned to the other agency. In such a case, it seems the planning activity has no more place than must be considered usually and seems like an administrative ritual. If monitoring the development plans is very important, tasks and activities are overlapped and not clearly defined. The other problem is that the government agencies have never asked for feedback from the public and did not publish complete reports around all implemented development plans correctly and without delay.

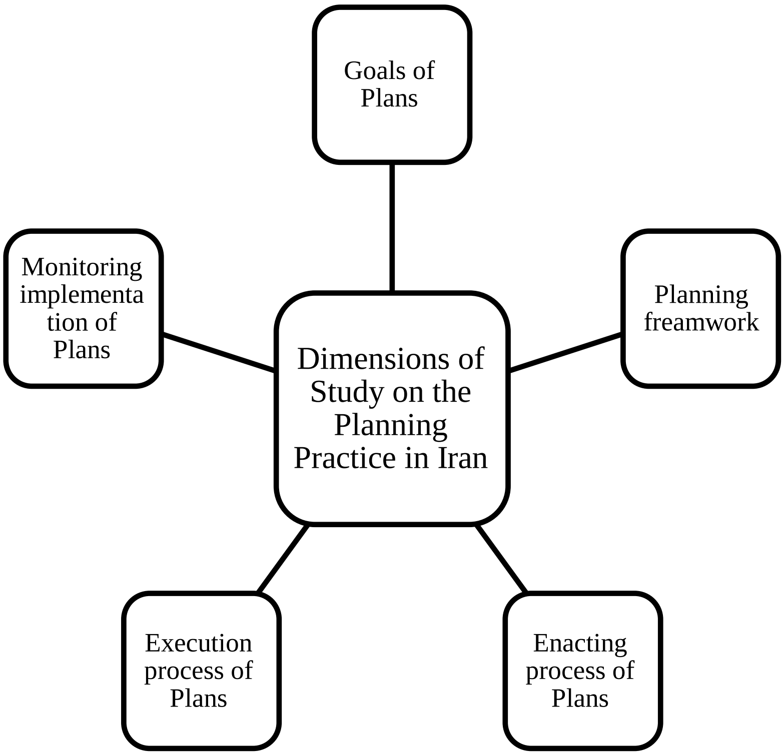


Figure 142 The dimensions of studying Iran's planning system (by the author)

The problems mentioned above and shortages at the significant level of the national management and planning sectors have been made development plans ineffective and inefficient at the city, regional and national levels.

The results of one study on the municipalities' revenue and financial resources have shown, in Iran, there is a significant relationship between the government's economic policies and implementation of monetization policies such as selling surplus building density by municipalities in the cities (Latifi, 1376). The government, many times, has reduced financial support to the municipalities from 100% in 1983 to less than 5% Today (AleEshagh, Parisa, Hodavand, Medi, 2014). And today, the municipalities have many financial problems; thus, they have been sacrificed valuable urban resources and urban sustainability for financial interests.

For example, they are parceling and selling valuable agricultural lands for new buildings or selling surplus building density to increase revenue. Both strategies have been threatening the sustainability of the environment and generated many environmental problems (Ziari K. , 1997). And todays' cities are overcrowded and populated more than what planners define in the cities development plan. Moreover, selling surplus building density increases the number of inhabitants in a place, while infrastructures are not enough (Mojtahedzadeh G. H., 2006).

Understanding Iran's political-economic structures have helped identify the origin of urban problems and what external factors negatively affected Iran's urban management system. Additionally, this study has analyzed the passed bills and implemented urban development policies that had been implemented during the first and second national development plans between 1988s-1999s.

The law of the first development plan 1988s specified the following policies for urban development:

- Realizing balance in the distribution of population, decentralization of activities in the Tehran city as a capital, and prevention of dramatic physical and population growth in the big cities

- Ensuring parallel development accordance with the population centers, priority in reconstruction and renovation of war-damaged cities

-Improving urban management and enhancing technical, financial, and executive potentials of municipalities to be independent financially

In the general policies chapter of the plan, one of the central specified urban development policies was:

provision of part of municipalities' financial resources through legal taxes on the buying or selling of real estate.

In the executive chapter of the plan, one of the central specified urban development policies was:

- Supporting municipalities to be independent financially (Plan and Budjet Organiyation, 1988).

After the war, Iran faced dramatic financial problems because selling crude oil has decreased significantly, so there was not enough budget for all projects and organizations. That's one of the main factors that the government has started privatizing the municipalities at that time. That was a solution to save money for the projects (Qasemi, Mohammad; Fayazi, Mohammad Taqi; Javadi, Shahin, 1985).

But realizing this idea was unfavorable at that time. How can privatize the municipalities quickly, without considering how the municipalities can give service to the citizens without enough financial budget? While municipalities initially have to provide services to millions of people every day! For more than five decades, the municipalities were under the support and a part administration before privatizing. And then, in a short time, set apart from the administration body and be independent just in terms of finance? As a result, instead of concentrating on their tasks and plans, the municipalities are captivated by financial problems today.

After disconnecting the municipality from the government body, the first development plans' law emphasized finding new financial resources to increase municipalities' revenues. So, they have never planed to provide financial resources before the privatization of municipalities. As mentioned above, this is one of the main reasons that municipalities have been selling surplus building density, which faced Iranian cities with many additional new difficulties and environmental crises today.

The law of the second development plan 1994s specified the following qualitative policies for urban development:

- Foundation of Urban Councils to improve technical and execution abilities of the municipalities to be more independence

In the general policies chapter of the plan, one of the central urban development policies was:

- Providing new revenue resources for municipalities through imposing new taxes limited to the cities' official borders (Plan and Budjet Organization, 1994).

Making such incongruous policies and dissonant with reality turned the cities into unpleasant places. For example, the "Mehr Housing" project was launched in 2007 by the administration to provide cheaper buildings for low-income groups at the national levels, especially for the urban zones (Naseri, Ali Mohammad, Naqavi, and Ehsan, 2017). But the administration did not allow the municipalities to comment on the locating, planning, and executing steps of this project (Meshkini Shahrokhi Far, Hossein Tahmasebi Moghadam , 2019). The researchers have done numerous studies on this project and have analyzed its effects on urban spaces. The most common problems that this study have enumerated are:

- most of them are located in the wrong places,
- used inferior materials with shallow stability during building,
- lack of infrastructures and services concerning age groups,
- lack of accessibility to the transportation systems, schools, health centers, and markets (Khalili, Ahmad, Haniyeh, Norallahi, Rashidi, Naeemeh, Rahmani, Maryam, 2015).

Domination of centralization in all aspects of political, administrational, social, and economic sectors made urban management ineffective.

Also, this sector's analysis results on planning and enacting urban development plans indicated an orderly behavior and a top-down view in the planning act. However, the methodologies of these projects have no compatibility with the administrational structure. In addition, the diversity of organizations has slowed down the planning and enacting process. The incompatibility of the ratifications for urban development plans with government institutions and organizations' budgeting methods is another problem in this field.

In the first urban development plans, the government had sharply manipulated the contents of development plans. In contrast, many planners have criticized this act at that time. And today, not only don't want to stop this behavior, even have tried to separate their dominance in all sectors tremendously. Why? Because the base of development panning guidelines and principles theorized as a government-owned plan in Iran (culturally and structurally). And should be noted, this is also one of the main reasons that the people have never been invited or asked to participate in the planning process.

Some of the significant shortages of the centralized planning system and vertical-sectoral structure of the national administration issued for this part as follows:

- Lack of a national spatial development plan with a consensus among all involved organizations and guarantee a plan-based execution. An integrated form of the planning framework links the local and national organizations and coordinates activities.
- Provide and enact local development plans (for the cities) by the ministries at the national level due to centralization, which contrasts with cities' priorities and potentials at the local levels.

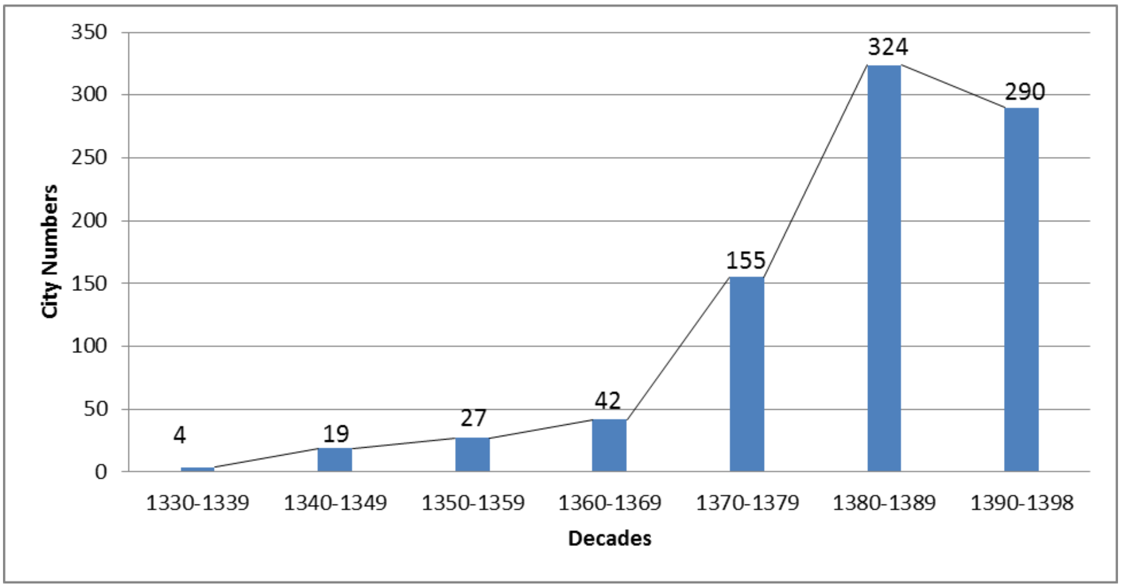


Figure 143 Numbers of enacted conperehencive plans for the development of Iranian cities (by the author)

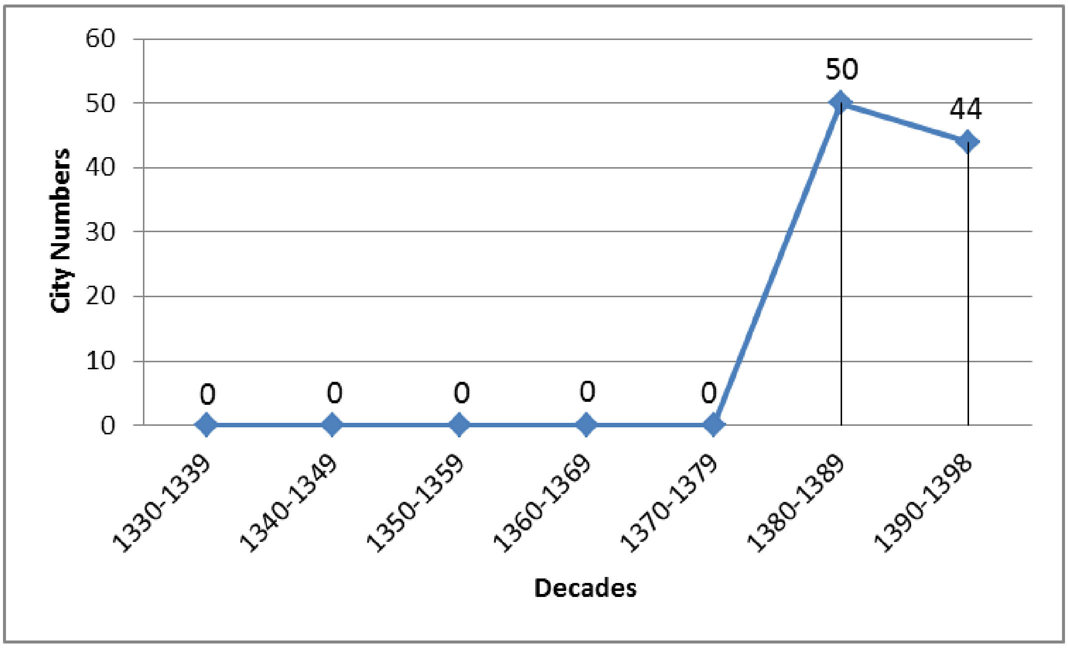


Figure 144 Numbers of cities that have faced contradictions in both Comprehensive Plan and Detailed Plan (by the author)

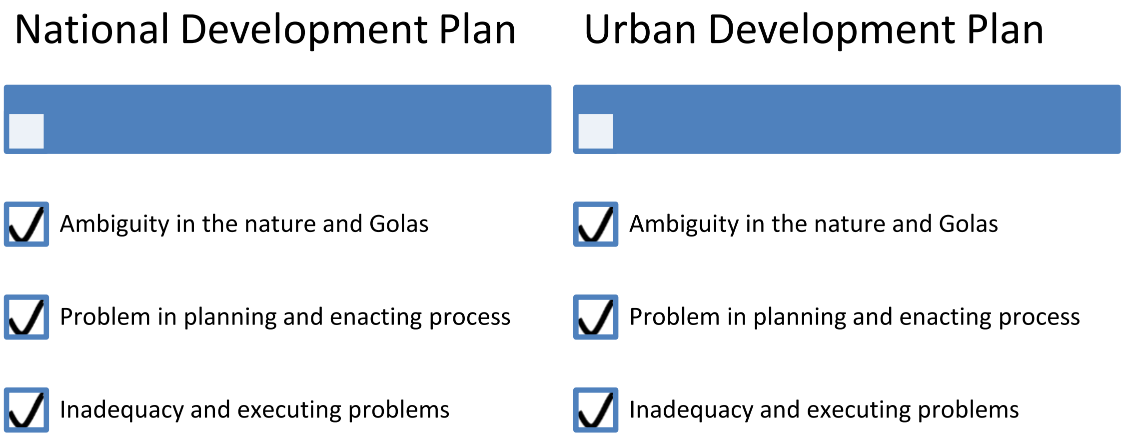


Figure 145 The systematic direct effects of national plans on the local plans in a centralized system (by the author)

9.4. Analysis of the contents of urban development plans

As mentioned before, the theories, principles, and methodology of Iran's urban development plans were copied from the industrialized countries before the 1970s and never updated the contents and theoretical foundations of the development plan considerably.

Planners have consistently criticized these plans' methodology because those who provide a development plan have no role in the implementation process, while they have to monitor and control it.

Belief in pure rationalism and making an absolute decision for cities' future were products of modernism and are doomed to failure initially, but such approaches applied to Iranian cities (Shokouei H. , 1992). This is the same problem in the industrialized countries, and today they are correcting or reconstructing some places in the cities that were building up incorrectly, particularly between the 1970s-1980s (Dehaghani, 1994). On the one hand, these plans positively affect the zoning and building; on the other hand, these couldn't realize the specified goals in these (Ziari K. , Urban Land Use Planning, 2009). Today's urbanism in terms of social, technological, and economic changes contrasts with the past urbanization and Iranian cities planned based on the planning theories up to the 1980s. Today, after many decades of executing these plans in the cities, unfortunately, these plans are failed to satisfy urban dwellers, and often a tiny percentage of proposed land uses are realized.

The results of a study on the Urban Comprehensive Plans that was done by Iran's National Planning and Budget Organization in 1993 have shown that most of these plans were unable to realize desired goals in practice. Also, more than 70% of population predictions did not occur. In 40% of the cases, the city development directions were in the opposite directions that were predicted in the plans (Plan and Budjet Organization, 1993).

Moreover, proposed building densities are realized rarely in the cities. Land parcels and proposed per-capita lost their efficiency due to the failure to predict population (Goldis Vahidi Borji, Farshad Nourian, Mohammadmehdi Azizi, 2017). City Comprehensive plan is just physical oriented and can not solve social-economic problems (Keramatollah Ziari, Alireza Mohammadi, 1395). Today, after about six decades of implementing many comprehensive development plans in most Iranian cities and towns; however, these plans have failed to prevent the unbalanced and heterogeneous development of cities and provide solutions to manage urban growth

(Ali Zangiabadi, Mehdi Abdollahi, Roghayeh Salek Ghahfarkhi, Behnam Ghasemzadeh, 2014).

Ambiguities and problems in urban development plan's nature

Unfortunately, the nature and contents of the urban development plans have not been localized and accommodated with Iranian cities' geographical conditions, especially according to its administrative structure (Ziari K. , Principles and Methods of Regional Planning, 2008) (Dalir, 2009).

Because cities' problems and challenges are different in the same region, Iran has various geographical and environmental climates, features, and landscapes. Therefore, proposed solutions, strategies, and prioritizing are according to each city's problems and needs in its geographical-spatial location.

Surprisingly, planning guidelines for all Iranian cities and towns are the same, without considering these geographical, environmental, spatial, social, cultural, and economic diversities (Nazarian, 1994).

Also, the time-consuming and lengthy enactment process of development plans is the other main reason that faced predictions of the following sectors in most cases to fail included: social-economic projections, population changes, land-use changes, and urban growth. In some cases, just enacting a development plan has been taken 3 or 4 years!

Chapter Ten

Land Use Changes Modelling

10.1. Introduction

The importance of land use/land cover changes

Land use/land cover change is considered as one of the most critical environmental issues of global concern (Iverson, 1988). Changes in land use/land cover and the associated habitat loss and fragmentation are significant causes of biodiversity loss (Erich Tasser, Ulrike Tappeiner, 2002). Such changes have been generated by human activities such as industrialization, urbanization, agriculture intensification, land degradation, and overgrazing (Bryan C Pijanowski, Daniel G Brown, Bradley A Shellito, Gaurav A Manik, 2002). These human-induced changes decline natural resources and led to severe social, economic, and political consequences (Balak, 2003).

These significant issues led to the emergence of many international multidisciplinary research projects to monitor and study Land Use and Land- Cover (LULC) changes (Thenkabail, P. S., Schull, M., & Turral, H., 2007) and Global Land Project (GLP) (Ademola K. Braimoh, M. Osaki , 2010). Both are joint projects of the International Geosphere-Biosphere Project (IGBP), launched in 1987 to examine how Earth's ecological processes interact at a broad scale and how they are affected by human systems (Smucker, 1998). Or an International Human Dimension Project

(IHDP) was launched in the 1990s to study global changes from the social perspective (Ola Uhrqvist, Eva Lövbrand, 2014).

In this regard, also the availability of remotely sensed data and its advance in the temporal, spatial, and spectral resolutions have provided some possibilities to detect daily changes on the Earth's surface at different scales (T. V. Ramachandra, Uttam Kumar, 2004). Monitoring and understanding these dynamic land-use changes provide more accurate information, which can also help to meet better strategies in the decision-making process during the planning and managing steps (Lambin, Eric F. and Geist, Helmut J. and Lepers, Erika, 2003). Especially over the last three decades, various hardware and software have been developed for capturing and analyzing remote sensing data. Rogan and Chen, in 2004, have defined a new digital and/or detection system to describe land use/land cover changes based on the co-registered multi-temporal remote sensing data. The used techniques for assessing change were numerous and included both statistical and rule-based methods (Chen, J., Gong, P., He, C., Pu, R., & Shi, P. , 2003).

Material and methods

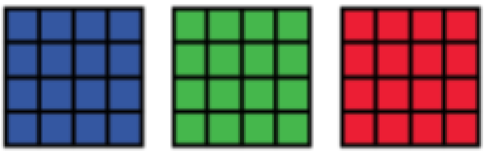
For the step of this analysis, this study has used time-series Landsat images from the 1972s by 2020s, as listed in the following Table 69.

Table 69, The used time-series Landsat images (by the author)

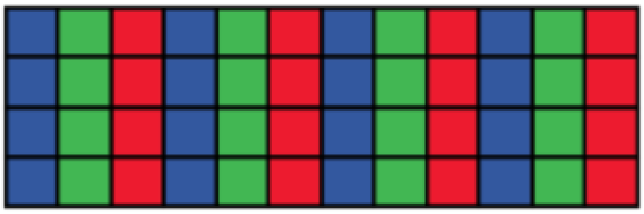
Timeline	Processing correction level	Bands
1972.09.22	LM01_L1TP	(6,5,4)
1988.07.02	LM05_L1TP	(3, 2, 1)
1999.06.30	LE07_L1TP	(4, 3, 2)
2010.06.05	L7_ L1T	(4, 3, 2)
2020.06.24	LC08_L1TP	(5, 4, 3)

Satellite Imagery Formats

Band sequential with three bands, four columns, by four rows



Band-interleaved-by-pixel with three bands 12 columns by 4 rows (Clarklabs, 2020)



Geographic Database Concepts

The used time-series Landsat images

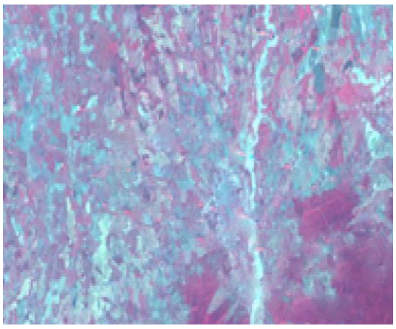


Figure 146: Landsat image of the 1972s (USGS, 2021)

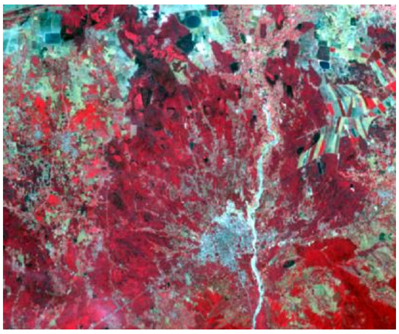


Figure 147: Landsat images of the 1988s (USGS, 2021)

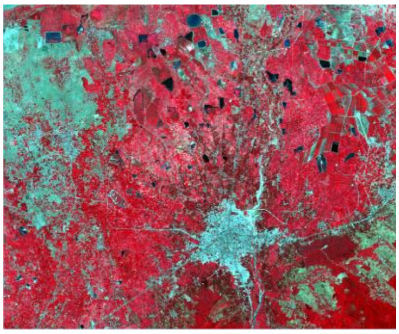


Figure 148: Landsat images of the 1999s (USGS, 2021)

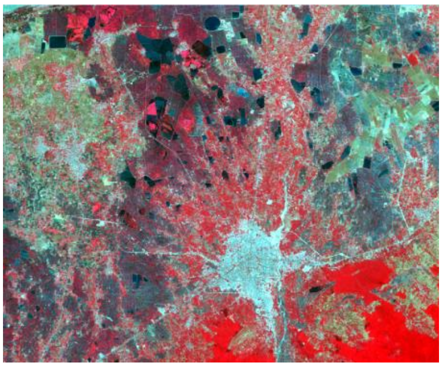


Figure 149: Landsat images of the 2010s (USGS, 2021)

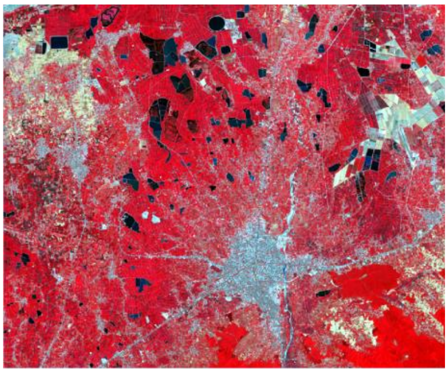


Figure 150: Landsat images of the 2020s (USGS, 2021)

Classifying the Images

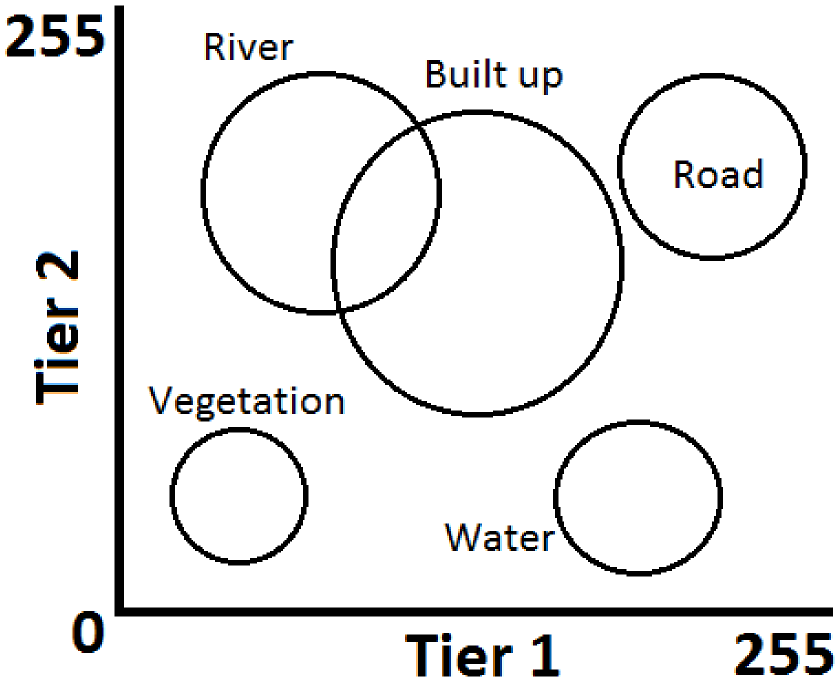


Figure 151: The defined color ranges for the land covers (Clarklabs, 2020)

10.2. Maximum Likelihood

The MAXLIKE module has provided the Maximum Likelihood procedure in the IDRISI Image Processing toolset to compensate for the main deficiencies of both the Parallelepiped and Minimum-Distance-to-Means procedures. The Maximum Likelihood procedure is based on Bayesian probability theory. The MAXLIKE module uses the mean and variance/covariance data of the signatures to estimate the posterior probability to determine which pixel belongs to predefined classes (Clarklabs, 2020).

In many ways, the MAXLIKE module is similar to the MINDIST with the standardized distance option. The only difference refers to the MAXLIKE accounts for intercorrelation between bands (Reveshty, 2011). MAXLIKE incorporates information about the covariance between bands as well as their inherent variance and produces an elliptical zone of characterized signature but conceptualized (Paul, S. S., Li, J., Wheate, R., & Li, Y., 2018). In fact, it calculates the posterior probability of belonging to each class, where the probability is highest at the mean position of classifications and falls off in an elliptical pattern away from the mean (Parth Sarathi Roy, Lars T. Waser, 2017).

10.3. The change prediction process in LCM

Land change prediction in Land Change Modeler is an empirically driven process that moves stepwise from 1) Change Analysis, 2) Transition Potential Modeling, to 3) Change Prediction. It is based on the historical change of land cover maps from time point 1 to time point 2 to project future scenarios (Kshitij Mohan, Praveen Kumar Rai, Varun Narayan Mishra, 2014).

The Land Change modeler interface is organized around a set of six major tasks:

- Change Analysis: Analyzing past landcover change
- Transition potentials: Modeling the potential for land transitions
- Change prediction: Predicting the course of change into the future
- Planning: Evaluating planning interventions
- REDD Project: Estimating GHG emissions from REDD projects
- Harmonize: Formatting land cover maps to use in Land Change Modeler (lab only launches when landcover maps are incorrectly formatted) (Clarklabs, 2020)

The landcover maps used by LCM must be formatted to meet the following conditions:

1. legends in both maps are the same.
2. Categories in both maps are the same and sequential.
3. Backgrounds in both maps are the same and have a value of zero.

4. Spatial dimensions, including resolution and coordinates, are the same (R. K. Jain, Kamal Jain, S. Rehan Ali, 2017).

Change Analysis

In Change Analysis, change is assessed between time point 1 and time point 2 between two land cover maps. Identified changes are transitions from one land cover state to another. It is likely that with many landcover classes, the potential combination of transitions can be very large. What is important is to identify the dominant transitions that can be grouped, modeled, and termed submodels (Nidhi Nagabhatla, C. Max Finlayson, Sonali Seneratna Sellamuttu, 2012).

10.4. Transition potential modeling

The second step in the change prediction process is Transition Potential Modeling, where we can identify the potentials of land to transition. This step will create potential transition maps of suitability for each transition. In LCM, a collection of potential transition maps is organized within an empirically evaluated transition sub-model that has the same underlying driver variables (Clarklabs, 2020). A transition sub-model can contain a single land cover transition or a group of transitions that have the same underlying driver of variables. These driver variables use to model the historical change process. For example, if you are modeling deforestation due to agriculture, river variables to consider would be slopes, proximity to roads, or previously deforested areas (Florencia Sangermano, J Ronald Eastman, Honglei Zhu, 2021). Transitions are modeled using either a multilayer perceptron (MLP) neural network, logistic regression, or a similarity-weighted instance-based machine learning tool (Same Weight) (Rahim Aguejdad, Thomas Houet, Laurence Hubert-Moy , 2017). Once calibrated, the model is used to predict future scenarios.

Change Prediction

The third and final step in the Change Analysis is Change Prediction. Using the historical rates of change and the transition potential model, LCM can predict a future scenario for a specified future date. In its simplest form, the model will determine how the variables influence future change, how much change took place between time 1 and time 2, and then calculate a relative amount of transition to the future date (Clarklabs, 2020). To remake the model more robust, the Land Change Modeler allows for the incorporation of constraints and incentives, such as zoning maps; and planned infrastructure changes, such as new roads or land cover development. Driver variables can also be dynamic in nature so that at regular interim intervals, they can be recalculated and reenter the model (Megersa Kebede Leta, Tamene Adugna Demissie, Jens Tränckner, 2021). For example, you may have as one of your driver variables distance from previously deforested areas. This variable could be recalculated at regular intervals as and cover transitions from forest to agriculture.

10.5. Hard classifying

The distinguishing characteristic of hard classifies is that they all decide the landcover class to which any pixel belongs. TerrSet offers a host of supervised classifiers in this group. Some like (MAXLIKE) means maximum likelihood, and this procedure is unquestionably the most widely used classifier in the classification of remotely sensed imagery.

10.6. Soft classifying

Contrary to the hard classifier, the sot classifier does not decide the landcover class to which each pixel belongs. Instead, they develop statements of degrees to which each pixel belongs to each of the landcover classes being considered. Thus, for example, a soft classifier might indicate that pixel has a 20.72 probability of being forest, a .24 probability of being pasture, and a 0.04 probability of being bare ground. A hard classifier would resolve this uncertainty by concluding that the pixel was a forest. However, a soft classifier makes this uncertainty explicitly available for various reasons (Clarklabs, 2020).

10.7. Markov model

Markov model has been widely used in ecological modeling (Nouri, J., Gharagozlou, A., Arjmandi, R. et al. , 2014). Markov model considers past states to predict how changes a particular variable over change modeling is promising because of its ability to quantify not only the states of conversion between land-use types but also the rate of conversion among the land-use types (Ye B., Bai Z., 2008). A homogenous Markov model for predicting land-use change is presented mathematically as follow;

$$L_{(t+1)} = P_{ij} * L_{(t)}$$

And

$$P_{ij} = \begin{bmatrix} P_{11} & P_{12} & \cdots & P_{1m} \\ P_{21} & P_{22} & \cdots & P_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots \\ P_{m1} & P_{m2} & \cdots & P_{mm} \end{bmatrix}$$

where, $L_{(t+1)}$ and $L_{(t)}$ are the land-use status at time t+1 and t respectively. ($0 \leq P_{ij} < 1$ and $\sum^{m}_{j=1} P_{ij}=1$, $(i,j= 1,2, \ldots ,m)$ is the transition probability matrix in a state.

10.7.1. Cellular Automaton Markov Model

A cellular automaton model is developed to investigate its utility in constructing scenarios of future urban land transformations (Clarke KC, Hoppen S, Gaydos L., 1997). CA-Markov model combines cellular automata, Markov chain, multi-criteria, and multi-objective land allocation to predict land cover change over time (BEHERA, M.D., BORATE, S.N., PANDA, S.N. et al., 2012). It adds into the Markov model not only spatial contiguity but also the probable spatial transitions occurring in a particular area over time. MARKOV and CA_MARKOV modules in IDRISI are used to create transition probability and transition area matrix (Adhikari, S.; Southworth, J., 2012). A transition probability matrix is obtained by cross-tabulation of two images of different times. It determines the probability of a pixel in a land-use class to change into another class during that time (Sylvertown J, Hotlier S, Johnson J and Dale P, 1992). On the other hand, a transition area matrix contains the number of pixels expected to change to a land-use class from another class during a period.

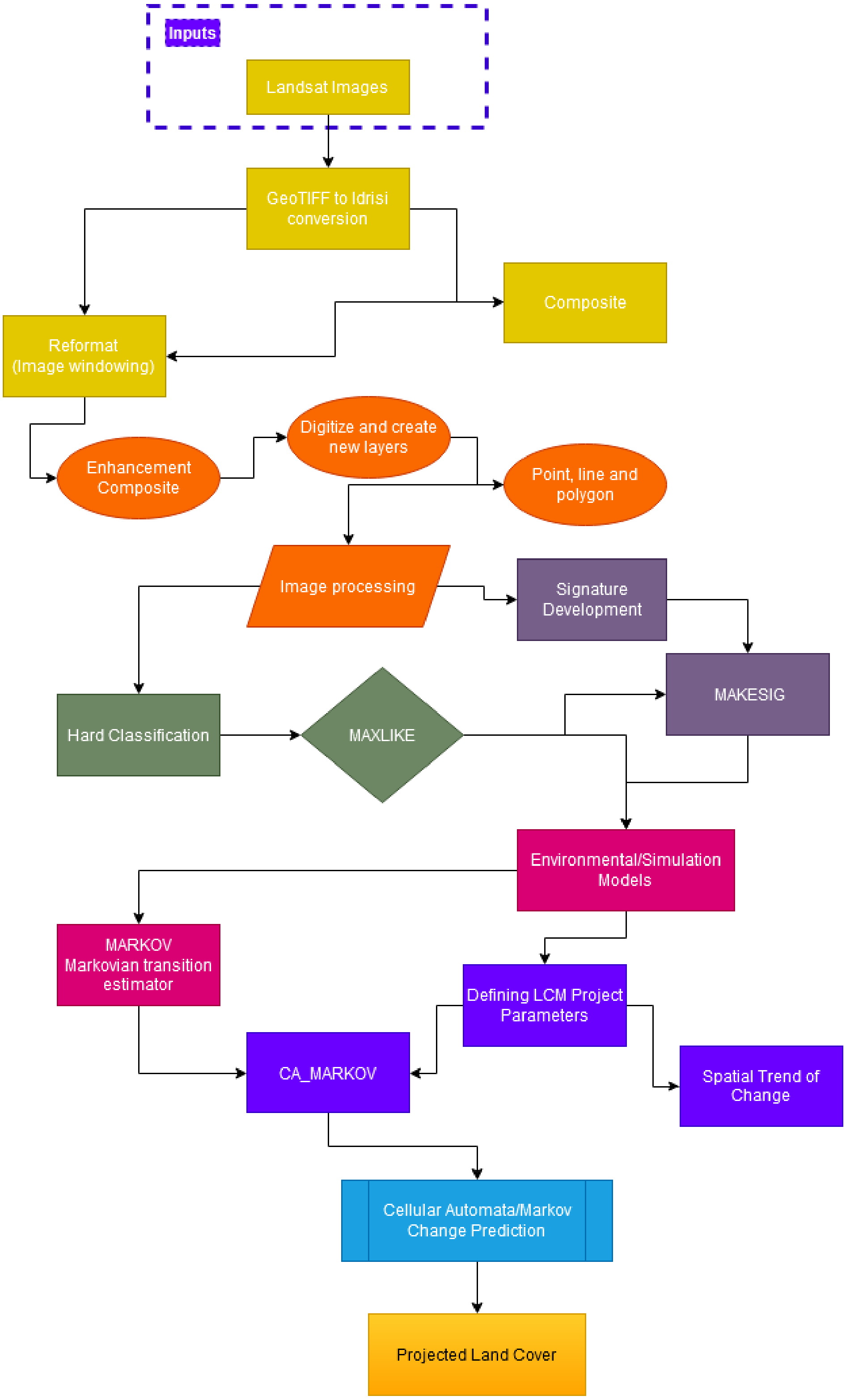


Figure 152: The research framework for remote sensing and modelling (by the author)

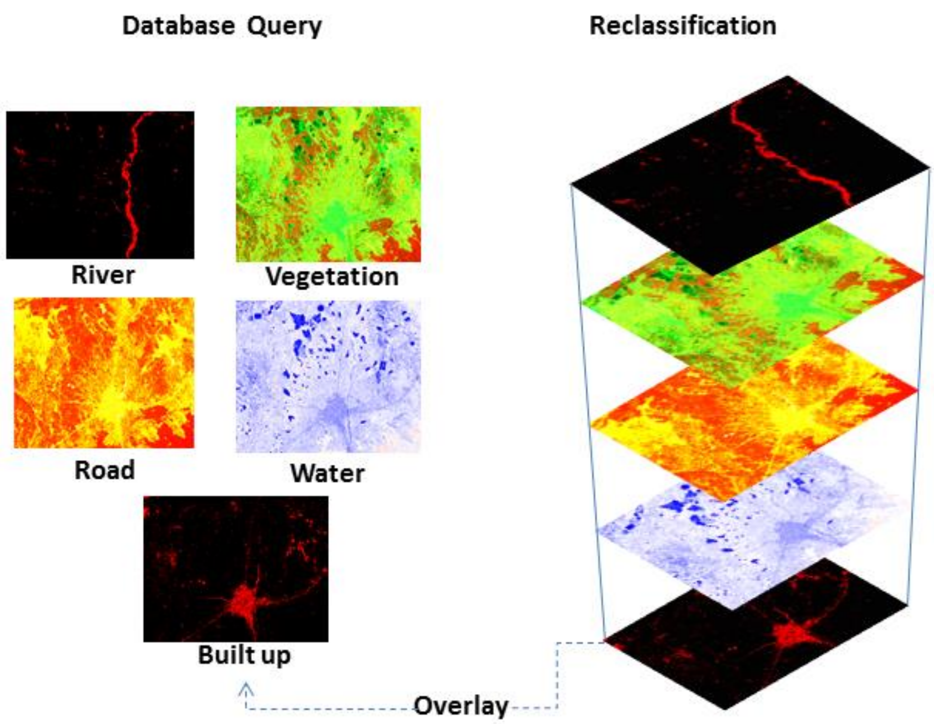


Figure 153: The classification and reclassification of the provided landsat images (by the author)

Land use/cover change

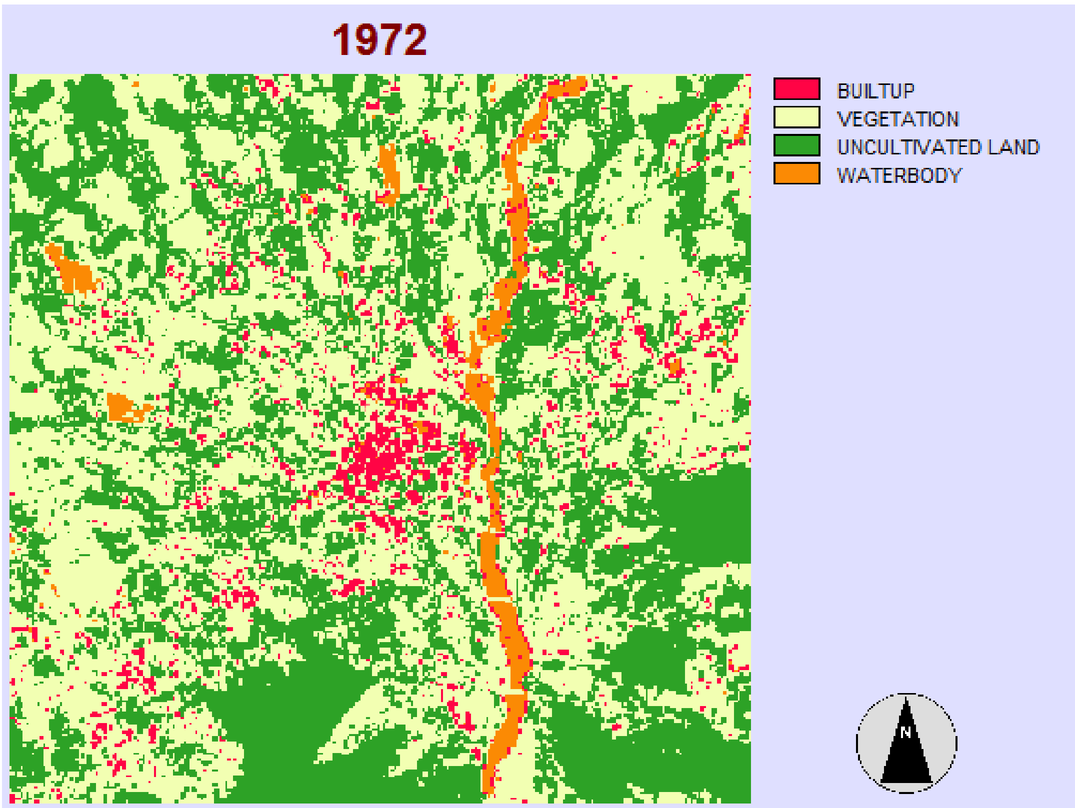


Figure 154: The classified land covers change of Sari city for the year 1972 (by the author)

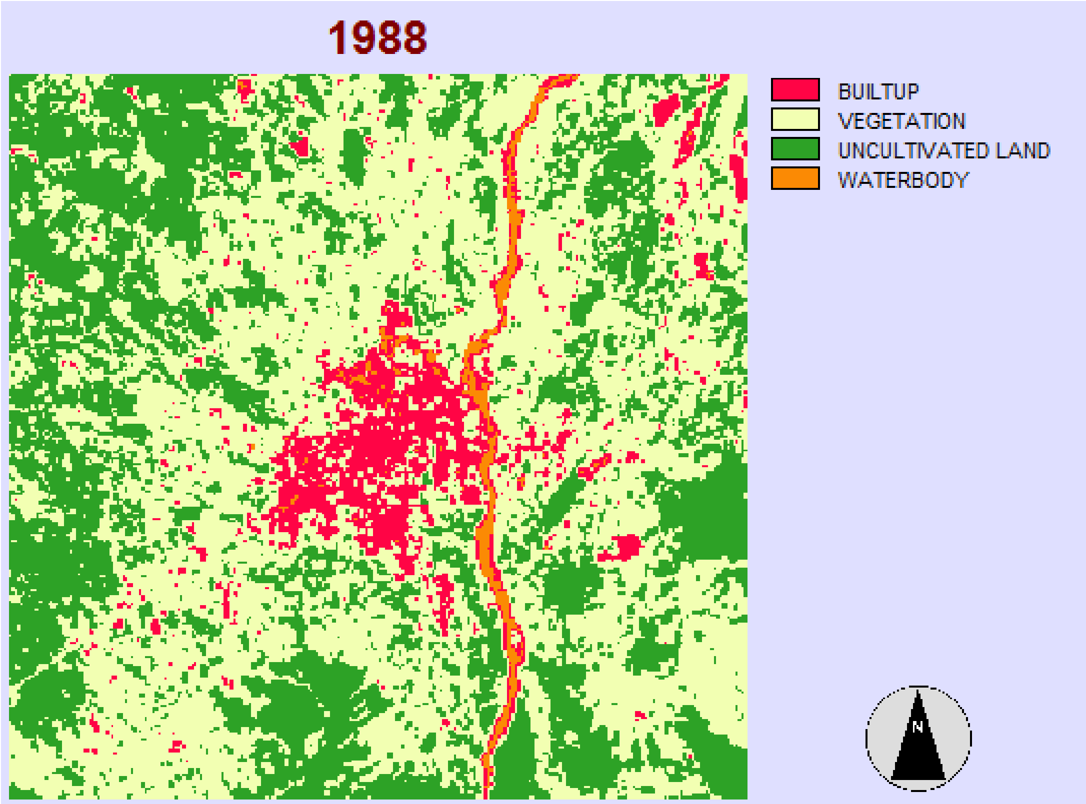


Figure 155: The classified land covers change of Sari city for the year 1988 (by the author)

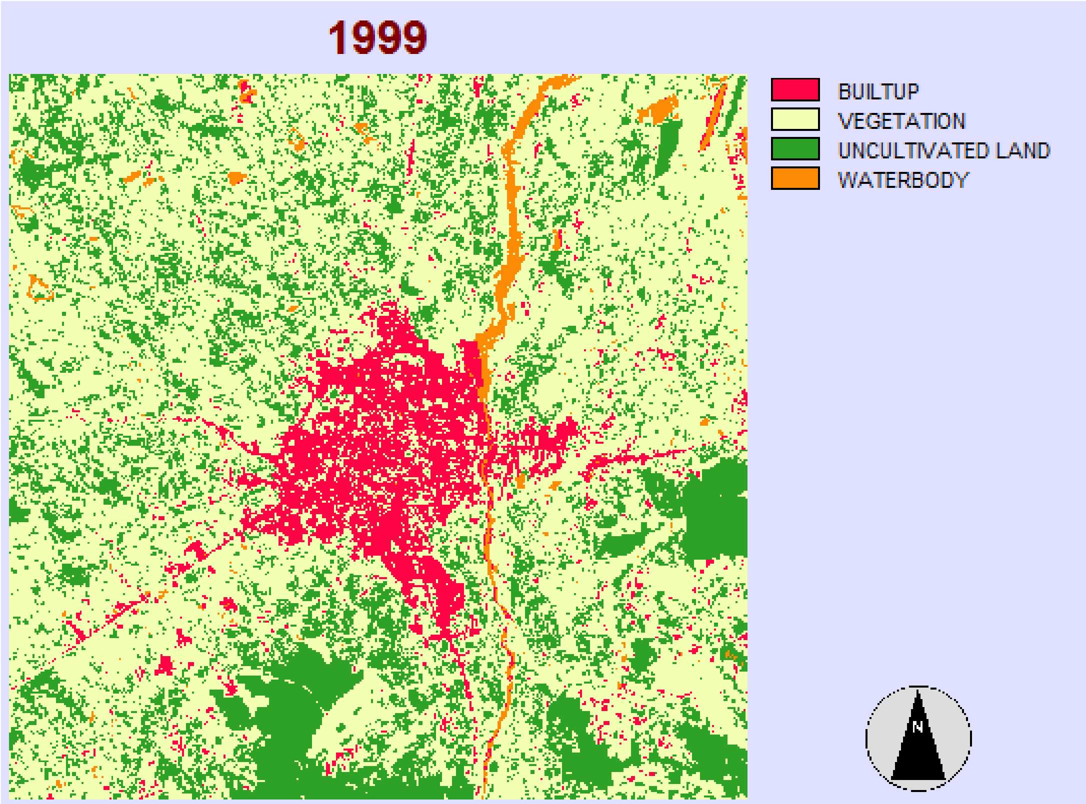


Figure 156: The classified land covers change of Sari city for the year 1999 (by the author)

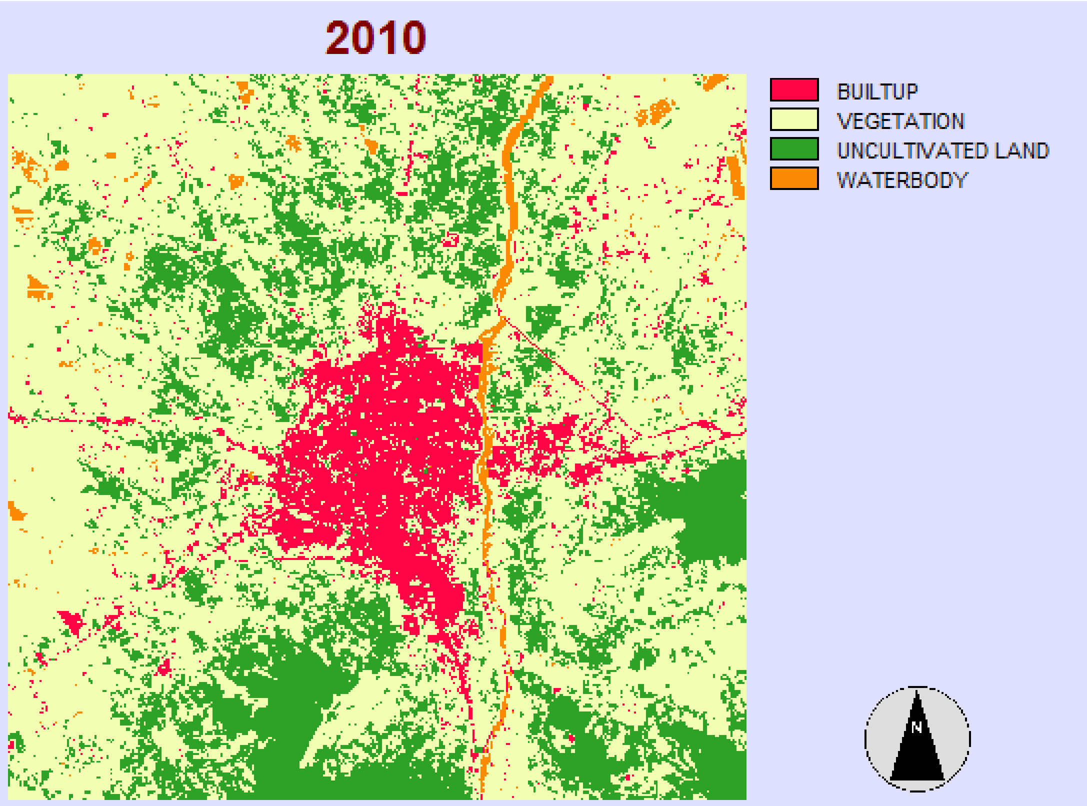


Figure 157: The classified land cover changes of Sari city for the year 2010 (by the author)

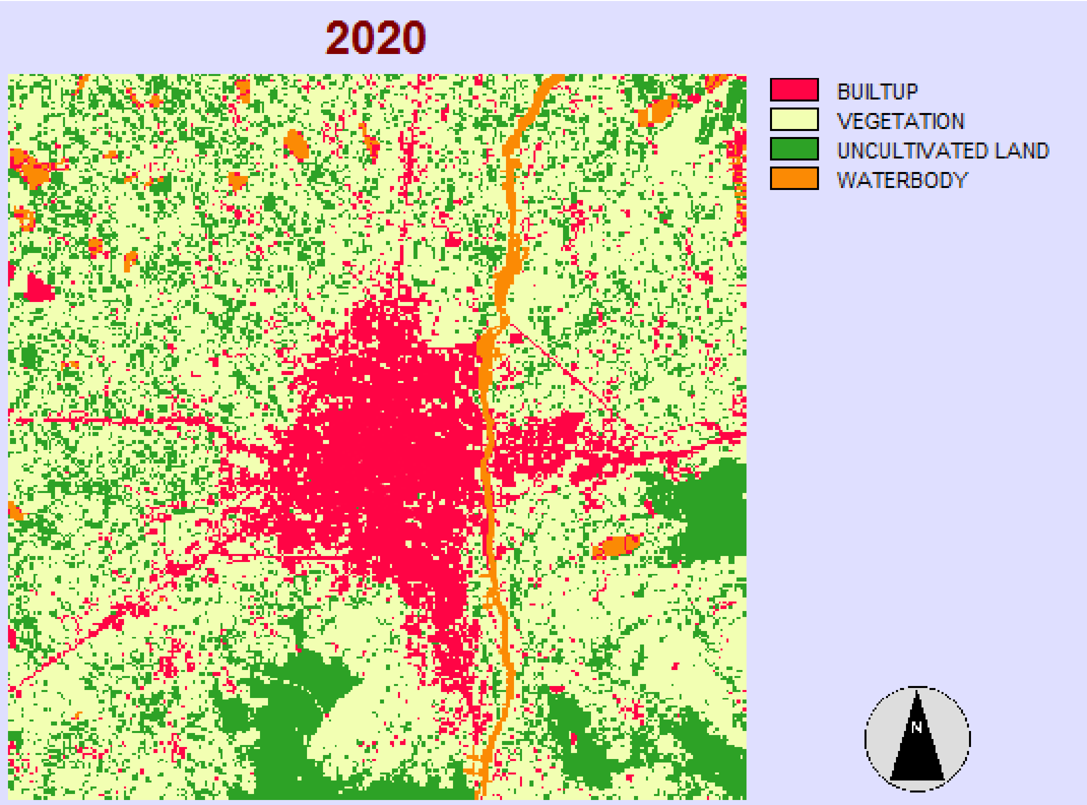


Figure 158: 2020 The classified land cover changes of Sari city for the year 2020 (by the author)

Table 70: Land Cover Changes of the Sari City, 1972-2020 (by the author)

.Categories/Time series	1972	%	1988	%	1999	%	2010	%	2020	%
BUILTUP	338.96	44.77	1216.08	63.31	1764.7	72.77	2234.69	62.19	3144.36	62.72
VEGETATION	312.92	41.33	501.8	26.12	448.92	18.51	1215.9	33.84	1674.2	33.39
UNCULTIVATED LAND	98.28	12.98	173.82	9.05	180.34	7.44	94.32	2.62	146.52	2.92
WATERBODY	6.92	0.91	29.15	1.52	31.07	1.28	48.37	1.35	48.29	0.96
Sum of the area of the Sari city (Hectares)	**757.08**	**100**	**1920.85**	**100**	**2425.03**	**100**	**3593.28**	**100**	**5013.37**	**100**

“Residential density od Sari city and projected population growth for this city”

Decades	1972	1988	1999	2010	2020
Population predicted based on the Modified Exponential Model	60108	161878	209188	290262	390452
Gross density of the population (Hectares)	79.39	84.27	86.26	80.78	77.88
The total density of the residential areas (Hectares)	177.33	133.11	118.54	129.89	124.18

Table 71: Population of Sari City, 1976-2016 (National Statistical Center of Iran, 2017)

Decades	1976	1986	1996	2006	2016
The total of the population according to the annual data	70753	141020	195882	259413	347402

The above table illustrates the physical expansion of the built-up area over the five decades. This study not only has tried to study the land cover changes of the city and also has studied periphery areas that surrounded the whole of the city. It helps to understand better and compare the land cover changes and figure out how these changes are for each decade. But should be noted, the presented results on the above table just are closed to the area that, specifically for this case, is named symbolic as "calculated area" Figure 160.

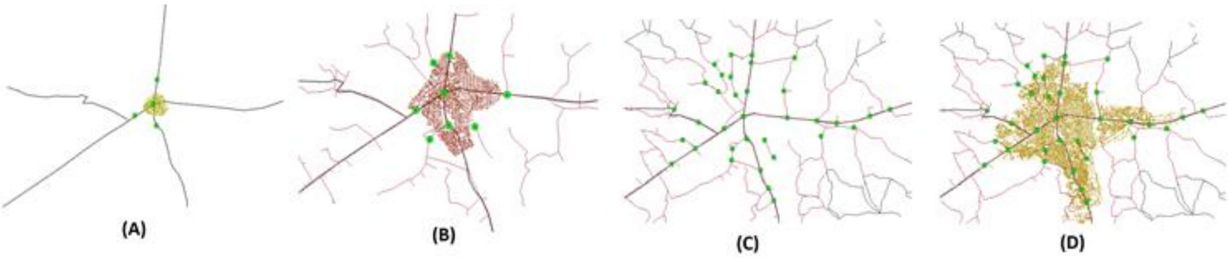


Figure 159: The simple dynamic model of the growth of Sari city that follows nodes and road development (by the author)

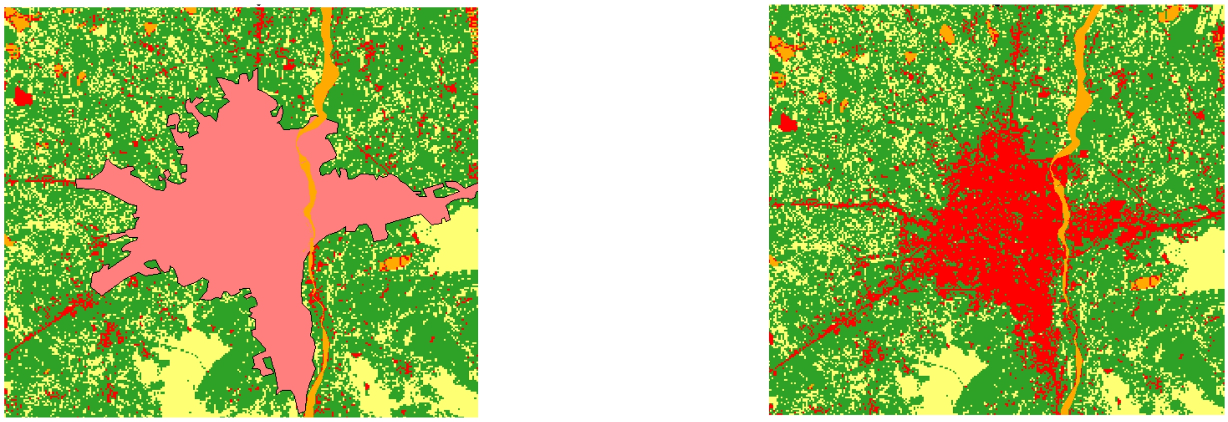


Figure 160: The built-up area within of the official border of the city (by the author)

According to the results shown in Table 71, the city has grown highly from 1972 to 2020 and has been facing a continuation of sprawl form of physical growth Figures 9-13. Area of the city under economic and social forces has been increased surprisingly. Concerning the results, just the city's built-up area in the 1972s was 338.96 hectares, and in the 1988s it expanded to 1216 Hectares, in 1999s became larger about 1764 hectares. In the 2010s, the area has progressed to 2234.69 hectares, and finally, in 2020s has expanded physically up to 3144.36 hectares Figure 165. According to the results, after five decades, today's city area is 9,3 times bigger than the area of the city in 1972 Figure 162.

According to the annual data, the city's population was about 60108 in the 1972s. And the final results show that the Built-up area was 44.77% of the city's total area, and the rest area was occupied by other land uses such as (Vegetation, Uncultivated land, and Waterbody) Table 71. But in the following decades, the area of the built-up zone compared to the other land use has dramatically changed Table 71, Figure 163, Figure 165.

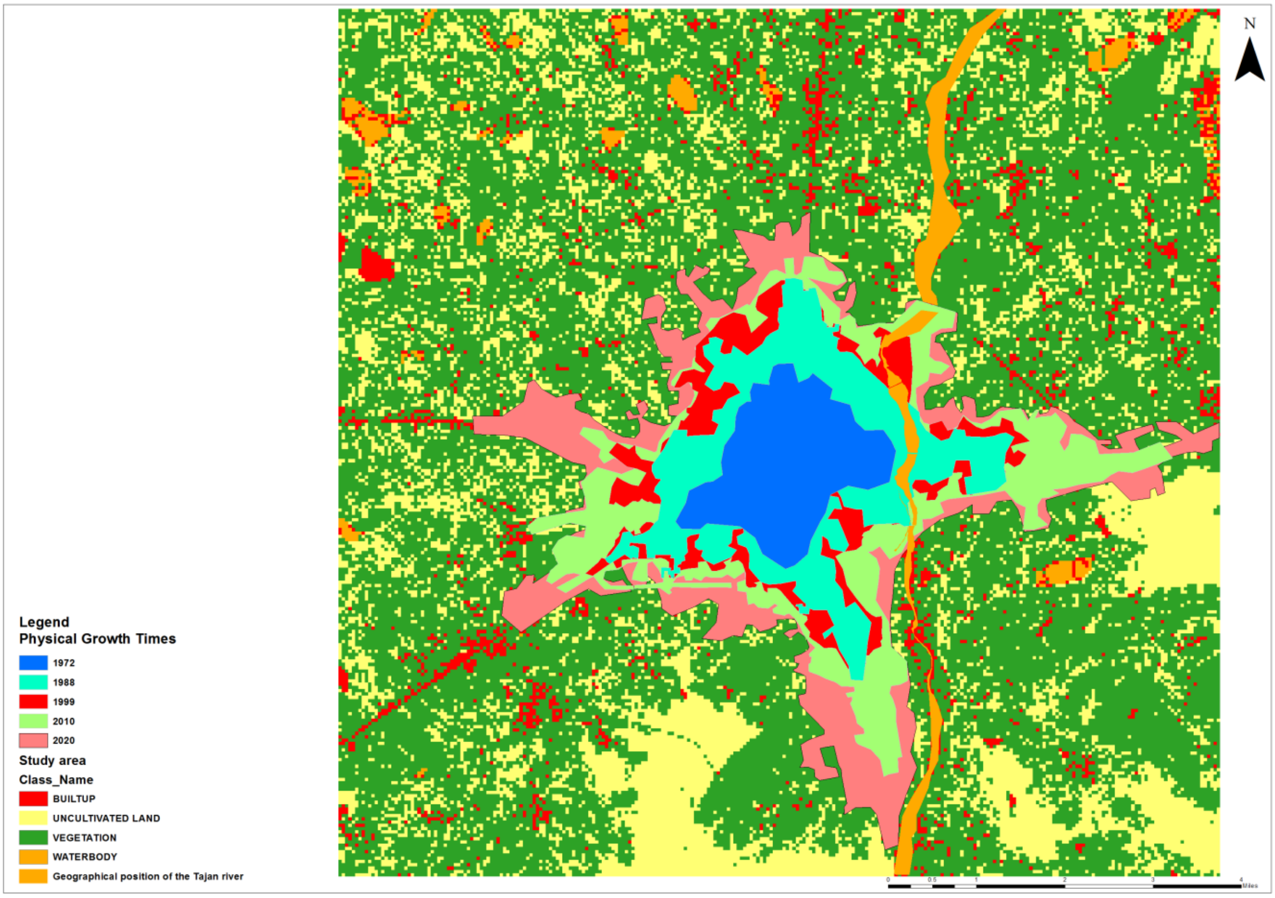


Figure 161 The physical growth stages of Sari city (by the author)

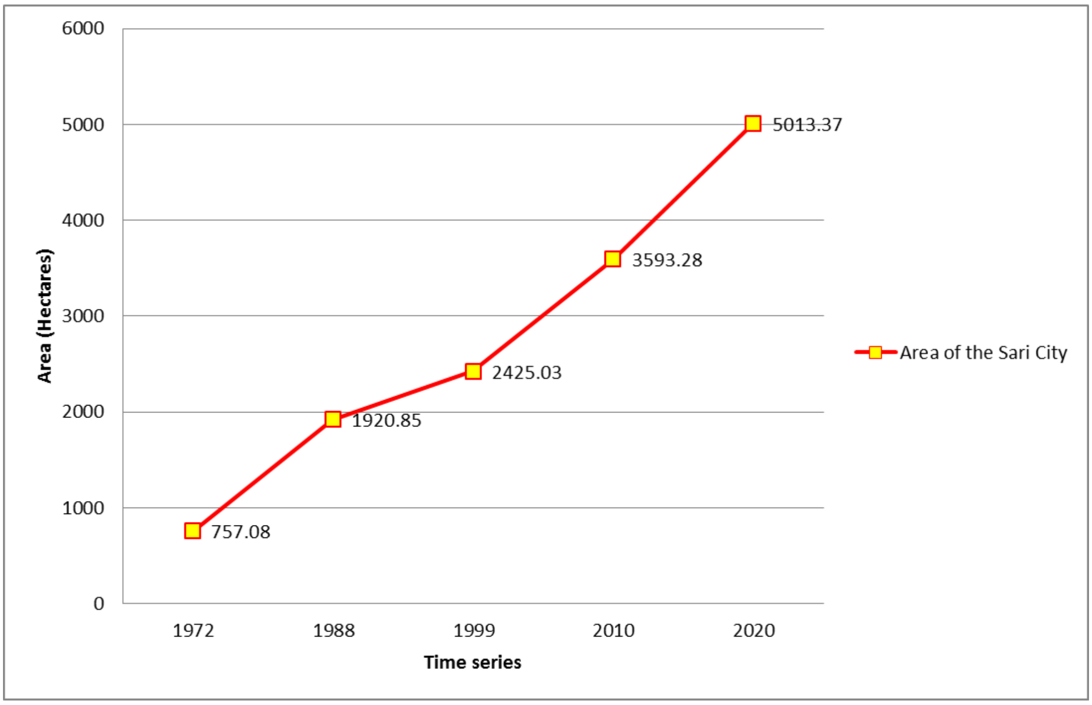


Figure 162 The physical growth of the city of Sari considering all land uses from 1972 to 2020 (by the author)

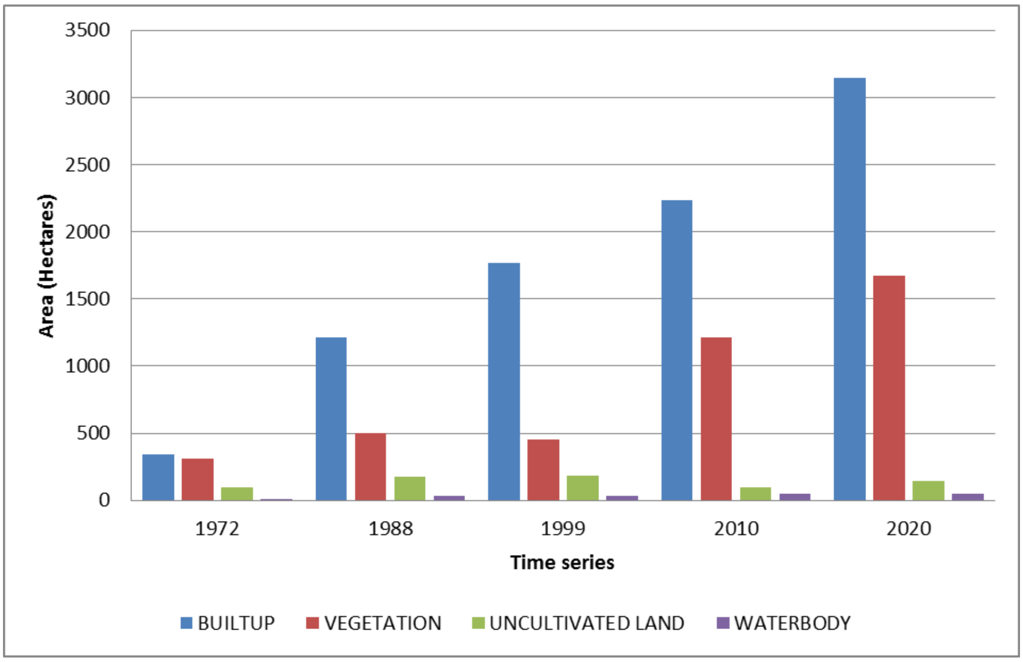


Figure 163: Changes of the area of Sari city including: Built-up, Vegetation, Uncultivated and water body over the last decades (by the author)

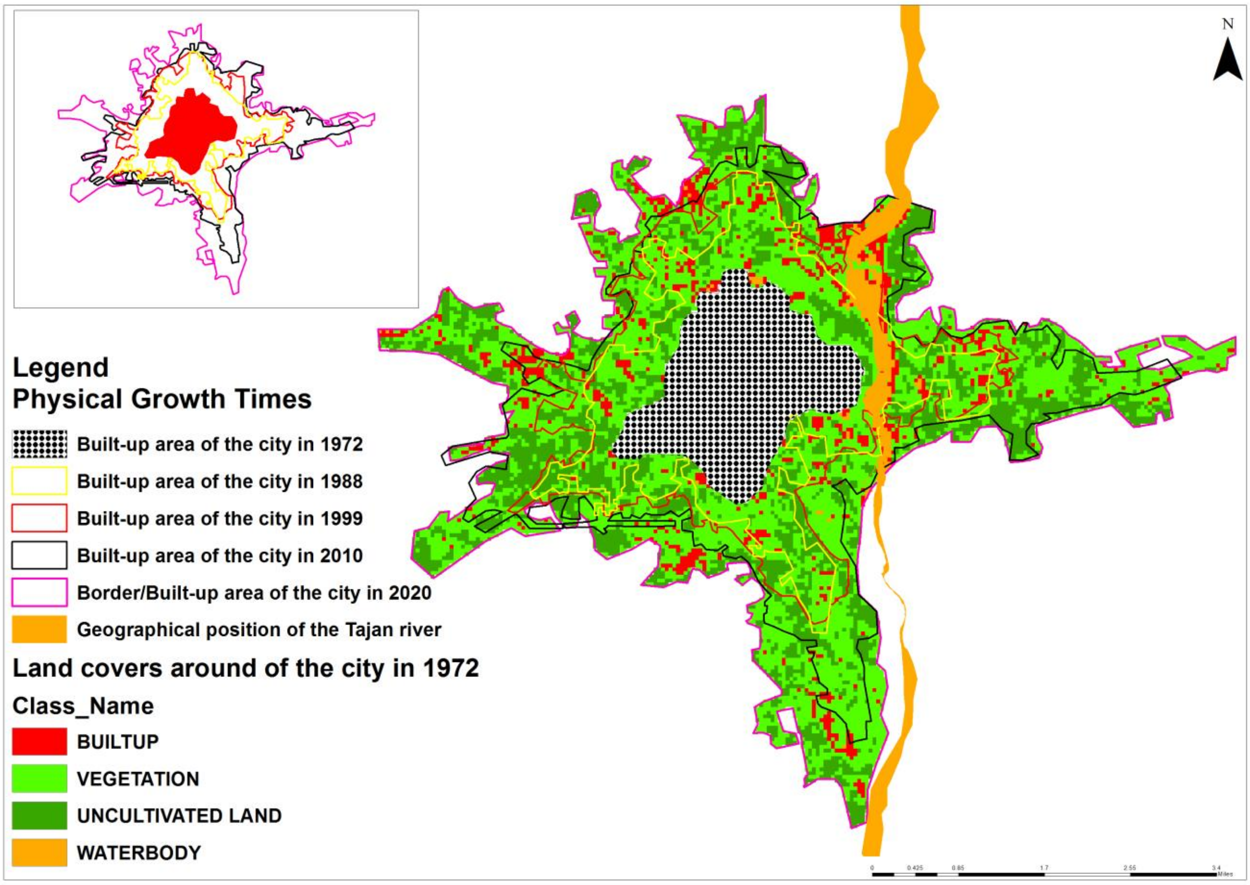


Figure 164 The physical growth of Sari city combined by the land cover changes from 1972 to 2020 (by the author)

After the 1972s, on the one hand, the city was faced with the dramatic growth of the built-up area, and on the other hand, the city lost the area of the other land uses, especially Vegetation. As is showed in Table 71, in 1972 rate of the built-up area was 44.77% and the Vegetation 41.33%, and in 2020 respectively are 62.72% and 33.39% Figure 164. In this figure, by colors, hachure and lines is incredibly represented a tremendous area of non-developed lands that have been replacing with Built-up area Figure 164. The hachured symbol shows the Built-up area of the city in the 1972s, and the other land covers area around the city is presented by red, light green, dark green, and gold colors. It is hard to imagine how these valuable land covers have been changed and replaced by buildings and asphalt.

Based on the results, the decade 1999 was one of the most dramatic times of land cover changes regarding these find out facts of this study that, the rate of built-up area was 72.77% and Vegetation 18.51%. It should be noted, according to the results of Elasticity Rate in chapter seven, between the "1986s-1996s," the city experienced the highest rate of elasticity from 1956 to 2016. It means the city has faced massive migration. Also, concerning the results of the "Isard Model" in chapter eight, between the 1996s, the city has experienced the highest rate of average Economic growth at the national level. Moreover, based on the results of the "Location Quotient Model" in chapter eight, in this decade, the city had been facing the highest rate of growth in the agriculture sector for about 1.209%. But in the service and industry sector rate of growth was not considerable. It means that the other forces are playing a role in this concept, such as economic polarization and expansion of a polar form of development at the national and regional level. The results of Rank-Size Role from 1986 to 2016 have approved domination of four big cities (Sari, Babol, Amol, and Ghaemshahr) in the urban hierarchies of this region. In Iran, 1961s "Growth Pole Theory" for the first time applied in the third national development plan to reduce social-economic imbalance first at the national and regional levels then locals. Actually, these four big cities have to share of development to the other places to reduce economic imbalance and reduce migration from rural and towns to the big cities or other developing areas that have more potential in the supply of jobs and other services to the dwellers. But as a result, the outcomes or what today is going on in the urban area is in contrast with the imaged goals of "Growth Pole Theory." According to the last annual data for the 2016s, Iran has 1242 cities and towns with about 59,146,847 dwellers. Surprisingly, 53.46% of urban populations are living just in 32 big cities with more than 250000 populations; meanwhile, these big cities just accounted for 2.58% of the total Iranian cities Table 72. Definitively it shows centralization in the urban system and concentration of population in the urban area. Why? What forces and performances have made such types of development plans fail? About urban development plans and planning systems in Iran and given answers to the above question discussed particularly in Chapter nine.

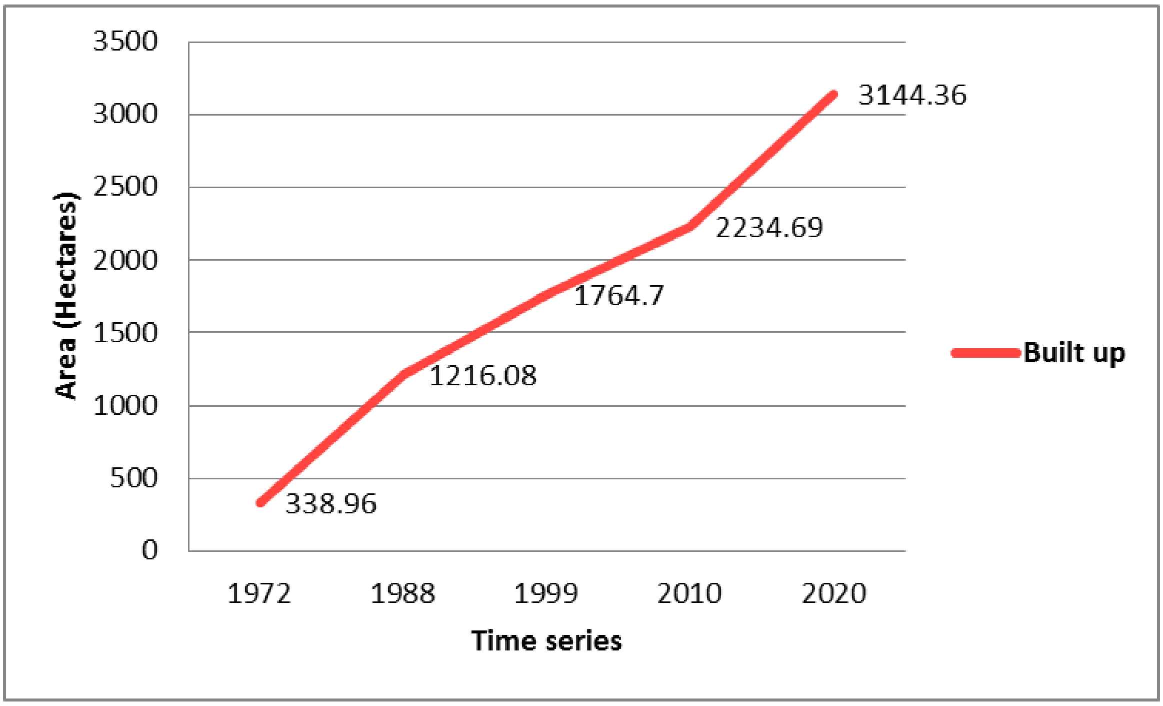


Figure 165: Physical growth of Sari city over the last decades (by the author)

Table 72, The lassification of urban areas considering population, Iran (by the author)

Size of the population of urban areas	Number of cities and Towns	Percent of cities and towns	Number of populations	Percent of Population
Urban areas with more than 250000	32	2.58	31,620,670	53.46
Urban areas with less than 250000	1,210	97.42	27,526,177	46.54
SUM	1,242	100	59,146,847	100

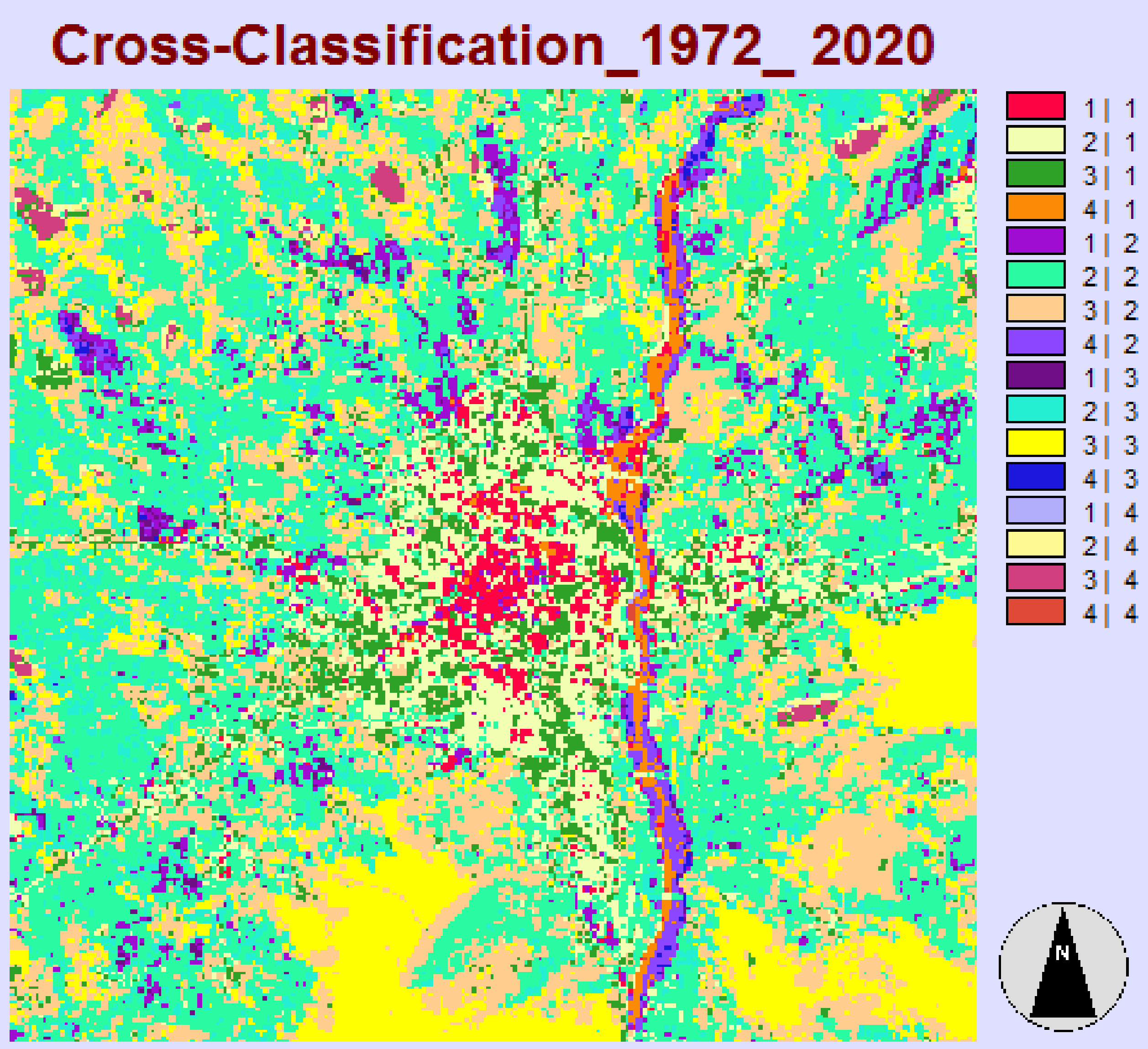


Figure 166: Changes in all land covers and comparison with each other between 1972-2020 (by the author)

Table 73 Changes of land uses from one type to the other type (by the author)

Types	Codes	Hectares	Percent of area	Converted to the type 1
BUILTUP	1	522	12 %	1 | 1
VEGETATION	2	3003.48	70 %	2 | 1
UNCULTIVATED LAND	3	473.4	11 %	3 | 1
WATERBODY	4	288.36	7 %	4 | 1

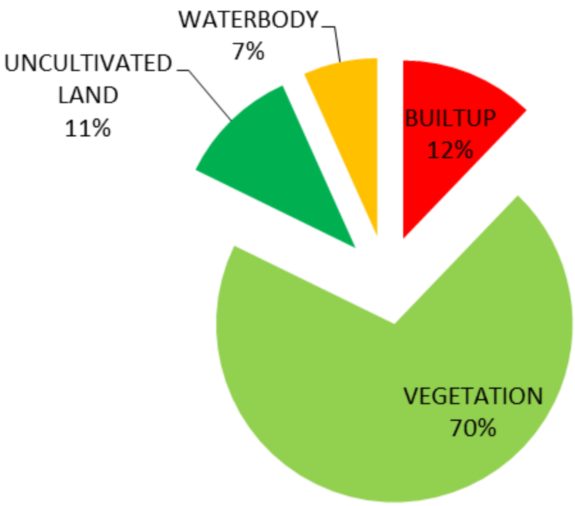


Figure 167 The graphical demonstration of land-use changes from one type to the other types (by the author)

Today's dramatic land covers changes resulted from five decades of political, social, and economic changes and the implementation of numerous development plans. The above picture demonstrates how land cover types have been changed into the other types Figure 166. The left side shows the changes of each land cover with predefined codes from 1 to 4. For every kind of land use are defined a code. For example, the number 1 is issued to the built-up area. The number 2 is issued to the Vegetation, the number 3 for the uncultivated lands, and the number 4 for the Waterbody Table 73.

According to the find outs of this study, after the 1972s, about 4287.27 hectares of land covers have been changed. This study has provided a transition map to better grasp how critical the intensity of these changes is. This map illustrates how the studied land covers around the city, such as vegetation, uncultivated land, and water body, have been changed into the built-up covers from 1972 by 2020; (see Figure 168). In this map, the red color symbolizes the lost land covers, and the green color indicates the gained lands with the green cover.

Surprisingly, the city has been lost about 3765.24 hectares of valuable lands with green covers, which changed into the built-up areas, approximately 87.82% of the total land covers of the city. About 3003.48 hectares of the uncultivated lands that accounted for 70% of the total area have been changed into the Built-up surfaces

Figure 167. Also, 473.4 hectares of Uncultivated land and 288.36 hectares of the Waterbody have been transformed into the Built-up area. Would you mind taking a look at Figure 164 and comparing it to Figure 166? It helps to understand better the land covers transformation in terms of scale and types in this area.

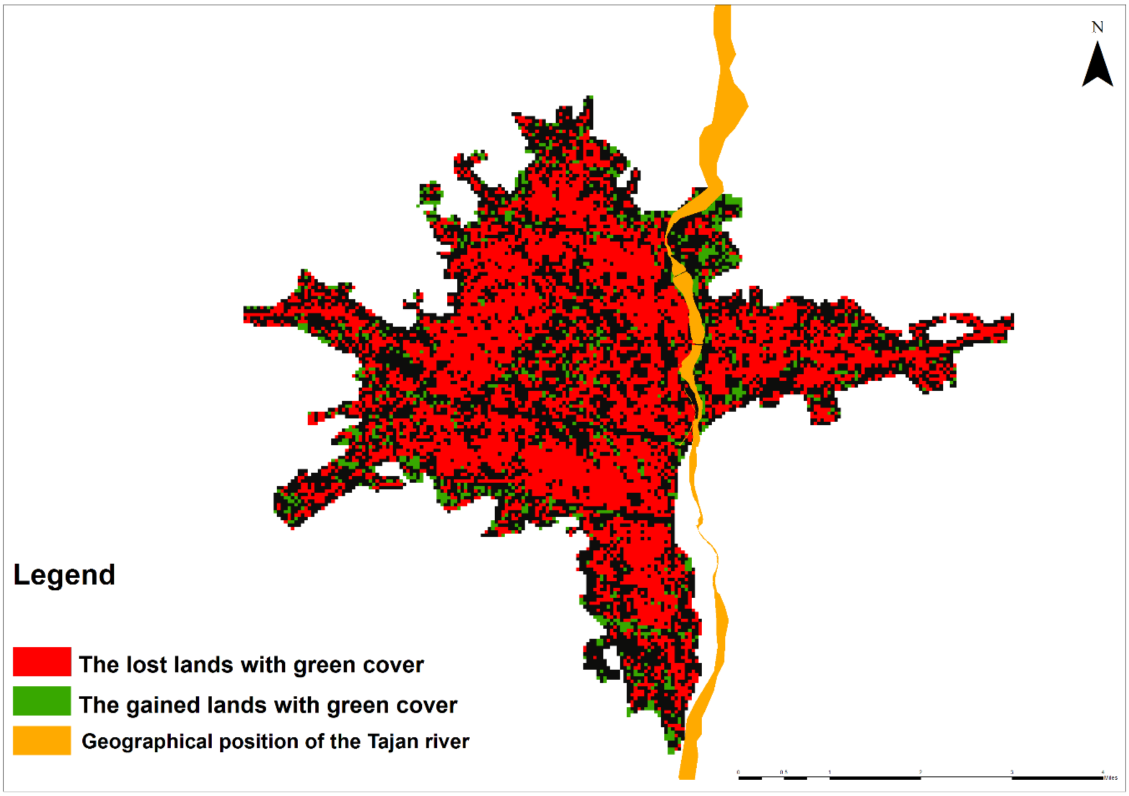


Figure 168 The map of changed land covers from 1972 to 2020 (by the author)

Spatial analysis on the transformation of the land cover

In general, the age of the current old texture of the Sari city back to the last century, and also some of them back to 250 years ago. The city was recognized as the capital of the Persian empire by Agha-Mohammad-Khan-e-Qajar[13] in 1796. It has affected the physical body of the city. But after the foundation of the Pahlavi dynasty by Reza Shah in 1925, the city had been built up according to reformist and modernist ideas of the Reza Shah, which had been applied to all Iranian cities. And today, the modern zones of the city with a different landscape differ obviously from the old texture. Over decades, the city has experienced physical growth in different scales and directions

13 He was king of Iran that time and the founder of the Qajar dynasty.

due to the different implemented strategies regarding governments' desires. For example, as mentioned above, political changes have played a significant role in changing and giving new functions to the city directly and indirectly. For example, this city is the capital of this metropolitan area and plays a tremendous position at the regional and national levels. Giving this city's new role to be a capital with administrational functions has also played considerable roles to be populated more than other cities in this metropolitan area. It had directly helped in the foundation of many central government organizations and offices and has provided valuable social-economic opportunities for this city and thousands of new many jobs. As a result, the city became one of the interesting places for migrants from elsewhere at the regional and national levels.

In general, the settling of people in the city follows the price of land parcels. Since the land value for around or outside the city's border is cheaper than the center or main body, it has provoked landowners to segregate agricultural lands informally and sold to the people for building new houses Figure 169.

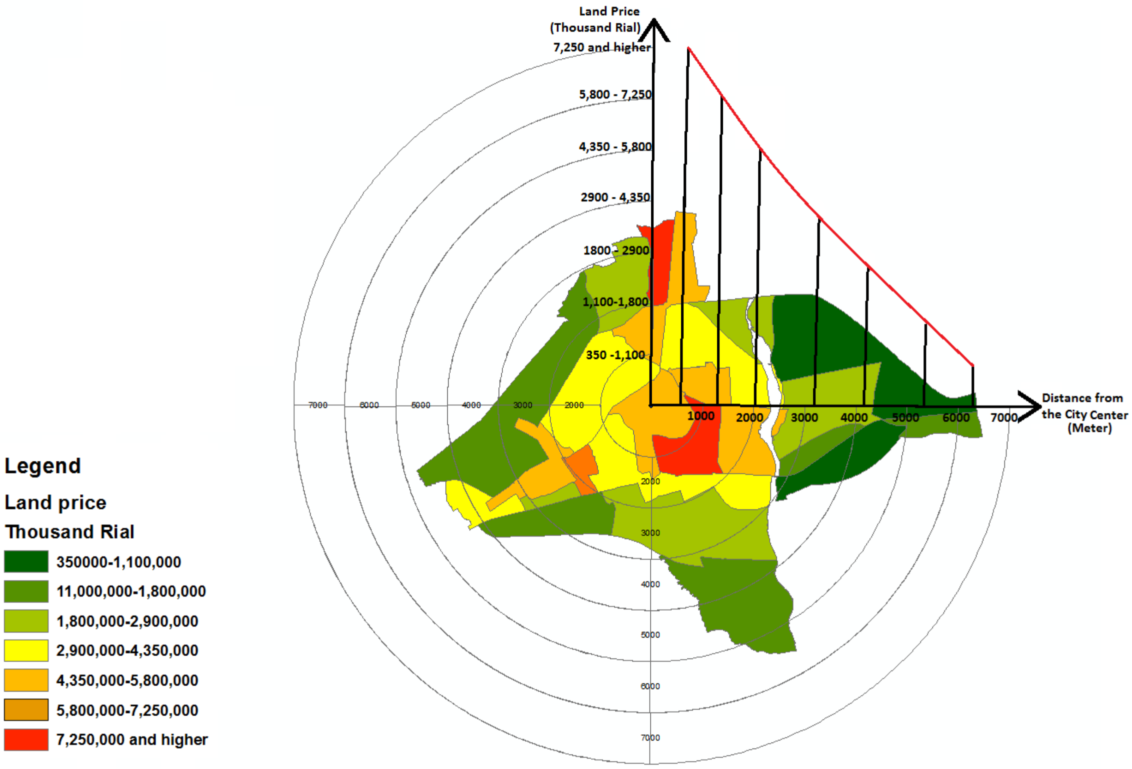


Figure 169, The radar graph of land values (by the author)

It should be noted, in Iran, according to the urban law "Article 100," the people are allowed to construct without a building permit and illegally, and finally, under cover of this role, they will be received a "Building permit." So this inappropriate legal article makes all urban plans affectless and powerless in the urban growth and formation process. In other words, under supports of this article, there is no matter how and where the people building and will be no paid attention to the city development plans, principles of urban design, and architectural factors. In such conditions, an urban planner can imagine how much dramatic the growth and development of a city can be in Iran. The city has been grown in sprawl form, and every day the people in the corners of this city start to construct a building illegally. Places with cheaper lands will be the most interesting locations to settle by the people. So this is one of the main factors that has been segregated the physical growth and borders of the city. The growth of the city in the north and northwest side is more segregated than the other sides. In the generated Cubic Trend map for the Vegetation to the Built-up area, the man illustrates many rings with different colors. In the map, the areas with the more intense change are indicated by the highest value of 0.30 and also colored with the strongest red Figure 170. The values between 0.30 up to 0.18 show the zones with the highest intensity rate, and the values between 0.14 to -0.34 show the area with sprawl growth and lowest intensity Figure 170.

Roads are the other main factor that have progressed the continuation of sprawl growth. Because as mentioned above, most of the new residential areas and buildings have been constructed in the informal segregated agricultural lands and without basic urban infrastructures. And in such conditions, people for building tend to find some places with more accessibility to the other parts of the city and services, like the transportation system. After an interview with home builders, people, experts of the "Home, Road, and Urban Development Organization," and also three years of practical experience of the author in the "Commission Article 5[14]" and working with

14 The Comission Article 5 is a government organization and branch office of the ministry of Housing, Road and Urban Development in Iran. Some main tasks of this comission are: controlling and analyzing urban development plans, apllying new

more than hundreds documentation, the results shows that accessibility to the road networks is one of the main criteria that determine the price of land parcels in this city. So, that's why in this city many people built up their homes near the main roads. In this city, there are six highways, and significantly the physical form of the city follows the location and direction of the roads; please take a look at Figure 171.

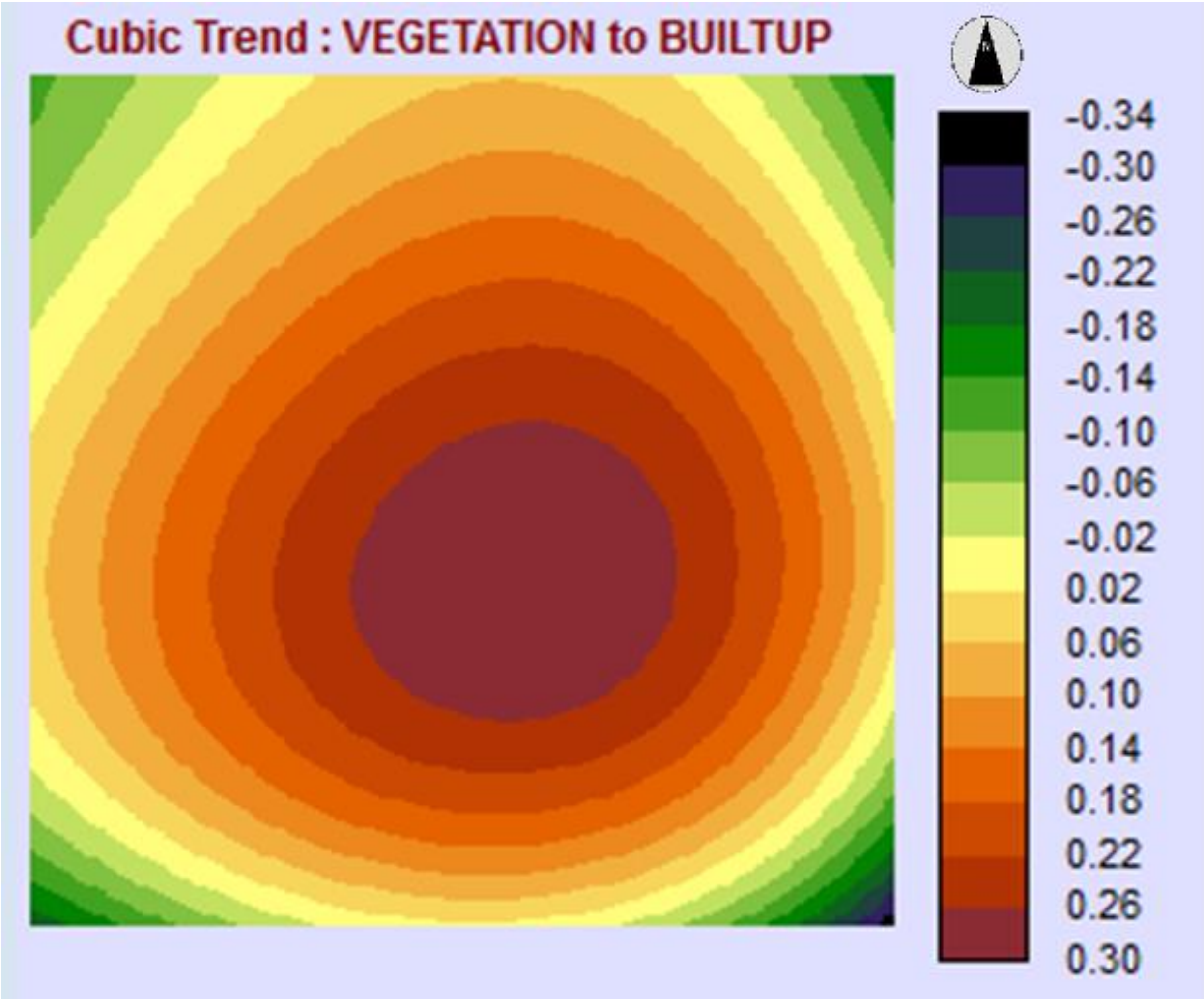


Figure 170 The Cubic Trend map for the change of Vegetation to the Built-up area (by the author)

As the above picture shows, the areas with the more intense change are indicated by the highest value of 0.30 and also colored with the strongest red. The values between 0.30 up to 0.18 show the zones with the highest intensity rate, and the values between 0.14 to -0.34 show the area with sprawl growth and lowest intensity.

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changes in the plans, dission-making for the all applications from applicants around changing type of land use, density of buildings, giving permit to the land segregations.

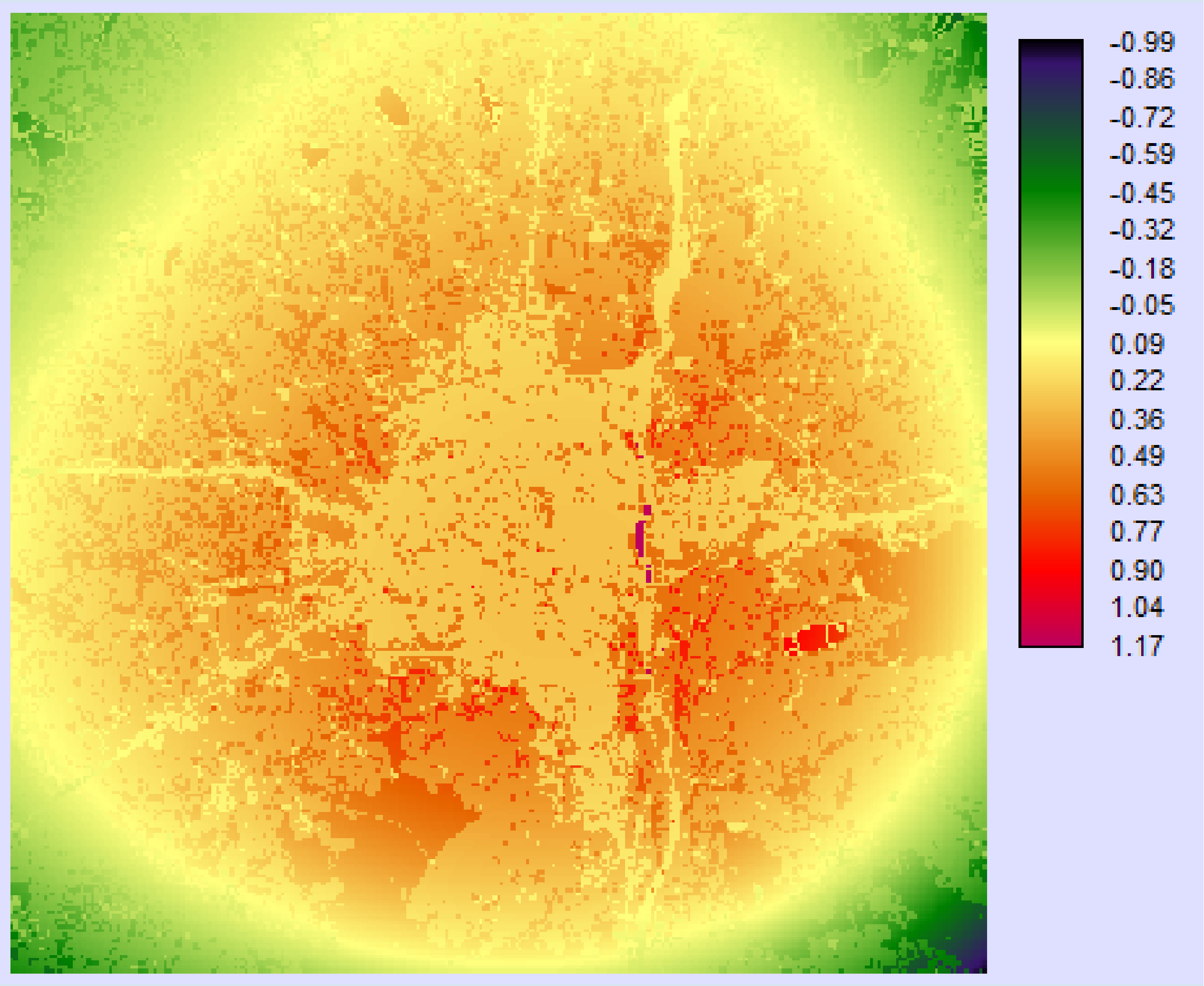

Figure 171 Illustration of the Built-up area, particularly roads (by the author)

As the above picture shows, the city has six highways, and significantly the physical growth of the city follows the roads.

Table 74: The projected land cover changes for the following decades 2030, 2040, and 2050 (by the author)

Decades	**2020**	**2030**	**2040**	**2050**
Built up area (Hectares)	3144.36	4154	4873	5548
	(regarded as the start point)	Predicted changes for each decade		

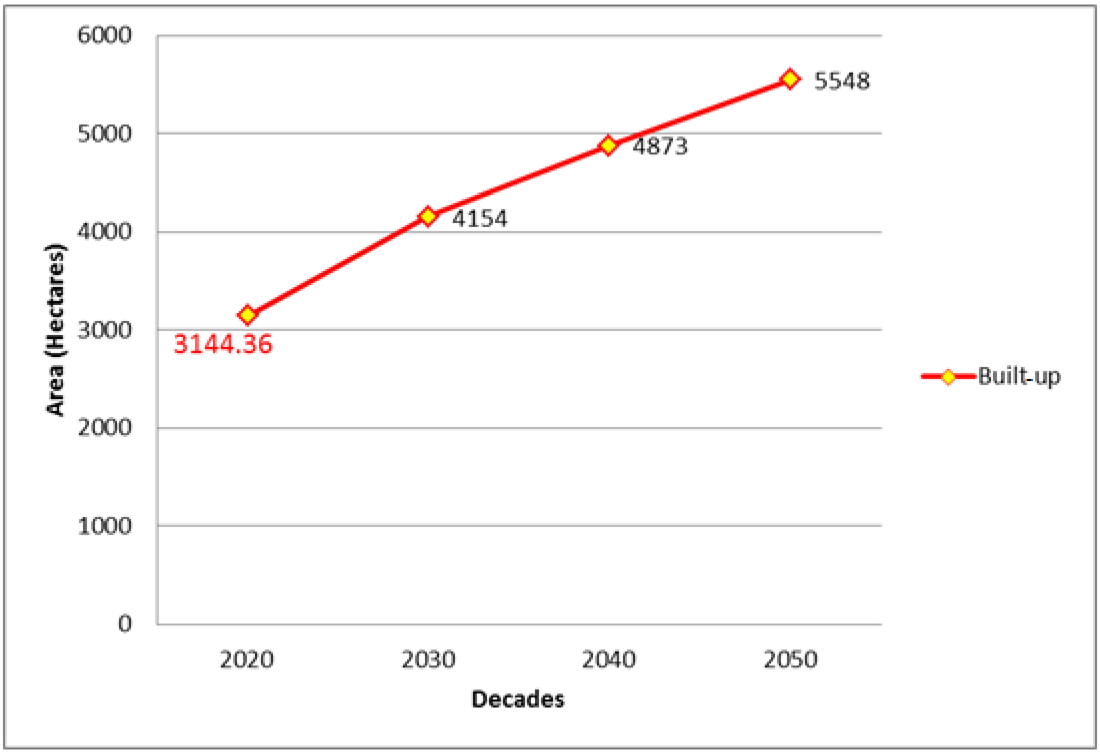

Figure 172 The projected growth of the Built-up area in the following decades 2030, 2040, and 2050 (by the author)

The projected land use changes for the 2030s

Table 75 Physical growth of the Built-up area for the projected decade 2030 (by the author)

Category	Hectares	Legend
Built-up	4154	BUILTUP

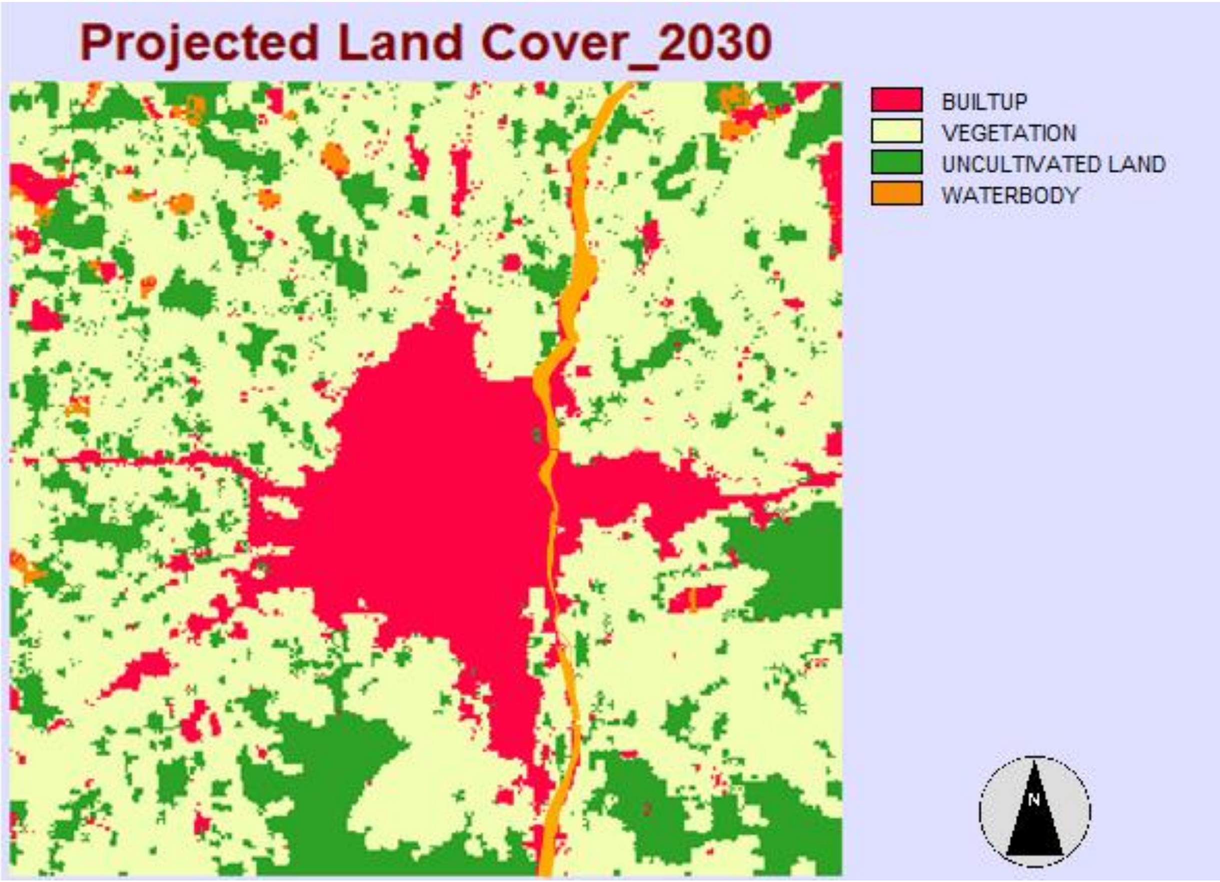

Figure 173 Projected land use changes for the decade 2030 (by the author)

The projected Land use changes for the 2040s

Table 76 Physical growth of the Built-up area for the projected decade 2040 (by the author)

Category	Hectares	Legend
Built-up	4873	BUILTUP

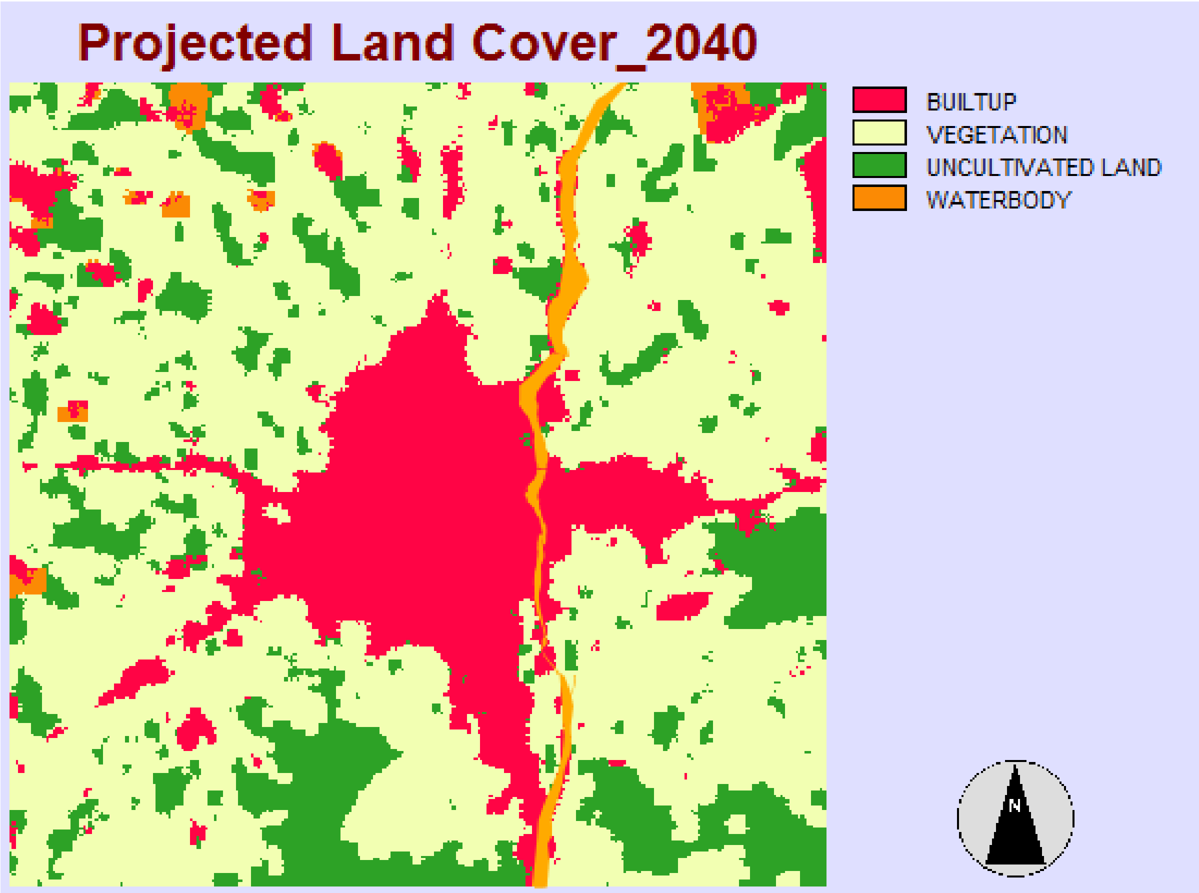

Figure 174 Projected land-use changes for the decade 2040 (by the author)

The projected land use changes for the 2050s

Table 77 Physical growth of the Built-up area for the projected decade 2050 (by the author)

Category	Hectares	Legend
	5548	BUILTUP

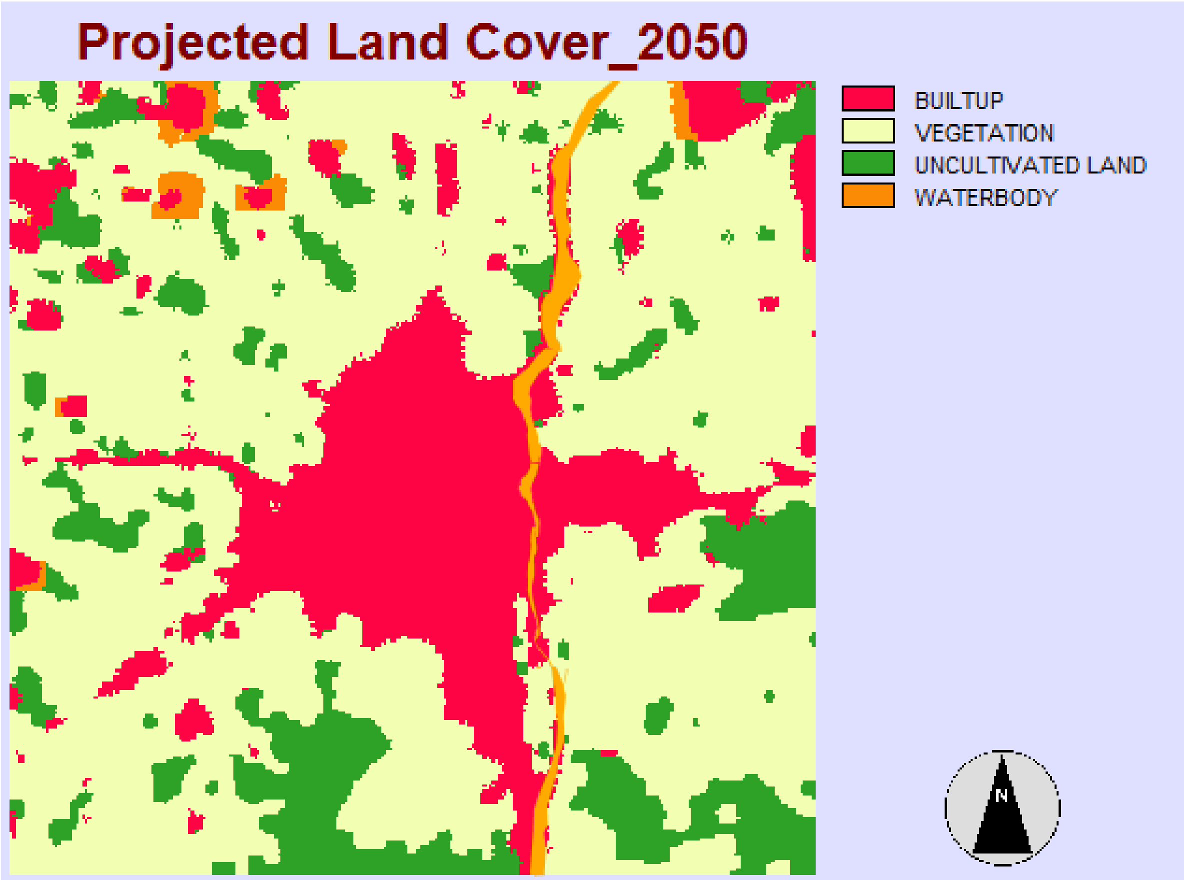

Figure 175 Projected land use changes for the decade 2050 (by the author)

For this case, this study mainly has focused on urbanization and sprawl growth. Accordingly, predictions of land-use changes primarily have concentrated on the urban physical growth that was defined here as the Built-up area. This study has projected forecasting the growth of the Built-up area for the three next decades, respectively 2030s, 2040s, and 2050s. The results of the LCM model have represented a significant sprawl growth that can happen in this city over the following decades. Of course, this study has made these predictions based on the LCM model and considered the city's historical land-use changes to show how the city has been grown physically over the last half-century.

The first prediction is projected for the 2030s, and the results show the continuation of dramatic land-use changes for this decade Figure 28. The Built-up area will be expanded to about 4154 hectares Table 75. Please consider, as shown by the results, the Built-up area of the city in the 2020s was 3144.36 hectares Figure 172. Unfortunately, the city will be faced with continuing the uncontrolled and unsustainable expansion of the built-up area to about 1010 hectares.

The results of the second prediction for the 2040s have shown the continuation of non-sustainable physical growth Figure 174, and surprisingly an increase from 4154 hectares to about 4873 hectares Table 76. It means the city in the 2040s will be experienced an explosion of physical sprawl growth for the built-up area in a total of about 1729 hectares for the following two decades. In other words, the model has predicted a grows about 893 hectares more than the built-up area indicated for the 2030s Figure 172.

The results of the third prediction for the 2050s have shown the continuation of this non-sustainable growth for the Built-up area Figure 175. The Built-up area will be expanded to about 5548 hectares; in other words, it is about 2403.64 hectares bigger than the area of the built-up sector in the 2020s Table 77. In the following, the study has provided more details to explain the main reasons for this non-sustainable growth and what forces are still the main drivers of this extreme land cover changes, particularly around and outside of the official borders of the city.

Chapter Eleven

Land Use Changes around the Border of Sari City

Urbanization and polarized development, unequal access to resources, facilities, and jobs, especially in small-sized cities and rural areas, has increased migration to this city. As a result, the city became bigger and bigger also more populated. For more information, please go to chapters eight and nine because these chapters discussed more about that and explained the main reasons specifically. In this chapter, objectives are concentrated exactly on the quantity and quality of land use changes and answer to the following questions.

Is the city of Sari encounter with uncontrolled or remarkable land-use changes?

If yes, why, how, and where happened these land-use changes?

Where happened the most land use changes and why?

What type of land-use changes happened inside or near the border and periphery areas of this city?

What form of growth and development is facing this city considering the pattern of the land-use change?

What type of land use changes happened mostly? Why and where?

What type of land use changes happened minimally? Why and where?

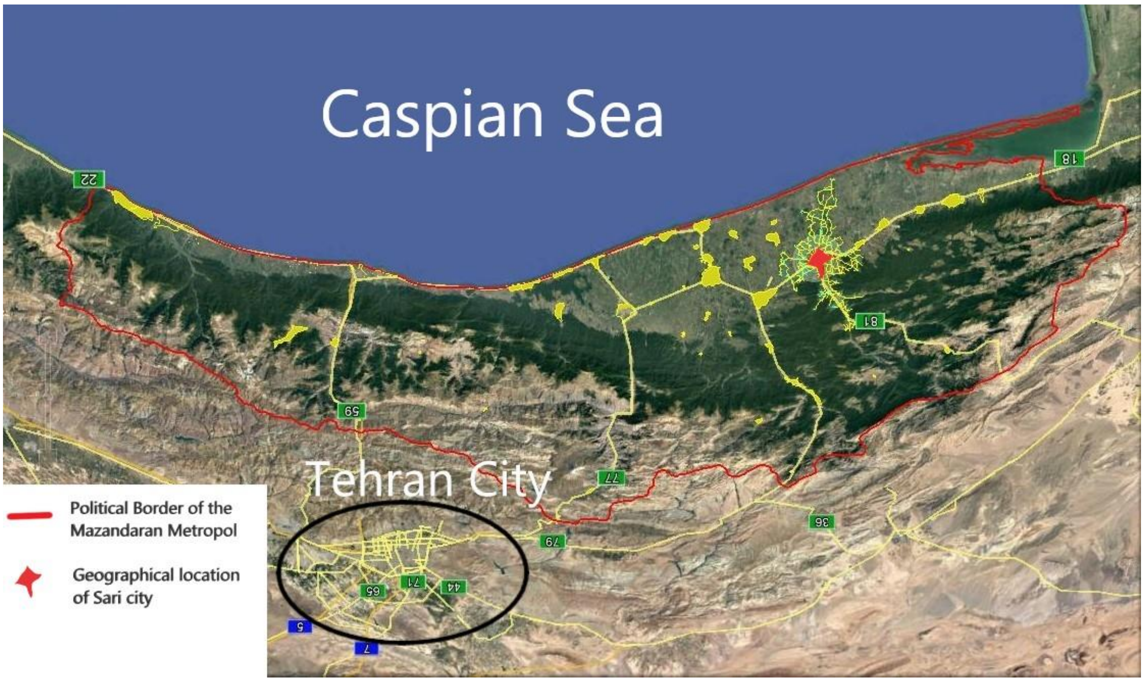

Figure 176 The hybrid map of the geographical location of Sari city in the Mazandaran Metropol (by the author)

As the above picture shows, the red polygon distinguishes Sari from other cities with yellow polygons.

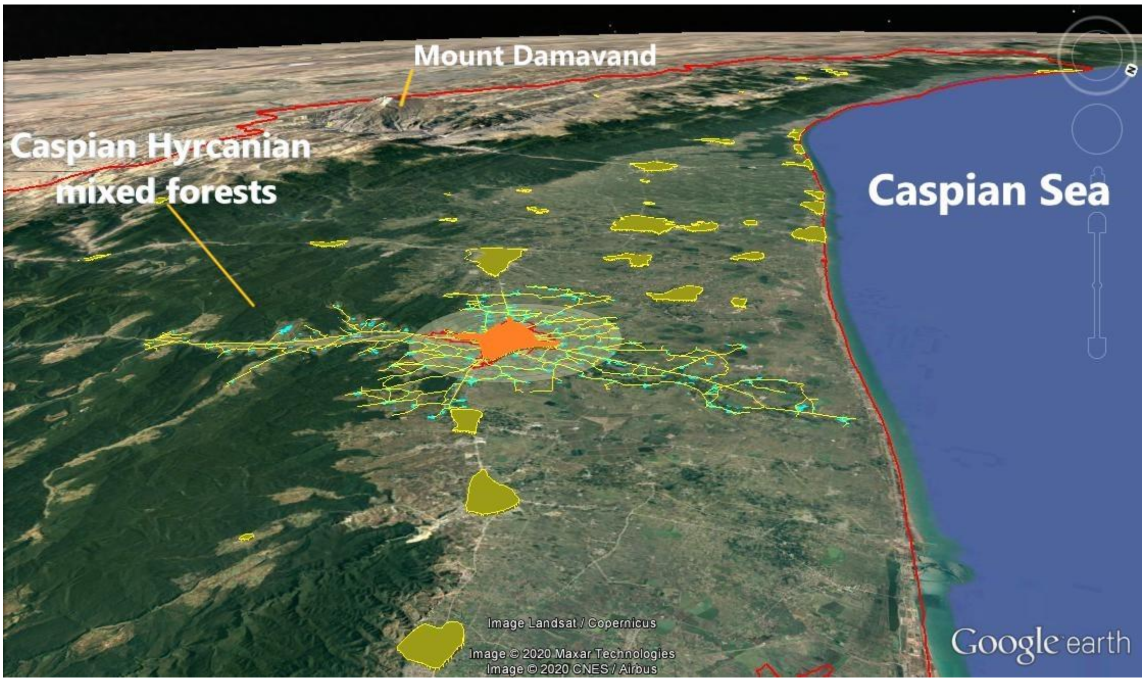

Figure 177 The hybrid map of the sphere of influence of Sari city at the local and regional levels (by the author)

As the above picture shows, the yellow lines show the road network in the city's sphere of influence in the Sari district. The yellow polygons show the location of all cities in this metropolitan area, and the red line shows the political border of this Metropol.

Figure 178 The hybrid view over the studied area (by the author)

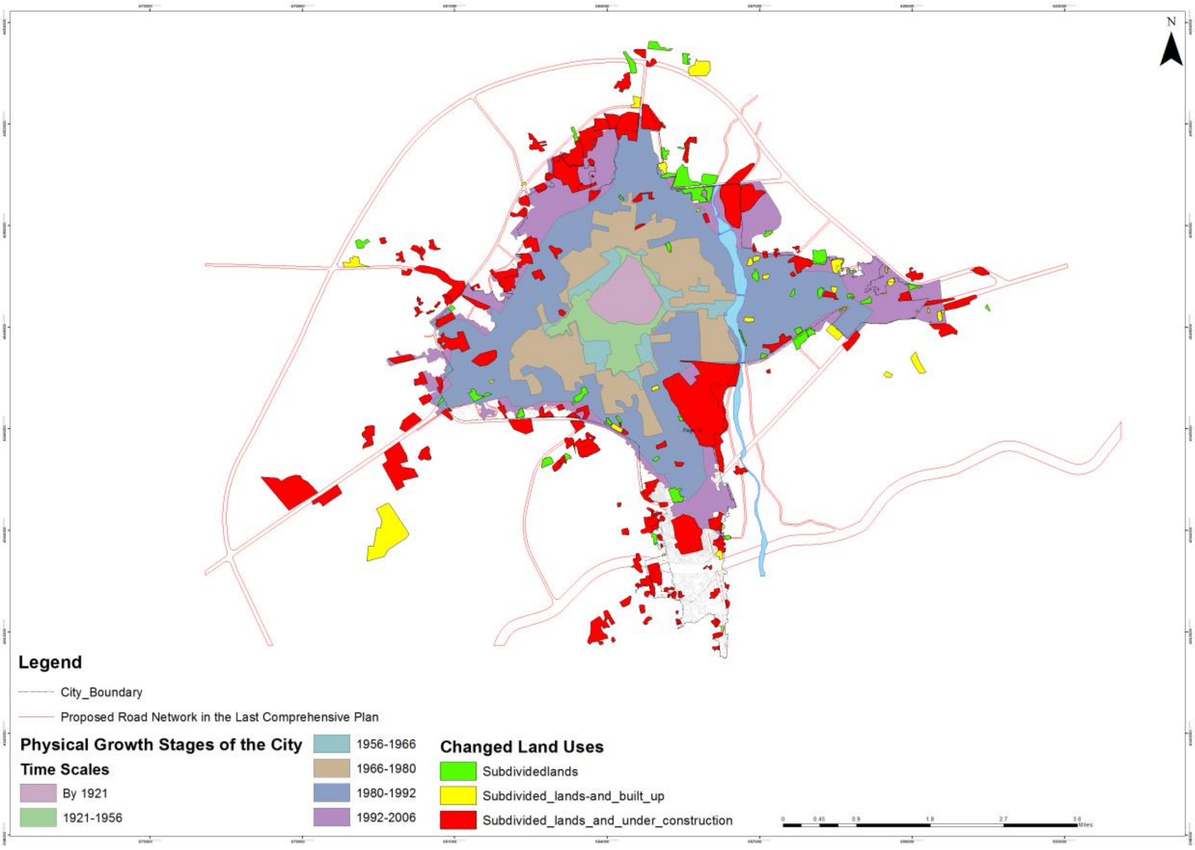

Figure 179 The hybrid map of the physical growth of Sari between 1921-2006 (by the author)

The above picture shows the land changes between 1972-2020 that illustrated by the green, yellow, and red colors.

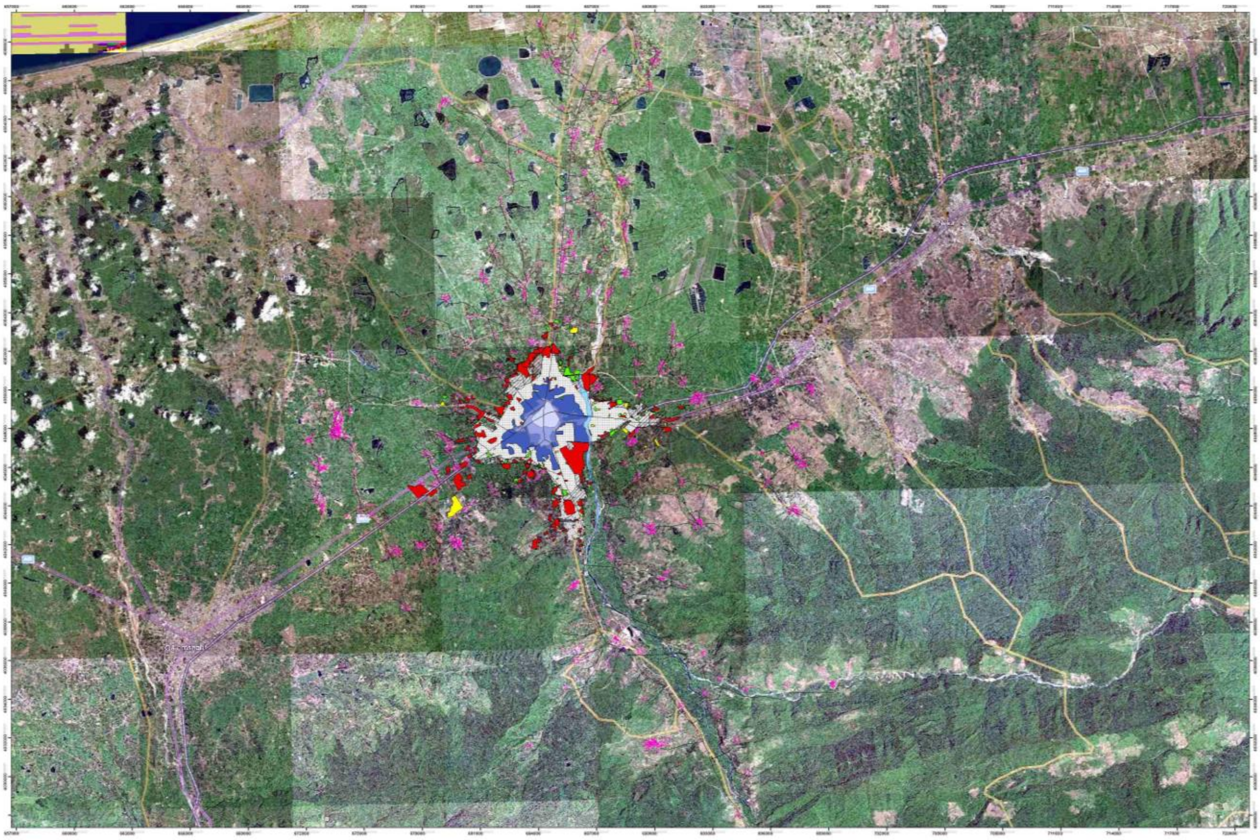

Figure 180 The hybrid map of the physical growth of Sari city between 1972-2020 (by the author)

As the above picture shows, the red color represents the subdivided lands that are still under construction: The yellow color illustrates the land parcels that were subdivided and built up. The green color indicates the land parcels that are subdivided but are not under construction. Around this city is covered by valuable green land covers. Unfortunately, because of sprawl growth and uncontrolled, thousands of hectares of farm lands that have been changed to the built-up area. And the map shows how the city grows in sprawl and scattered form.

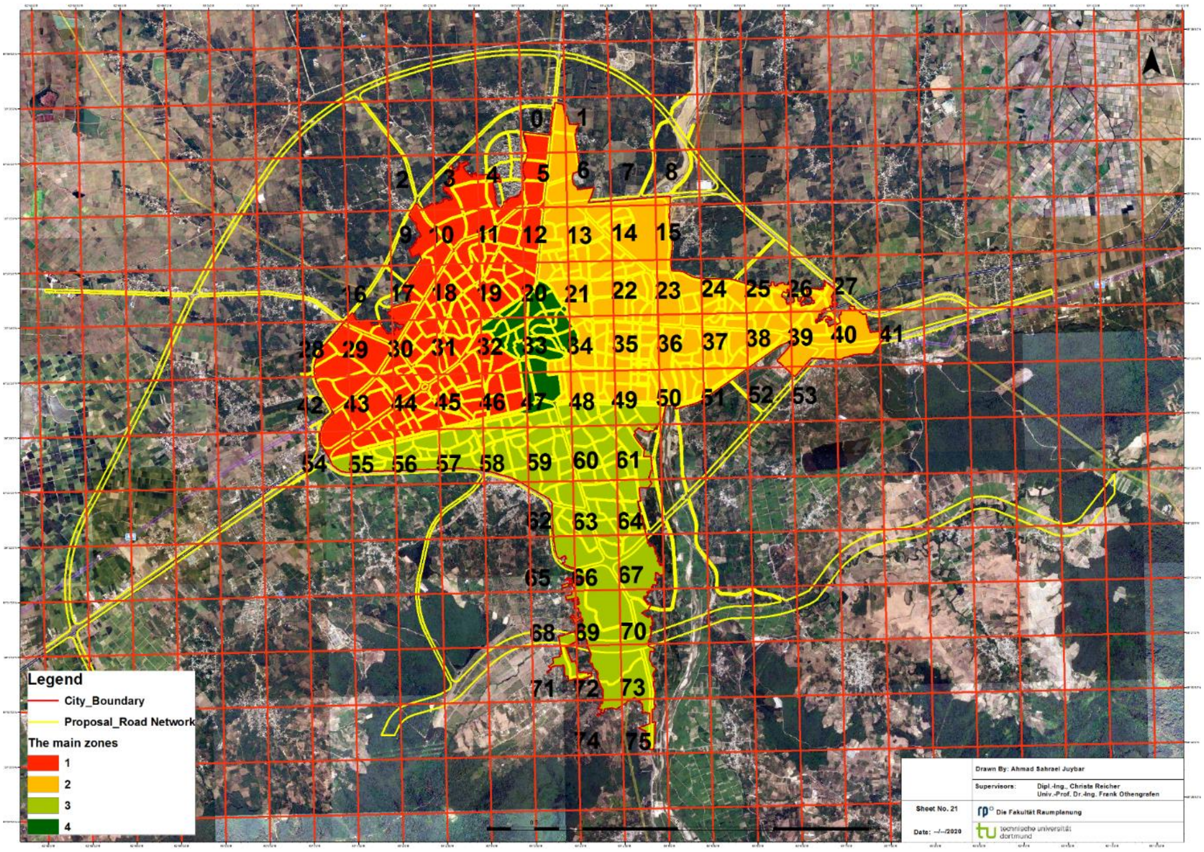

Figure 181 The defined reference system for the created grid sheets (by the author)

The above picture shows the defined grid reference system for creating the following land use maps between the numbers 0-75. Each grid has a particular number. A specific number is defined for each grid. The yellow lines show the proposed roads according to the last enacted Comprehensive Development Plan of Sari city.

11.1. Some tips for reading and understanding the following maps:

Please consider, this study has classified the study area into the three sectors to analyse better the land use changes as follow:

1. The sector one covers the all land use changes that accured in the insight of the official border of Sari city,
2. The sector two is a 1000 meters buffer that covers the all land use changes near the official border of this city. It includes two 500 meters buffer that covers the areas of the both sides of the official border.

3. The sector three is a 4000 meters buffer that covers all land use changes that occurred in the outside of the official border of the city.

This is a rapid, uncontrolled, scattered, and sprawl urban physical growth that happened simultaneously around this city. And the city has been grown physically quite on the agricultural land. Please attention that if hear stressed particularly on the agricultural land is because, this city is surrounded by farmlands. It does not mean this study is limited just to the land-use changes that happened in farmlands. So, this study has provided a map with grids numbered from 0 to 75 to show the happened land-use changes in the 23 sheets. These sheets have covered the city's insight and outside of the official border of this city. Of course, you can see the happened land-use changes in the areas next to the numbered grids in each sheet. This thesis has consciously illustrated these land-use changes by using satellite images to show how the green cover looks around this city? Are there geographical limitations that can hinder the physical expansion of this city? As you see, the city is located in a plain and flat area and surrounded by valuable agricultural lands. So, a satellite image with an aerial view helps better understand how this city devours these green covers uncontrolled and dramatically. Also, you have a direct and closed view over the change of the agricultural lands.

All land-use changes are classified under three sectors as follows:

1. Subdivided land parcels
2. Subdivided and built-up area
3. Subdivided and under construction

11.2. The subdivided land parcels

This sector includes all land-use changes that occured in all sectors of the studied area. These big agricultural lands have been divided into smaller parcels, regardless of legal or illegal.

The polyline with pink color on the following maps is addressed to this sector.

11.3. The subdivided and built-up parcels

This sector includes all land-use changes that happened in all sectors of the studied area. The lands have been divided into smaller parcels and built up entirely, regardless of legal or illegal.

The polyline with yellow color on the following maps is addressed to this sector.

11.4. The subdivided and under construction parcels

This sector includes all land-use changes that happened in all sectors the studied area. The lands have been divided into smaller parcels and are still under construction, regardless of legal or illegal.

The polyline with red color on the following maps is addressed to this sector.

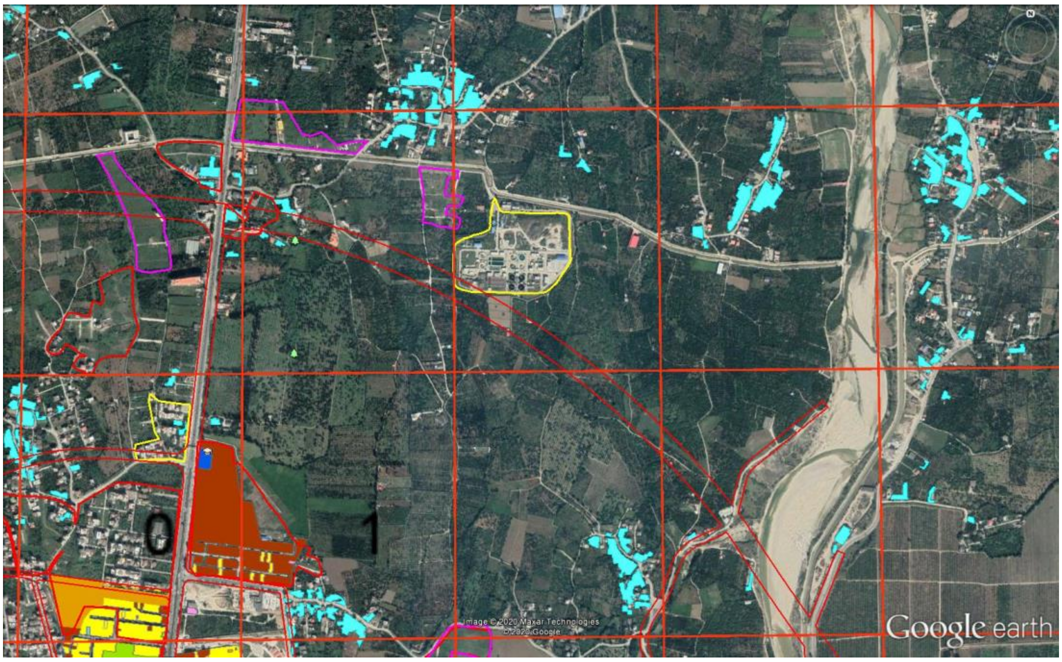

Figure 182 The grid 0 from zone one and grid one from zone two (by the author)

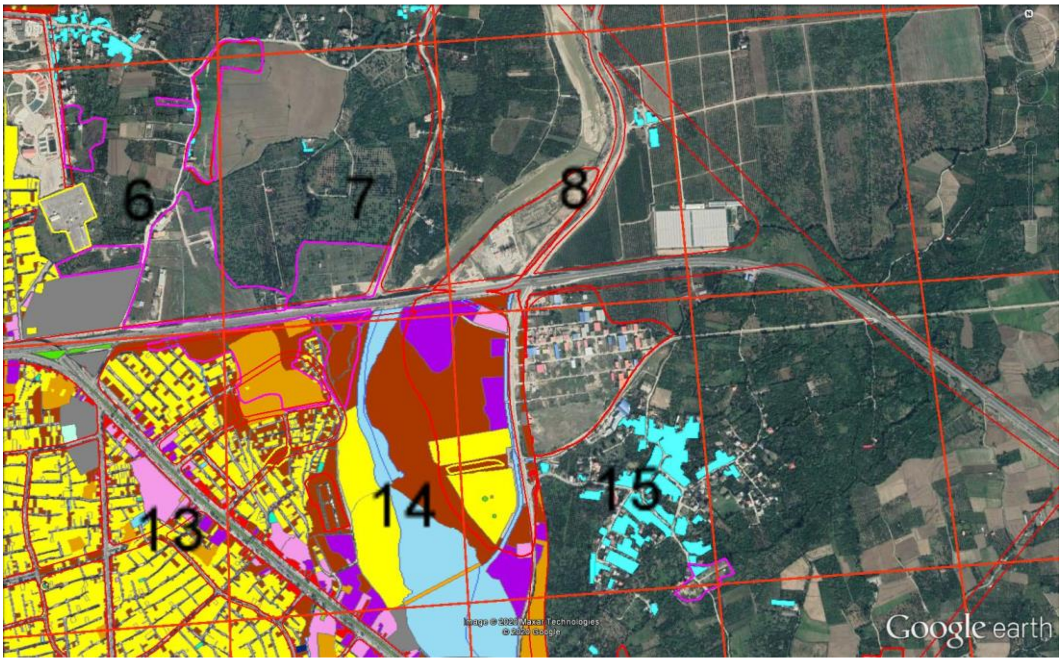

Figure 183 The grids 6, 7, 8, 13, 14, and 15 from zone two (by the author)

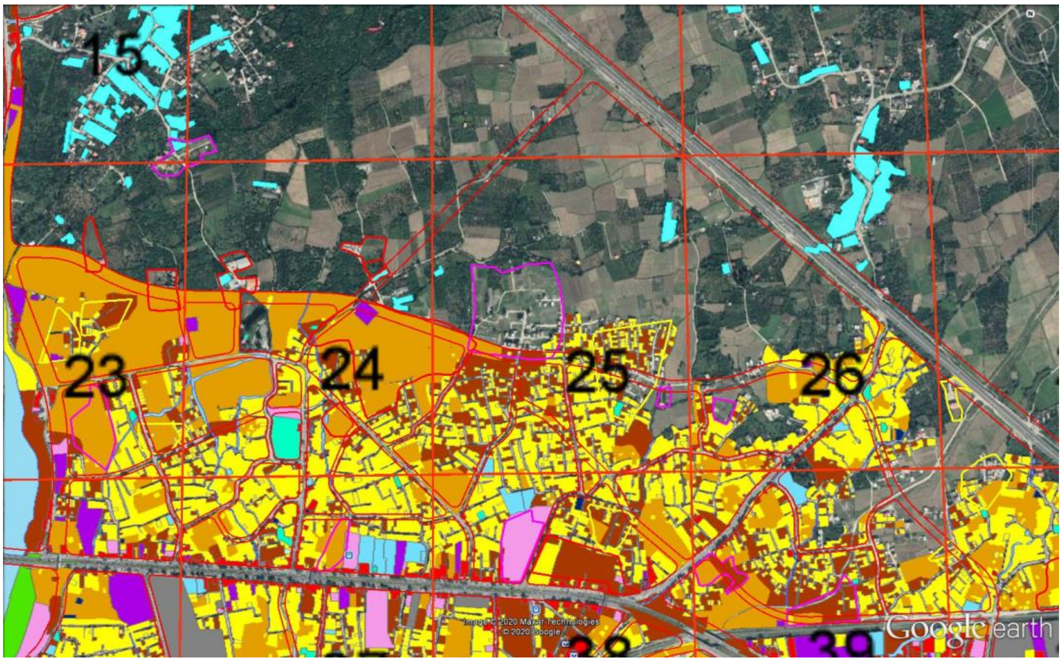

Figure 184 The grids 15, 23, 24, 25, and 26 from zone two (by the author)

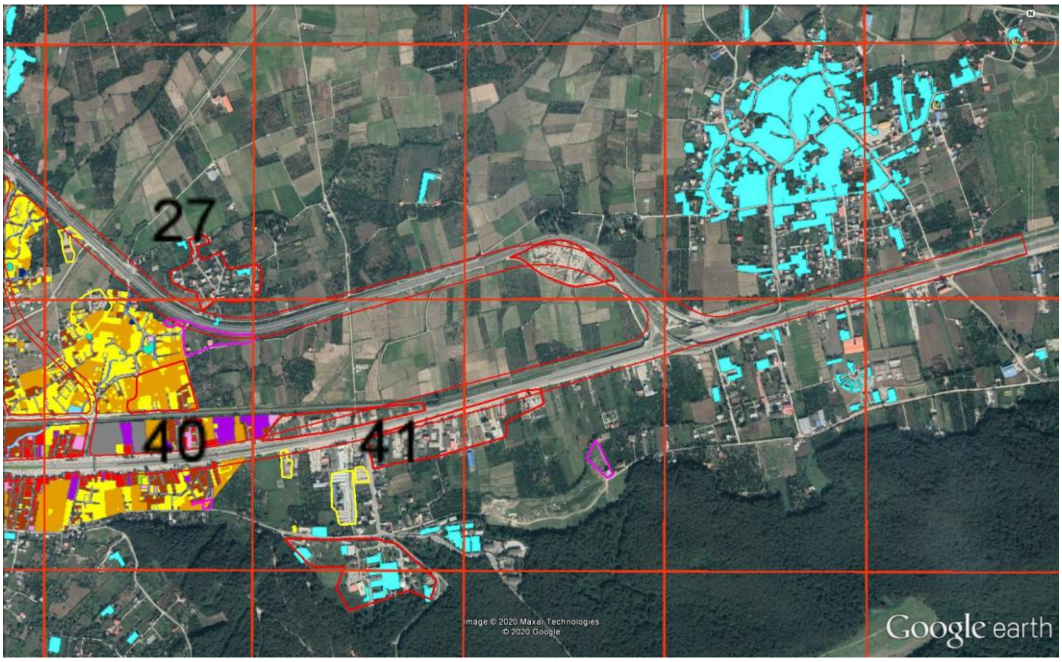

Figure 185 The grids 27, 40, and 41 from zone two (by the author)

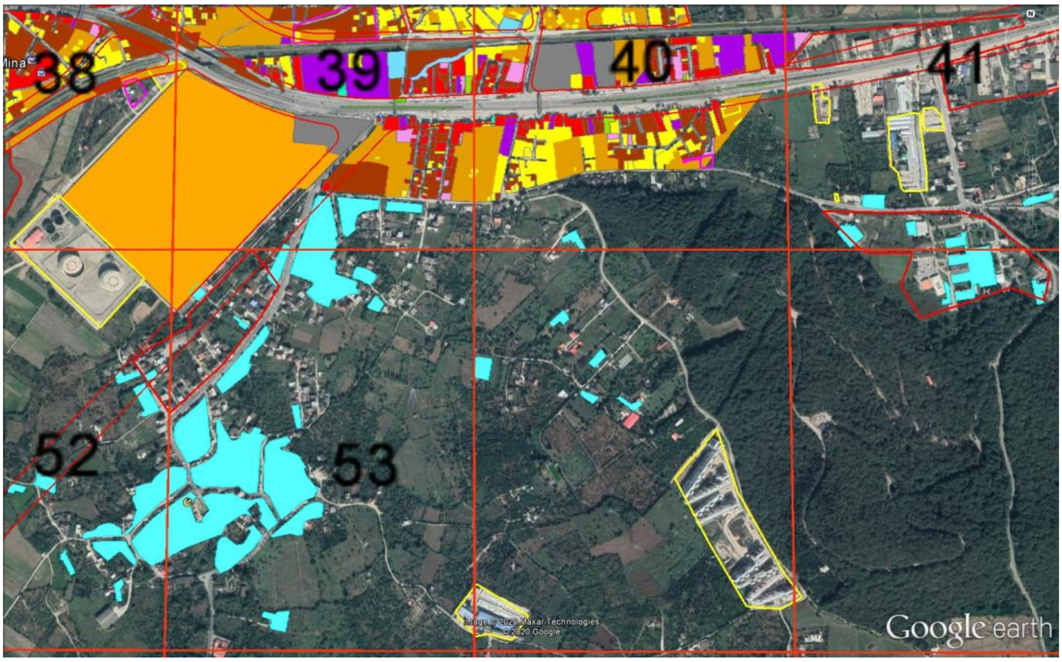

Figure 186 The grids 38, 39, 40, 41, 52 and 53 from zone two (by the author)

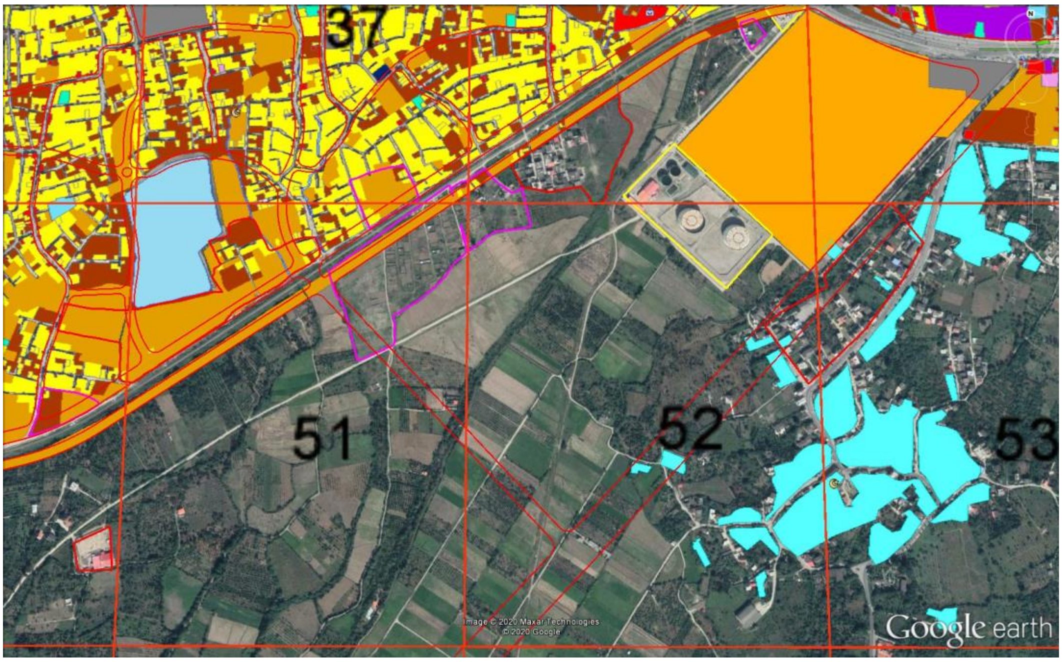

Figure 187 The grids 37, 51, 52, and 53 from zone two (by the author)

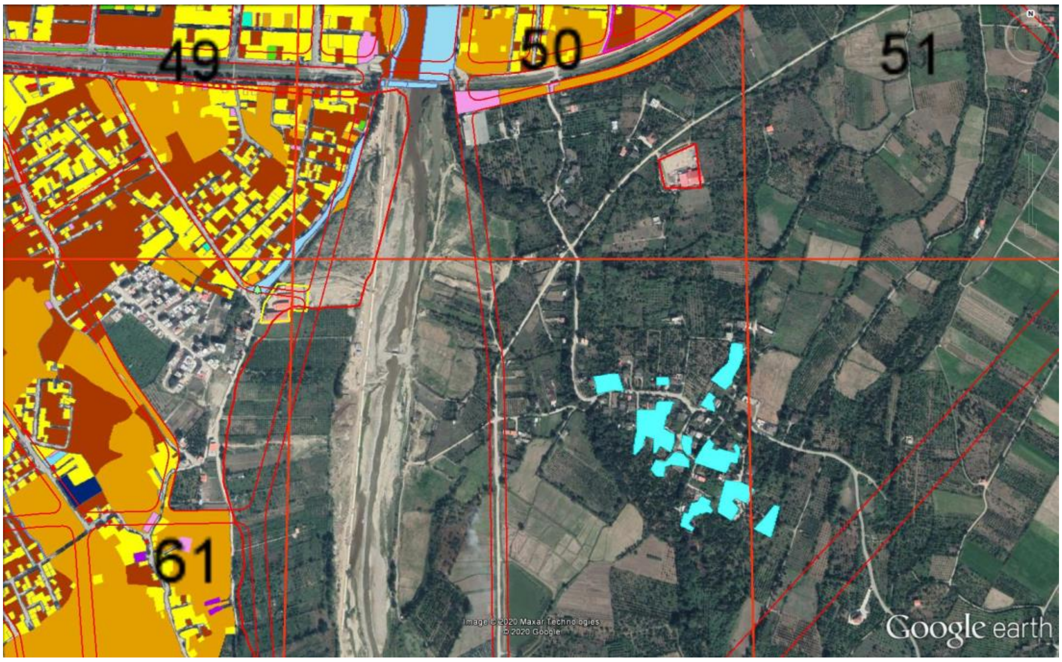

Figure 188 The grids 49, and 50 from zones one and two, and grids 51 and 61 from zone 2 (by the author)

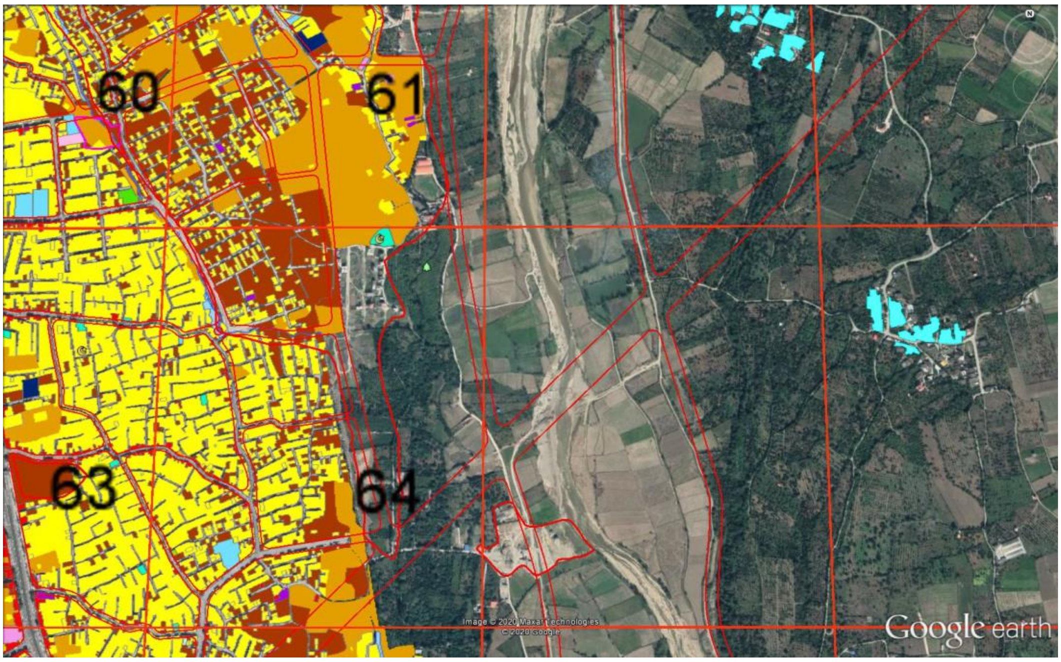

Figure 189 The grids 60, 61, 63 nad 64 from zones three (by the author)

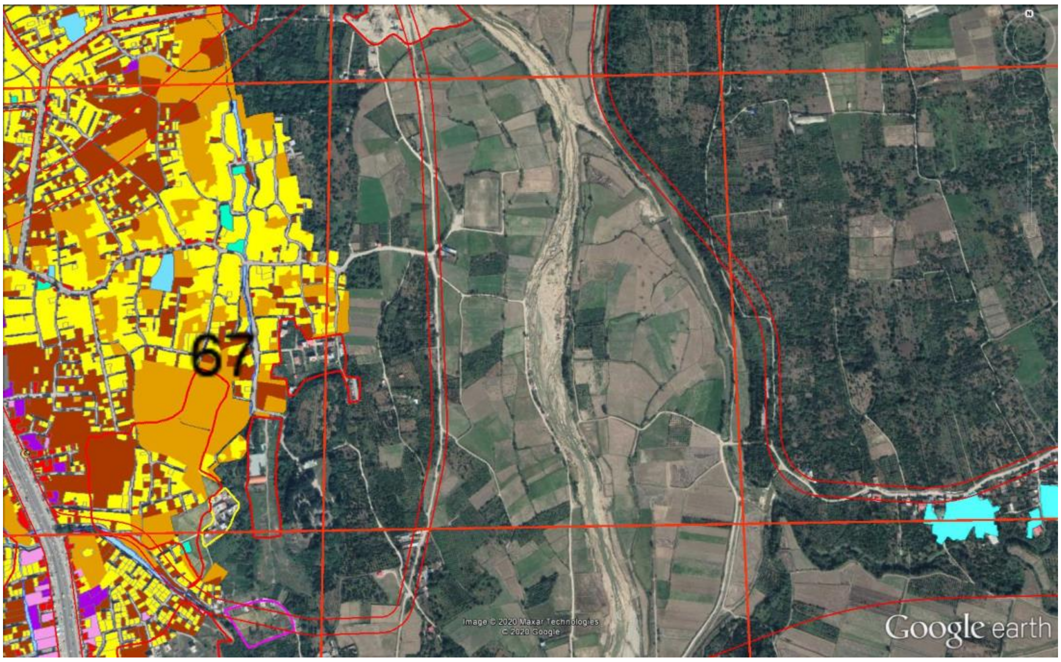

Figure 190 The grid 67 from zones three (by the author)

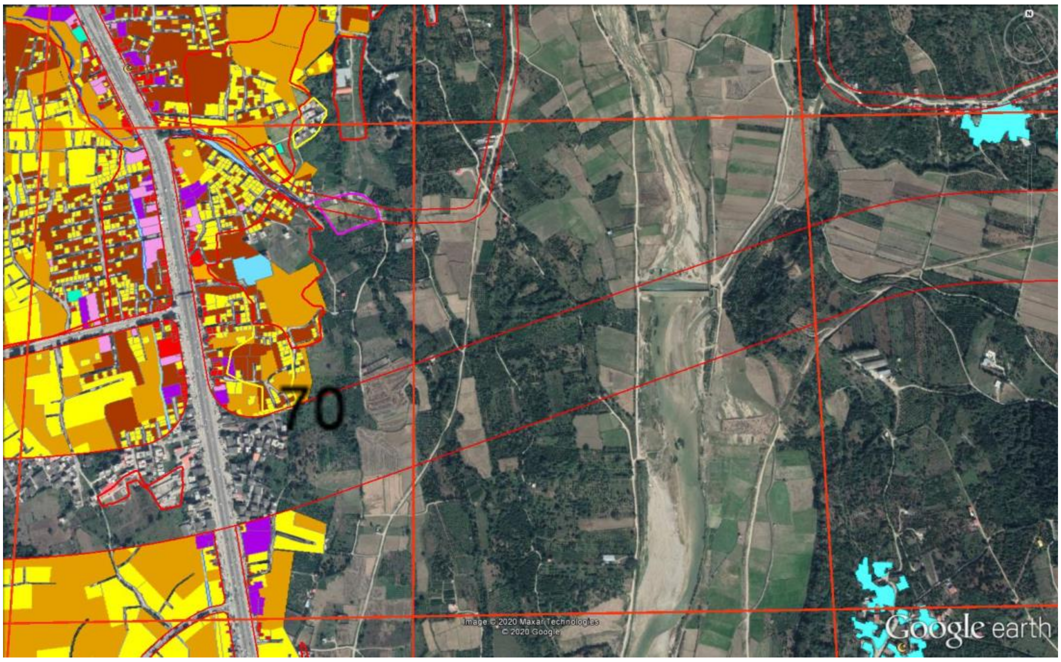

Figure 191 The grid 70 from zones three (by the author)

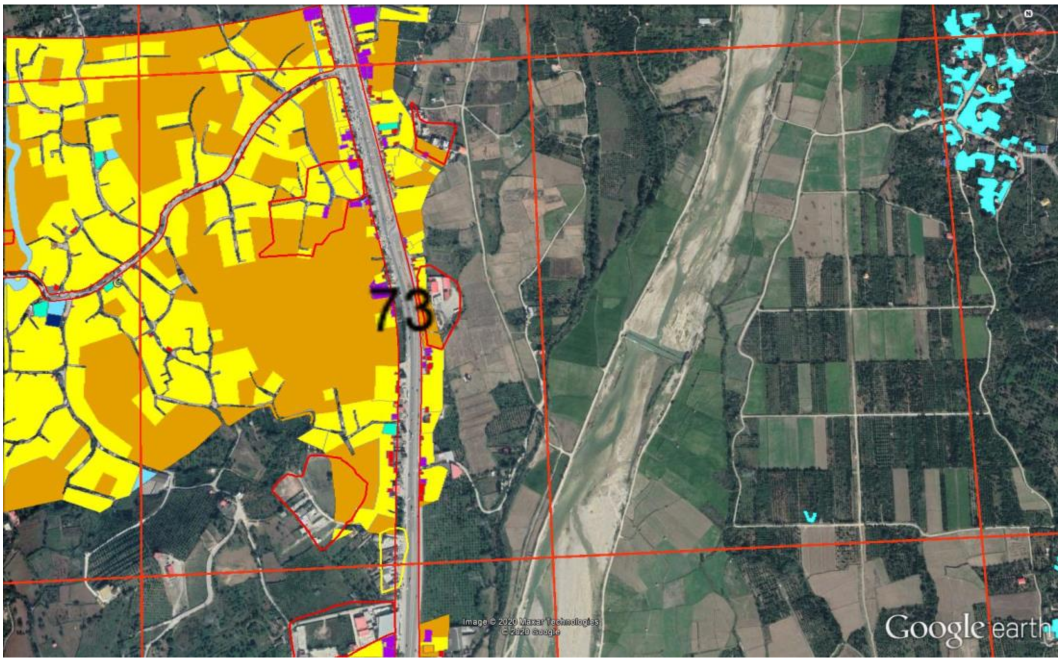

Figure 192 The grid 73 from zones three (by the author)

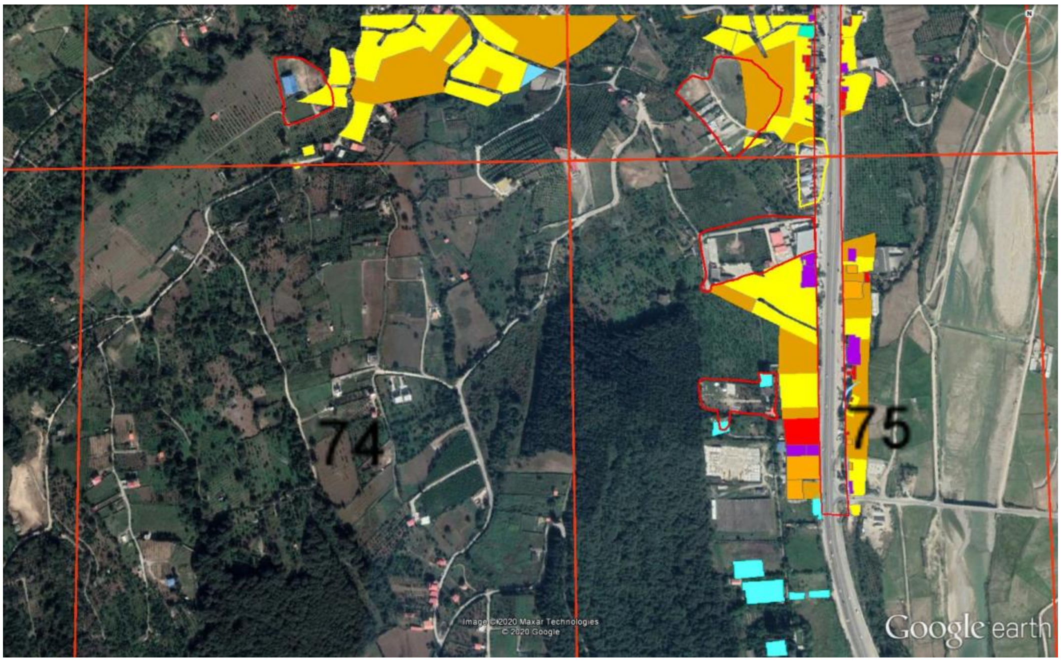

Figure 193 The grid 75 from zones three (by the author)

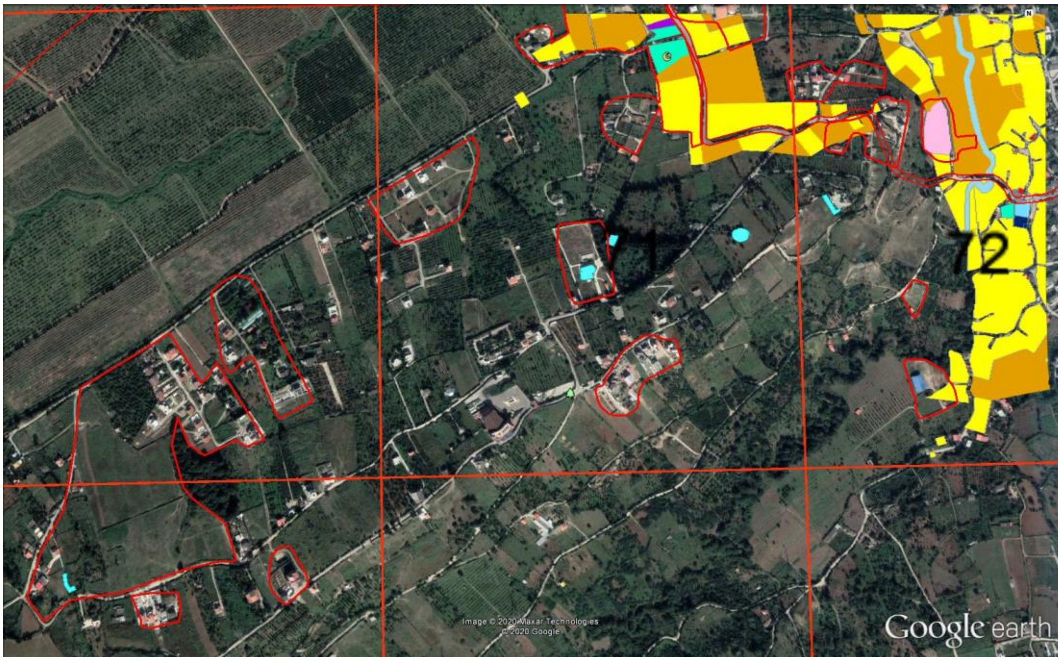

Figure 194 The grid 72 from zones three (by the author)

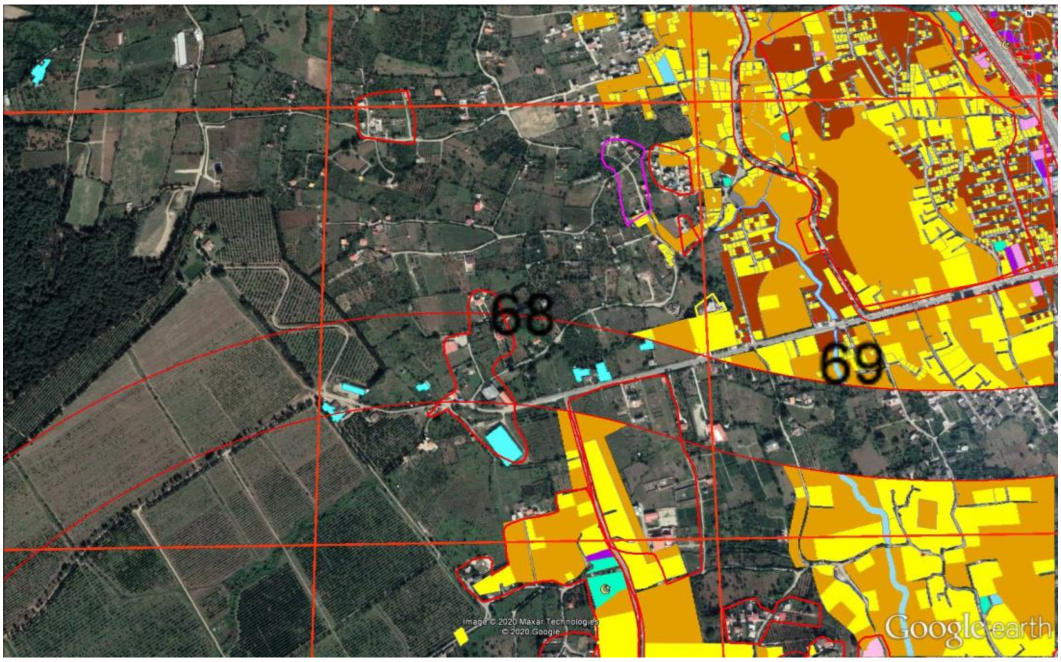

Figure 195 The grids 68 and 69from zones three (by the author)

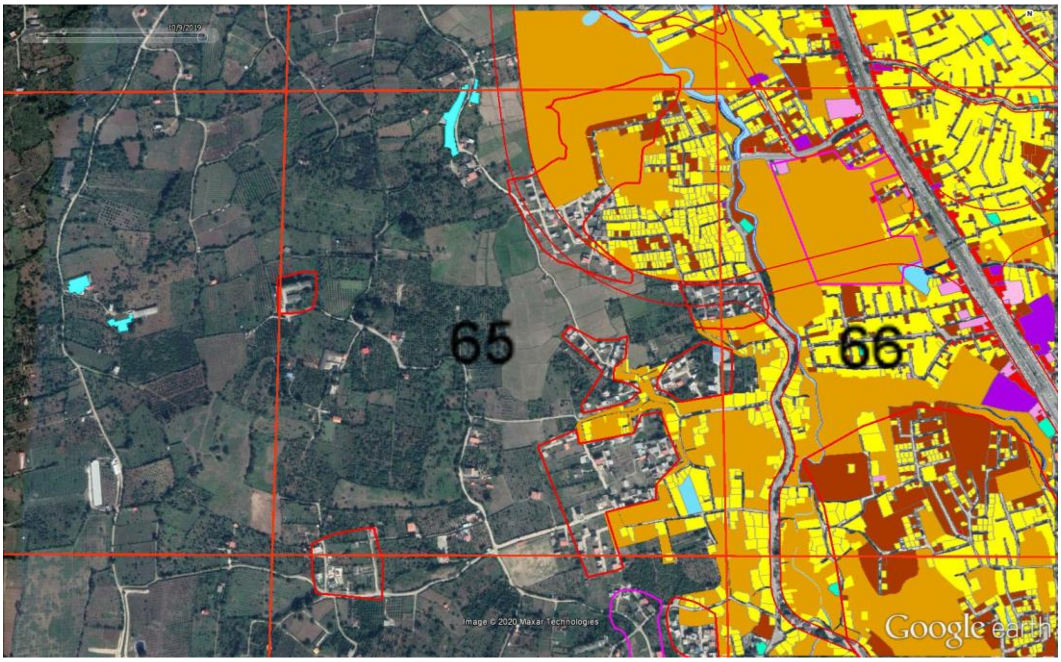

Figure 196 The 66 and 65 from zones three (by the author)

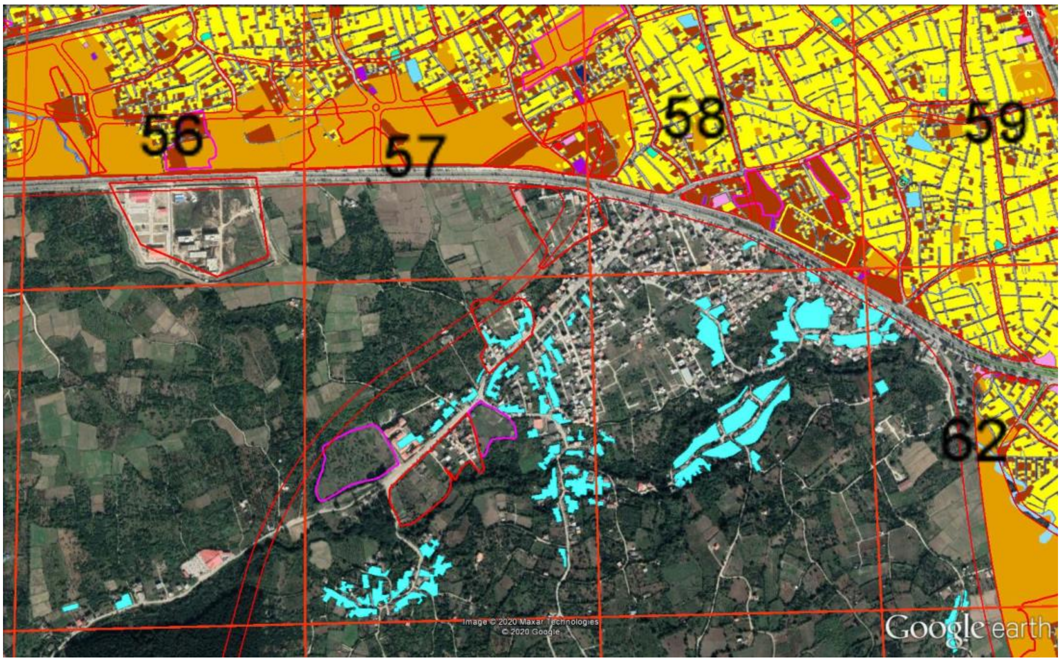

Figure 197 The grids 56, 57, 58, 59 and 62 from zones three (by the author)

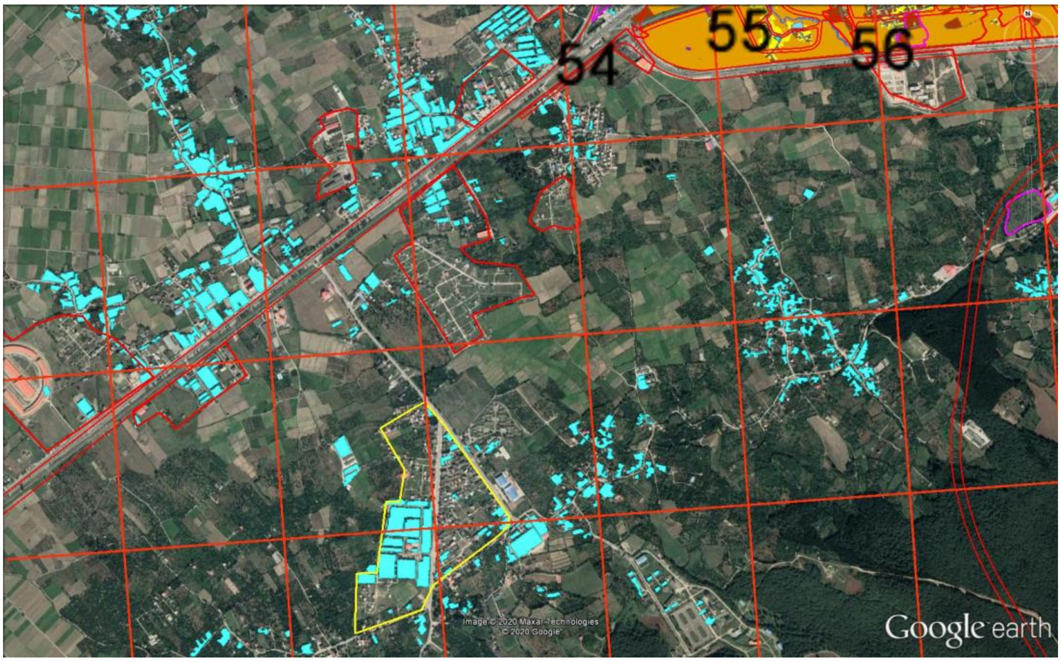

Figure 198 The grids 54, 55, and 56 from zones three (by the author)

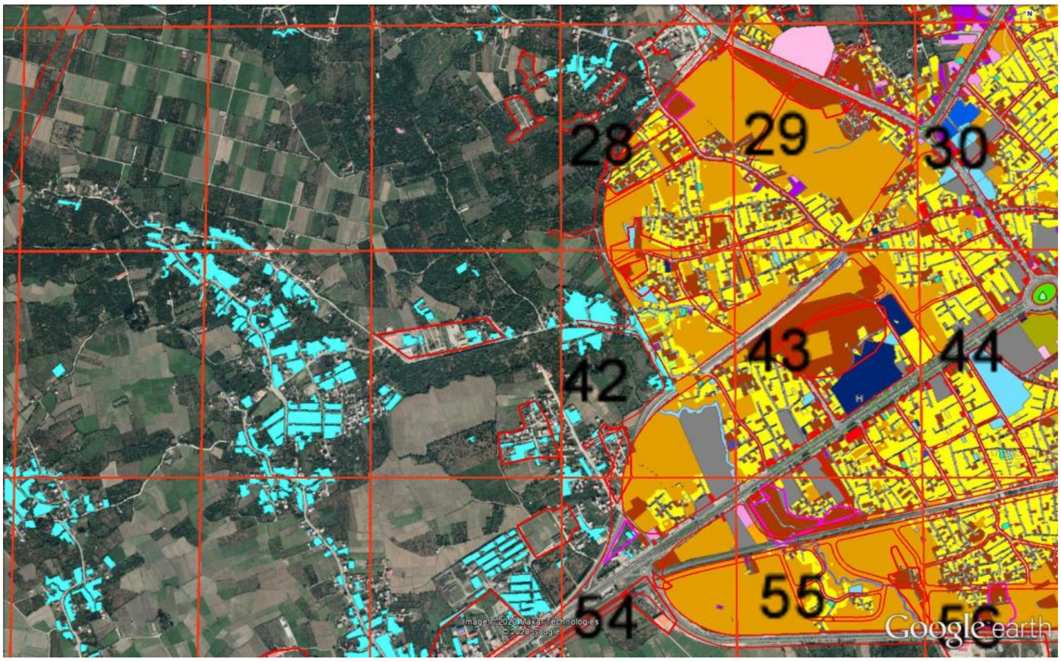

Figure 199 The grids 54, 55, and 56 from zonesone and three, and grids 28, 29, 30, 42, 43, and 44 from the zone one (by the author)

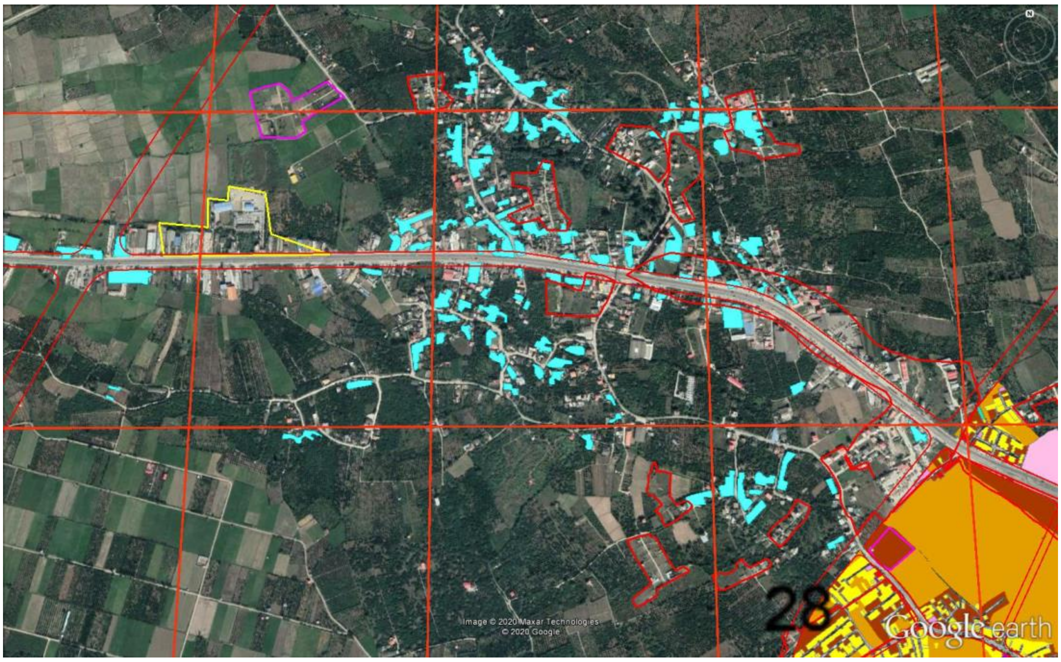

Figure 200 The grid 28 from zone one (by the author)

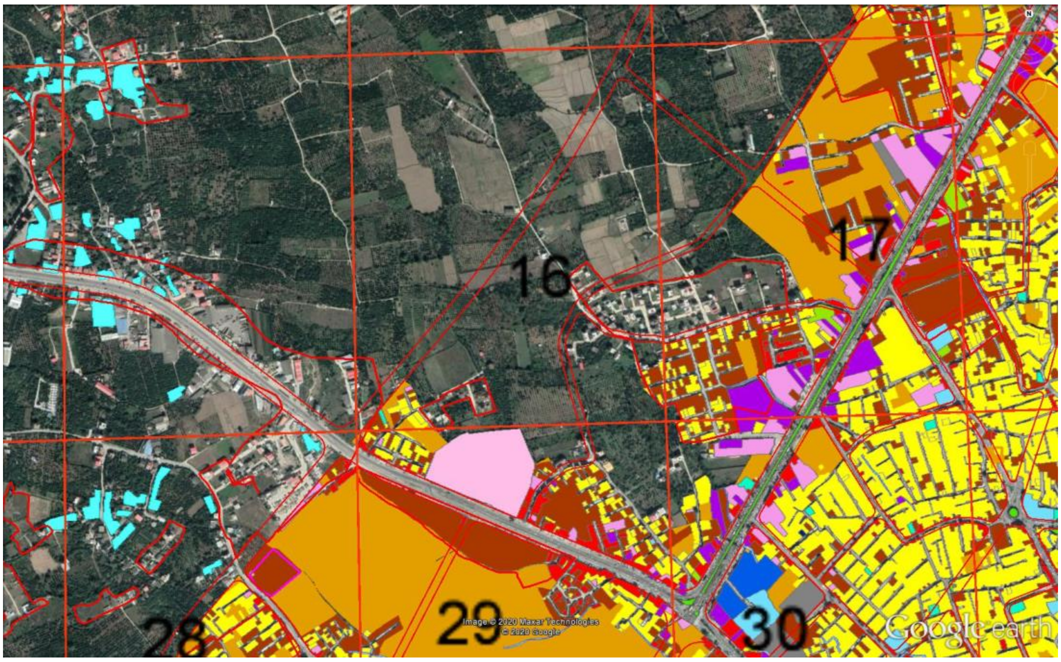

Figure 201 The grids 54, 55, and 56 from zones three 16, 17, 28, 29,and 30 from zone one (by the author)

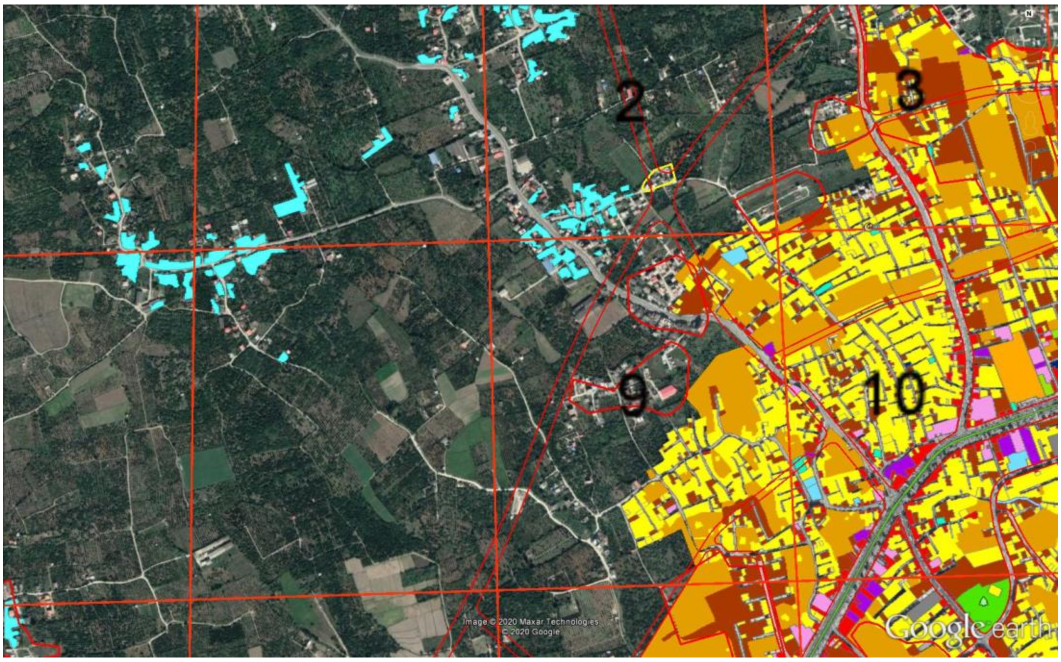

Figure 202 The grids 2, 3, 9, and 56 from zones one (by the author)

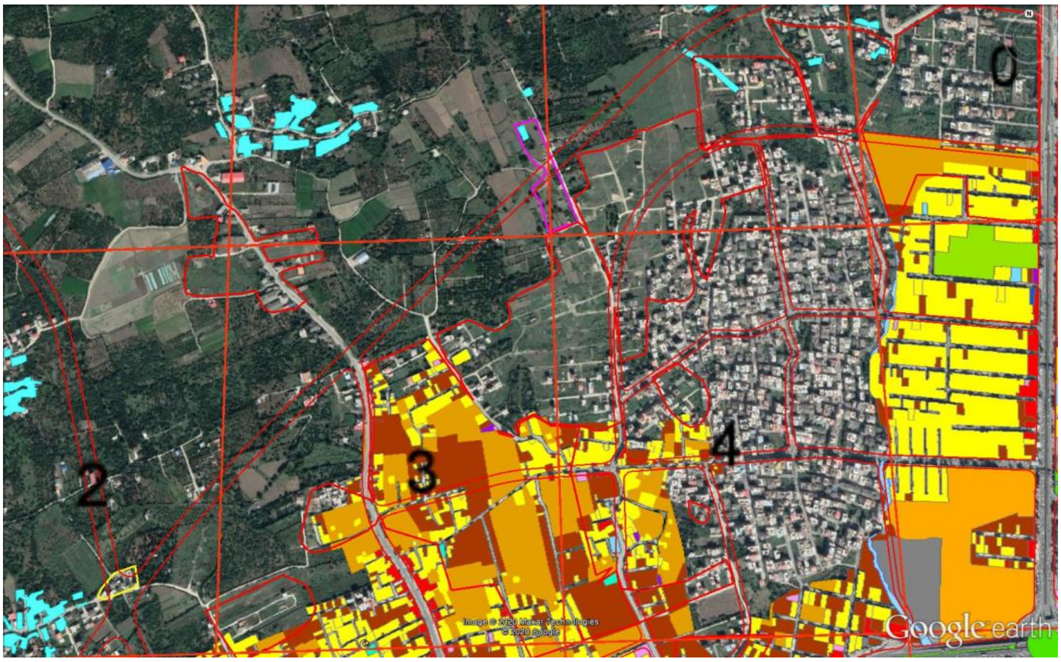

Figure 203 The grids 0, 2, 3, and 4 from zones one (by the author)

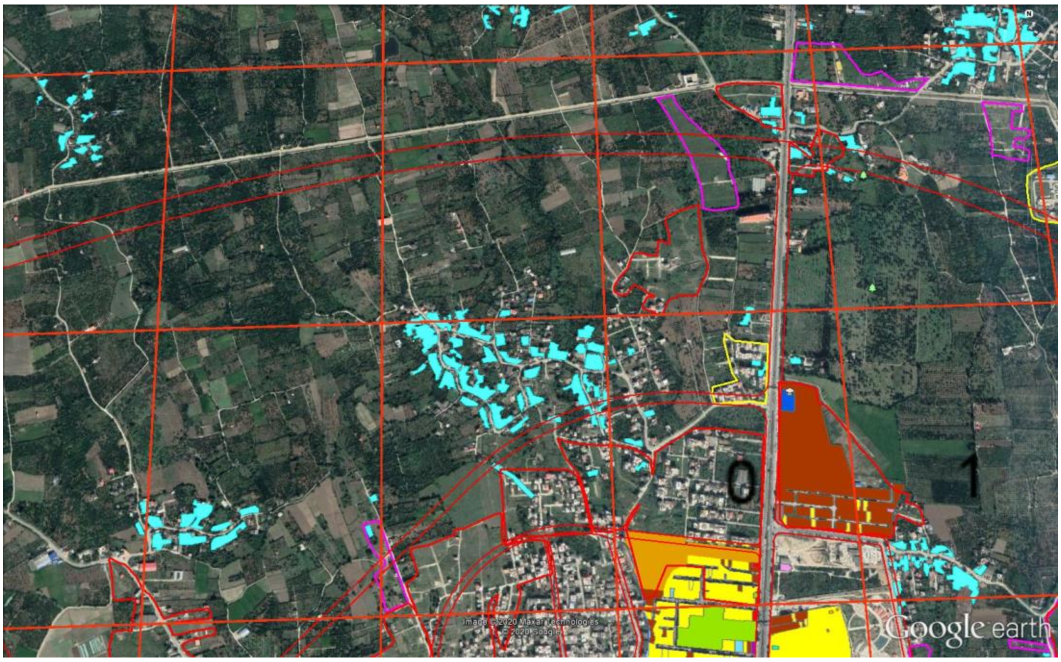

Figure 204 The grid 0 from zone one and two, and grid 1 from zone two (by the author)

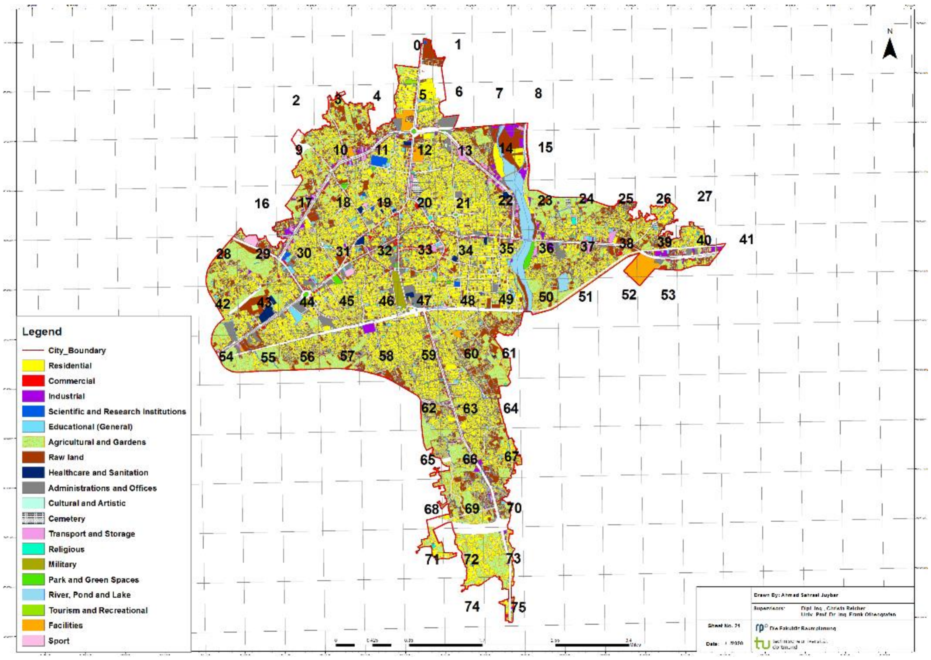

Figure 205 The land use map Sari city. The map provided by author, and the data from (The Ministry of Housing, Road, and Urban Development, 2015)

11.5. The interactions among the factors including: time of development, urban density and area of land parcels

The effects of the urban density on the land consumption and subdivision

Given this thesis, in general, some zones of this city that have experienced erlier city building than younger quarters, on the one hand, have a higer rate of density, on the other hand the area of land parcels are smaller than younger quarters. Because, the factor land value plays a significant role. Where the land value is high, area of land prcels has reduced. It is an strategy that make the land parcels payable for more people Figure 207. According to the Figure 206, the area **A** that addressed to the Inner-zone, has the higest rate population and buildings densities. This area generally has the erliest constructed buildings. And this sector has the higest rate of land value, subdivided land parcels are smaller, but has more high-rise buildings. In other words, insteade growth horizentally, tried to reduce area of percels and growth vertically Figure 218. It has increased more concentration of building and population in this sector.

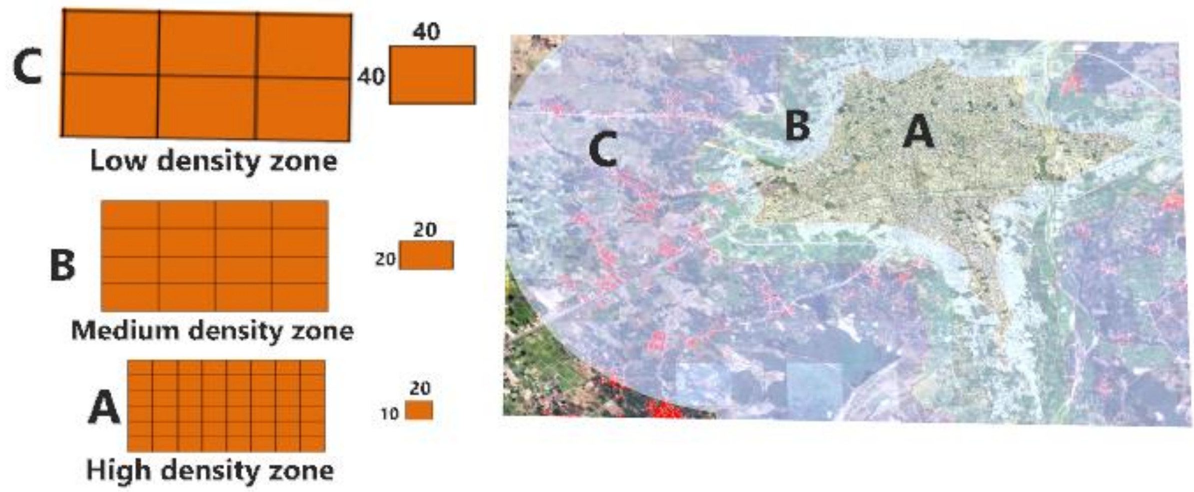

Figure 206 Urban density and its effect on the size of land when subdividing (by the author)

Considering the Figure 206, the area **B** addressed to the buffer 1000 meters. This area is closed to the city and has the newest tissues, buildings and scattered. And land value in this sector is lower than sector **A**, but the area of subdivided land parcels are significantly biger than sector **A**. Zone **B** has fewer high-rise buildings and more low-rised buildings. In other words, insteade growth vertically, tried to increase area of percels and growth horizentally. It has decreased concentration of building and population in this sector.

And the area **C** addressed to the buffer 4000 meters. This area refers to periphery area included suburbs and rural around this city. Land value in this sector is lower than sectors **A** and **B**, but the area of subdivided land parcels are significantly biger than sectors **A** and **B**. The most built up buildings in zone **C** are low-rised, area of percels are bigger than other sectors and has the lowest concentration of building and population.

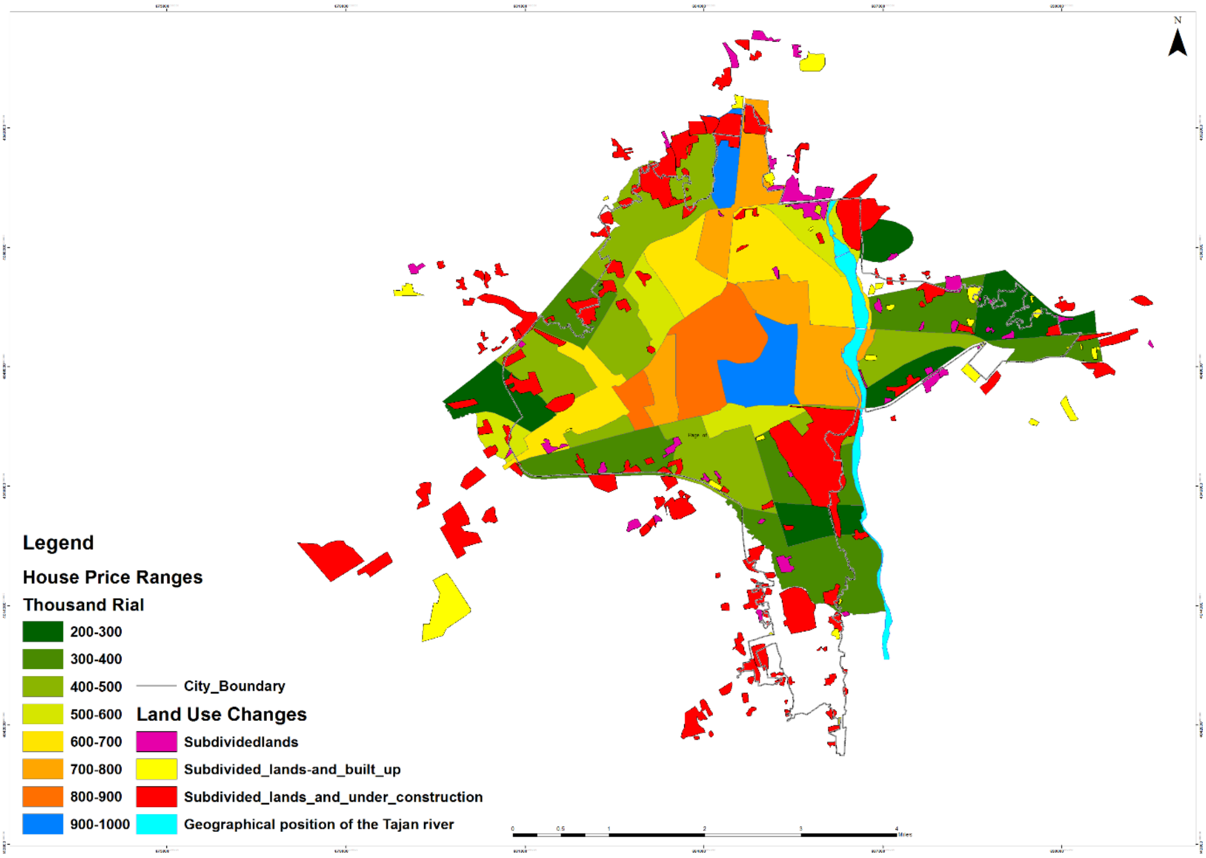

Figure 207 The map of land values combined with the changed land parcels (by the author)

11.6. Planned and unplanned land subdividing and zoning

Plan-based zoning and land subdividing help to use land resources efficiently and effectively. It provides frameworks on the form and scale of buildings and parcels to define the character of a neighborhood or quarters considering sustainability principles. Also, it provides a common understanding of allowable land uses for projects considering the community's articulated vision. Plan-based zoning encourages mixed-use development to manage better consumption of urban lands, minimize waste of valuable urban lands when land subdividing and allocating space or lands for streets or buildings, and helps to have productive and livable urban spaces.

In a plan- and form-based zoning, increasing the efficiency of land consumptions and maximum use of the capacity of urban spaces is one of the main goals. But in unplanned and uncontrolled zoning, land subdividing and using spaces is not efficient. Also, concerning principles of urban landscapes and harmony between elements, there are many contrasts between form, wide and capacity of streets, building, density, and land parcels. Also, in this area, no one paid attention to the accessibility and compatibility factors.

In this regard, this study has provided two examples from different places in the city of Sari. The first one (see Figure 208) shows plan-based zoning located in the inner-zone, zone 1. And in this area, planners have tried to realize harmony between places, parcels, and buildings considering the factors compatibility and accessibility. But in contrast, the second one (see Figure 209) shows a place that is located in the urban edge, zone 3, buffer 1000 meters. In this sample case, landowners have tried to subdivide farmlands without a permit and consider zoning principles. Also, irregular street system, inattention to factors compatibility and accessibility, inattention to density and size of land parcels, inattention to the high of buildings, architectural factors, materials, and facades of the building are the salient features of these areas. This is a sample of sprawl and uncontrolled zoning and land subdividing that are happening daily around this city, especially in the buffer 1000 meters.

Figure 208 Tabarestan is a mix-use development project horizontally integrating multifamily housing and retail, clinics, and other public services. This area is located in zone one of the city Sari (by the author)

Figure 209, An exemplar uncontrolled and sprawl area that is located in zone three, in the buffer 1000 meters, with growing single-use buildings projects on land parcels without accessibility to the basic services. These building projects started by private investors without getting building permits (by the author)

Sprawl Growth, land consumption, and land subdivision in Sari City

Zone 1

This zone encompasses half of the north and west sides and the northwest part of this city Figure 181.

Subdivided lands

This zone encompasses half of the north side, northwest, and the half of west of the part of this city. The layer of the Subdivided lands is the first group of these three classifications that were introduced above Figure 211. In zone one, in terms of area, the largest land subdivisions happened in the buffer 4000 meters, about 75403.39 m2. They were recently subdivided and still are not under the building (see Figure 210).

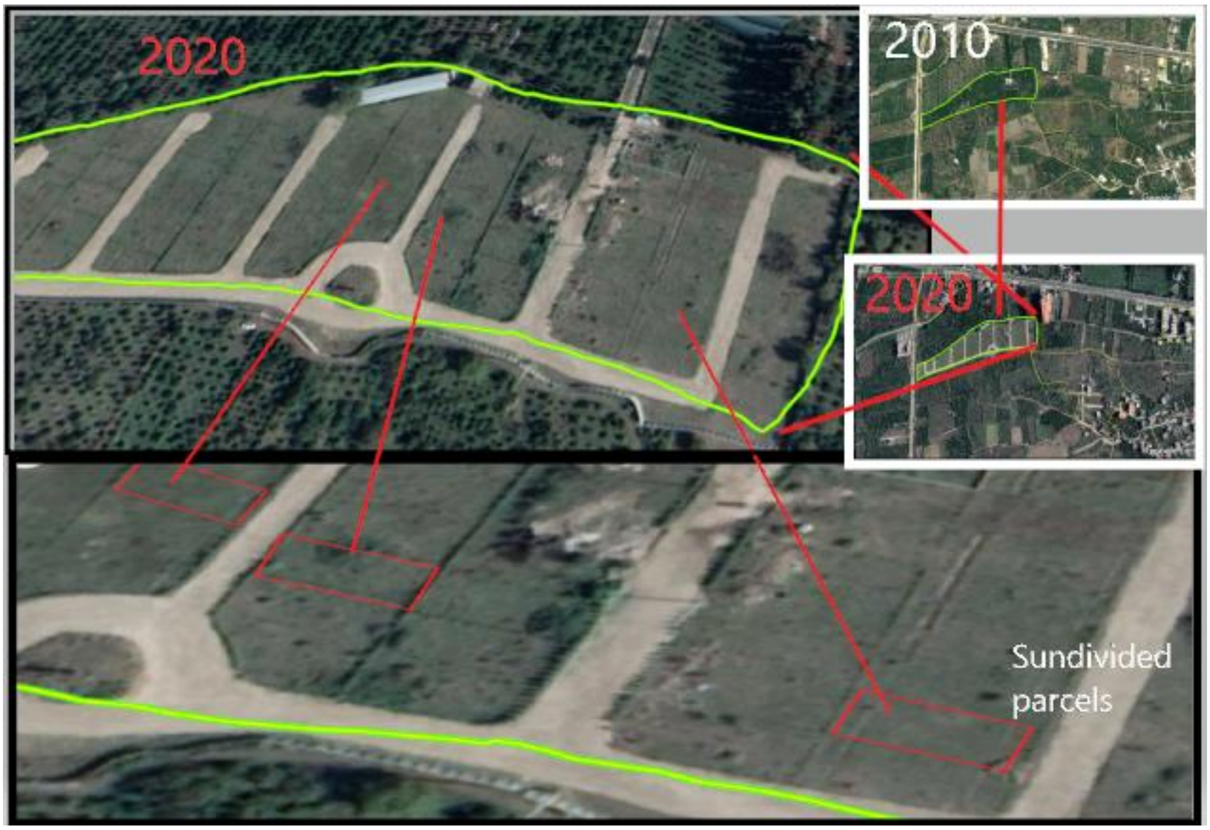

Figure 210 This big orchard is destroyed for starting a building project and and subdivided into many parcels (by the author)

As shown in Figure 210, just in one case, people have changed a big orchard about 46000 m2 to a new residential area. The above satellite image, left up, illustrated this orchard in 2010. And in left down, the orchard is completely destroyed. In the center of Figure 210 illustrates that this farmland is subdivided into small land parcels to build new buildings for constructing a new residential area.

As shown in Table 78, most land-use changes happened in the buffer 4000 meters, then in the buffer 1000 meters, and the lowest in the inner zone. And the reasons are that the subdivided lands in the periphery area were agricultural parcels.

For this sector, about 51% of the changes happened in the buffer 4000 meters, 40% in the buffer 1000 meters, and 9% in the Inner-zone Figure 212.

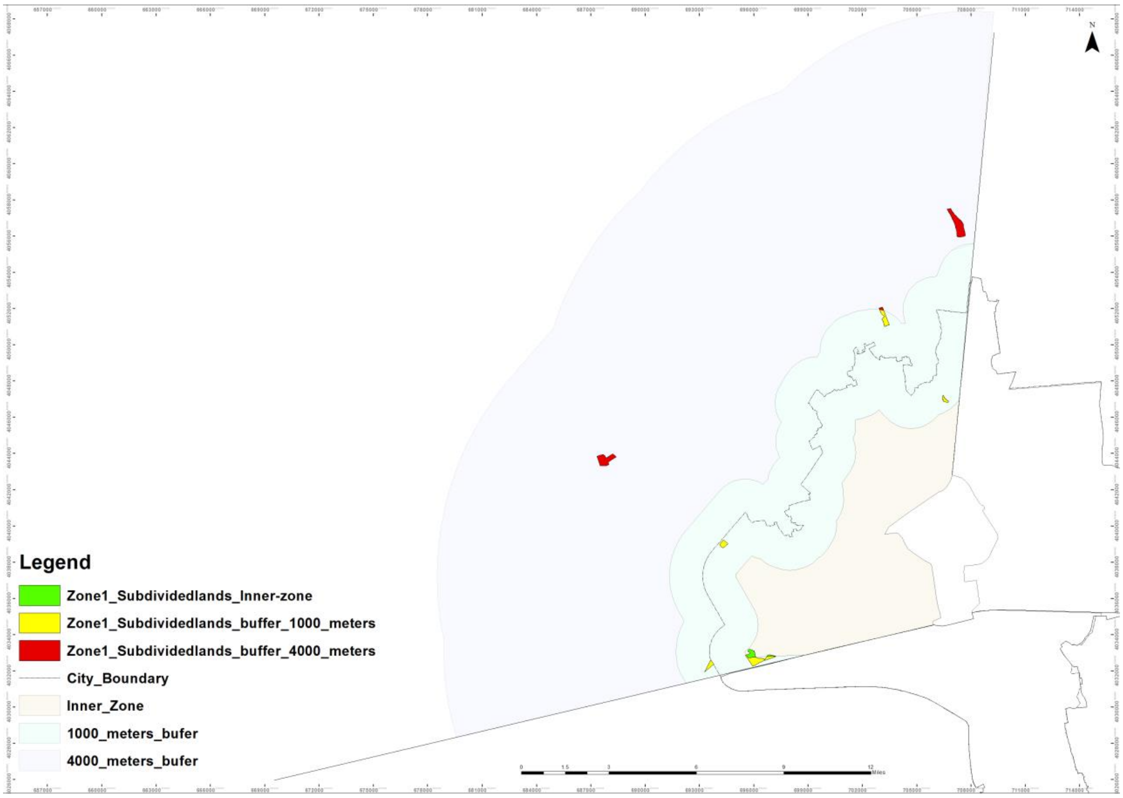

Figure 211 The subdivided land parcels in zone one considering the three classes of buffers (by the author)

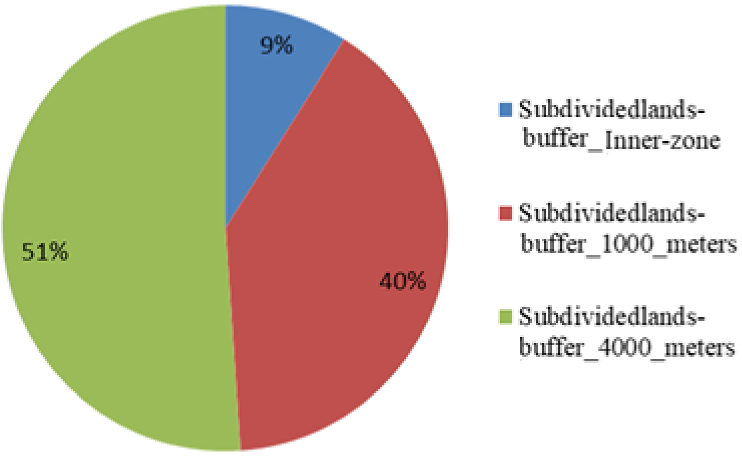

Figure 212 The percent of the subdivided land parcels in zone one considering the three classes of buffers (by the author)

Table 78 The area of the subdivided land parcels in zone one considering the three classes of buffers (by the author)

Zone's Class	Classes	Count	Square Meters
Zone1	Subdivided lands- Inner-zone	2	13204.85404
Zone1	Subdivided lands- buffer_1000_meters	6	59019.49445
Zone1	Subdividedlands- buffer_4000_meters	3	75403.39321
Sum		**11**	**147627.7417**

The subdivided lands and under construction

The sub-divided lands and under the construction layer are the second group of these three classifications Figure 213. In zone one, in terms of area, the largest land subdivisions happened in the buffer 1000 meters, about 1873760.177 m2.

As shown in Table 79, the most land use changes happened in the buffer 1000 meters, because this area refer to the urban edges where are in growing process and most of new buildings are building in in these sectors. And the buffer 4000 meters has the second place then in and the lowest changes have taken place in the Inner-zone.

For this sector, about 79% of the changes happened in the buffer 1000 meters, 15% in the buffer 4000 meters, and 6% in the Inner-zone Figure 214.

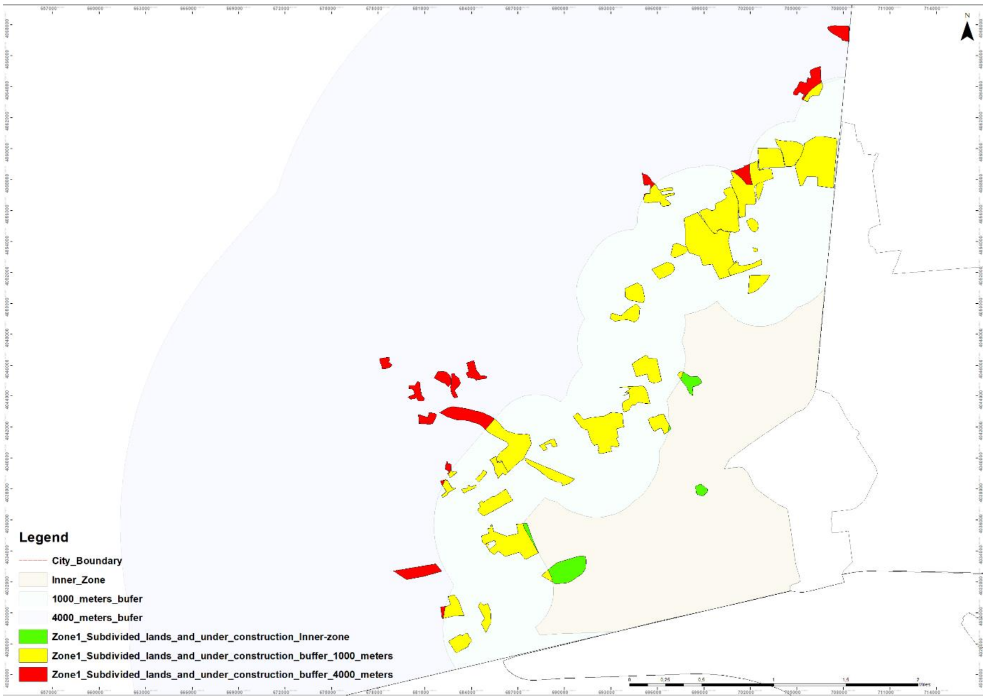

Figure 213 The subdivided and under construction land parcels in zone one considering the three classes of buffers (by the author)

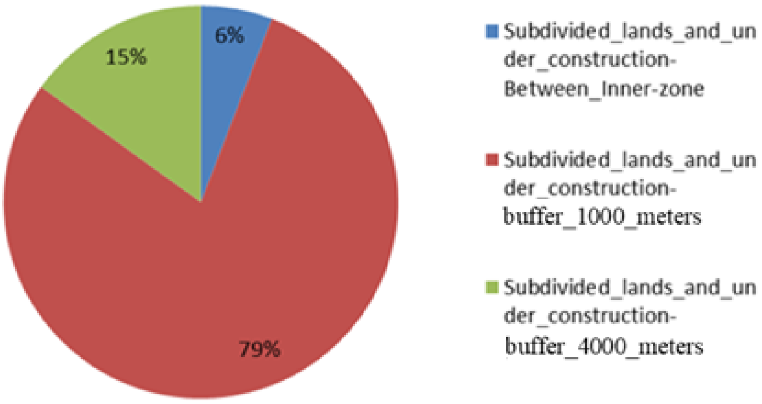

Figure 214 The percent of the subdivided and under construction land parcels in zone one (by the author)

Table 79 The area of the subdivided and under construction land parcels in zone one considering the three classes of buffers (by the author)

Zone's Class	Classes	Count	Square Meters
Zone1	Subdivided_lands_and_under_construction-Between_Inner-zone	5	138838.2012
Zone1	Subdivided_lands_and_under_construction-_buffer_1000_meters	36	1873760.177
Zone1	Subdivided_lands_and_under_construction _buffer_4000_meters	15	355767.8339
Sum		**56**	**2368366.212**

The subdivided lands and Built-up

The layer of the Subdivided lands and Built-up is the third group of these three classifications Figure 215. In zone one, in terms of area, the largest land subdivisions happened in the buffer 4000 meters, about 53700.40 m2.

As shown in Table 80, most land use changes happened in the buffer 4000 meters. That was happened in the periphery of this city, in a village quite near the city. These villages are growing and populating because the dwellers tend to work in the city but live outside of the city, away from the daily traffic and sound pollutions. And the buffer 4000 meters has the second place then in, and the lowest changes have taken place in the Inner-zone.

For this sector, about 59% of the changes happened in the buffer 4000 meters, 38% in the buffer 1000 meters, and 3% in the Inner-zone Figure 216.

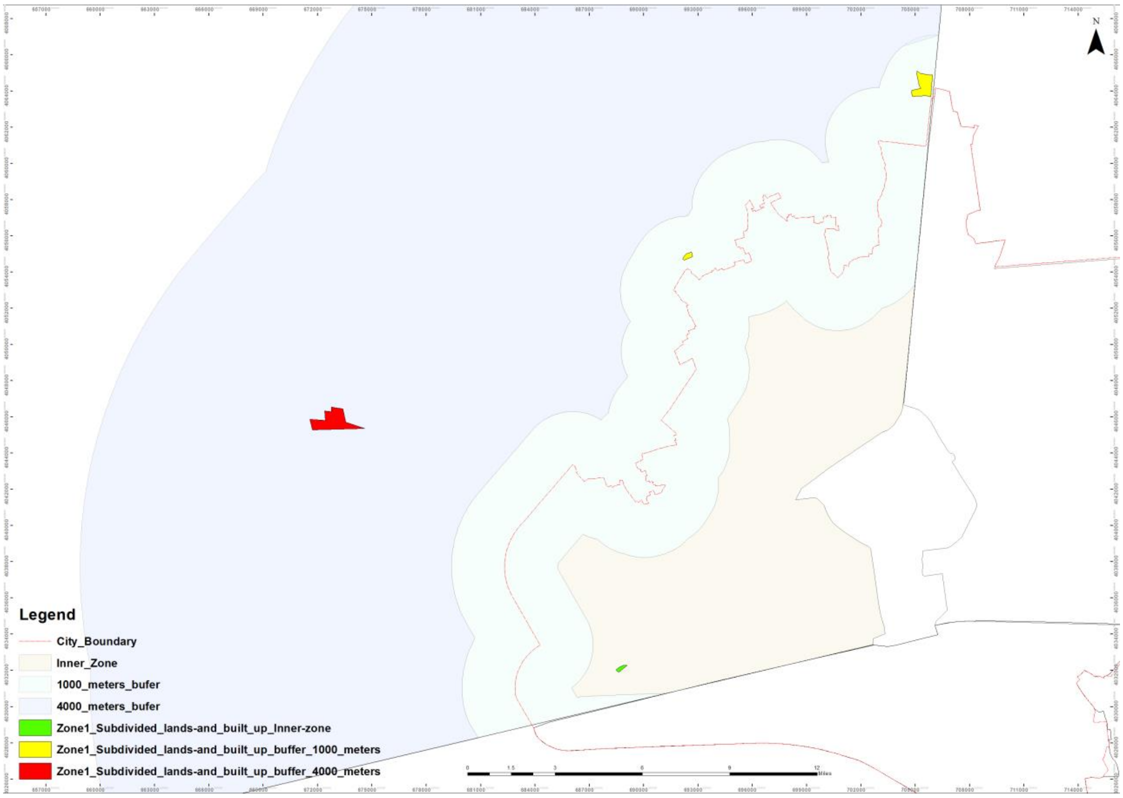

Figure 215 The subdivided and build up land parcels in zone one considering the three classes of buffers (by the author)

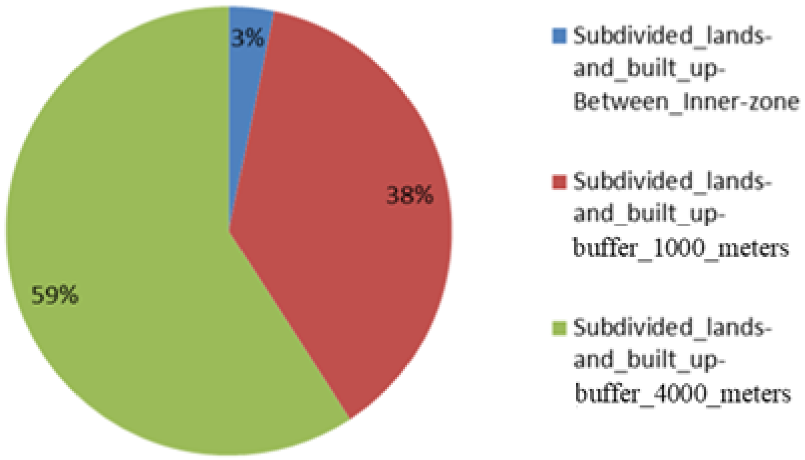

Figure 216 The percent of the subdivided and build up land parcels in zone one considering the three classes of buffers (by the author)

Table 80 The area of the subdivided and build up land parcels in zone one considering the three classes of buffers (by the author)

	Classes	Count	Square Meters
Zone's Class			
Zone1	Subdivided_lands-and_built_up-Between_Inner-zone	1	2945.105654
Zone1	Subdivided_lands-and_built_up _buffer_1000_meters	2	34139.82511
Zone1	Subdivided_lands-and_built_up _buffer_4000_meters	1	53700.40225
Sum		**4**	**90785.33301**

Zone 2

This zone encompasses half of the north and east sides and the northeast part of this city Figure 181.

The subdivided lands

The layer of the Subdivided lands is the first group of these three classifications Figure 221. In zone two, in terms of area, the largest land subdivisions happened in the buffer 1000 meters, about 633828.44 m2. But revers, in zone one, the largest land subdivisions happened in the buffer 4000 meters. For zone two, one of the main reasons refers to the natural restriction. In this part of the city located the Tajan river, and the river has limited physical expansion of the city compared to the other zones (see Figure 217, Figure 218, Figure 219, and Figure 220).

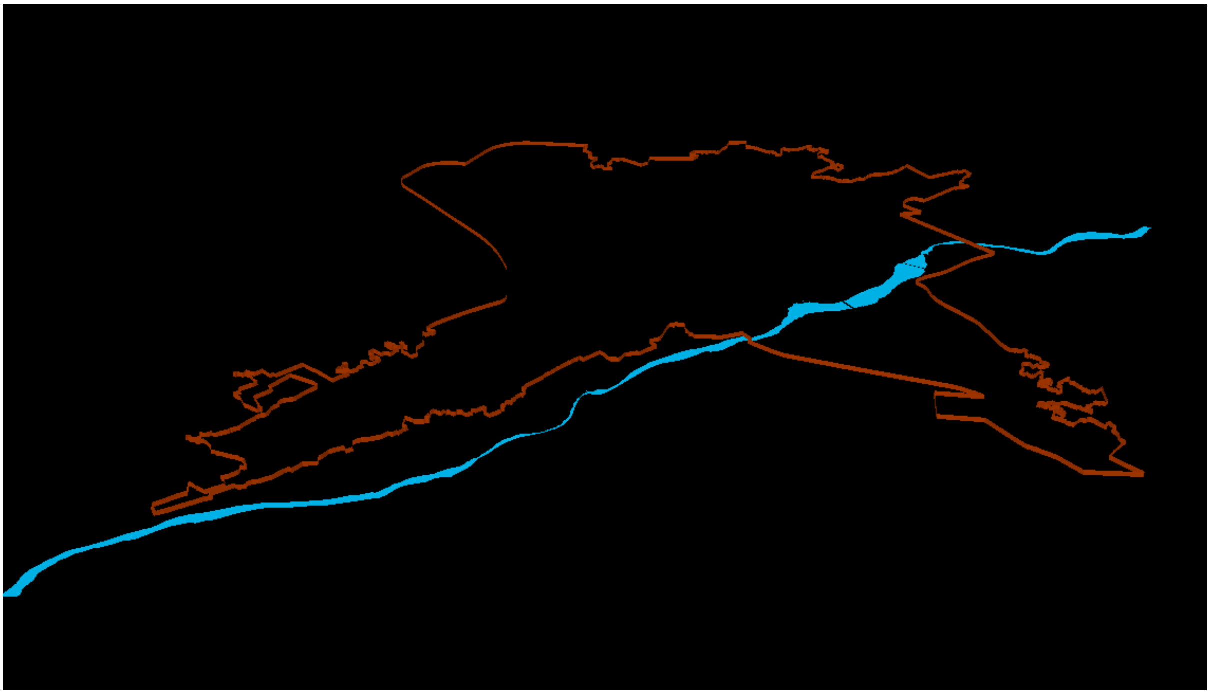

Figure 217 The geographical position of the Tajan river considering the official border to the Sari city (by the author)

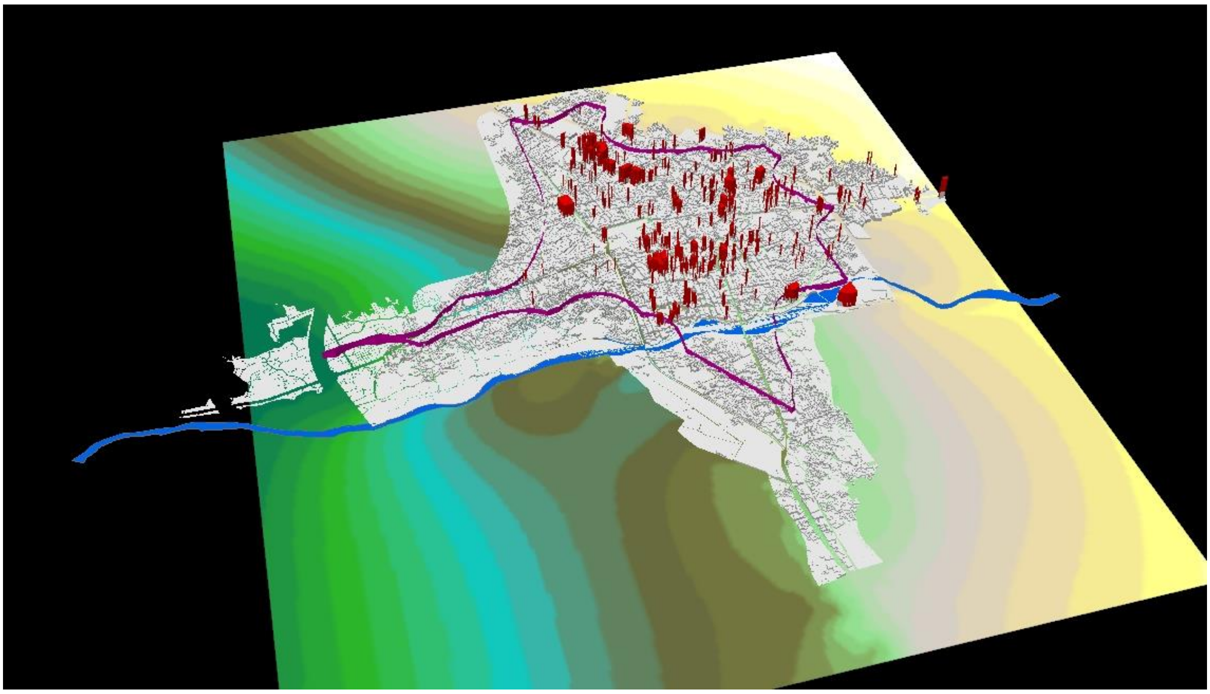

Figure 218 The presentation of the density of big buildings in the inner zone of Sari city (by the author)

As presented in the above picture, the red color distinguishes the shapes of the big buildings between 5-8 floors from small buildings and land parcels that are colored white. The purple color shows the official border, and the blue represents the Tajan river.

Figure 219 The geographical position of the Tajan river considering the physical body of Sari city (by the author)

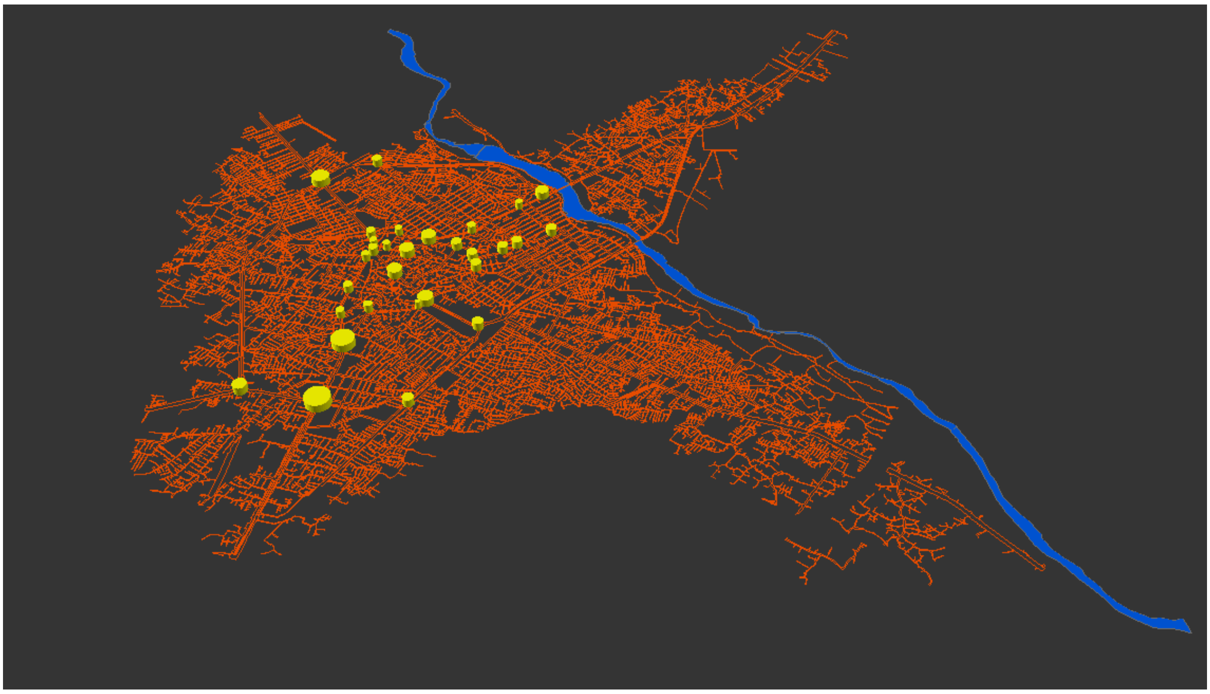

Figure 220 The road networks of Sari city (by the author)

The other factor refers to the land value and development policies in zone one. As shown in Figure 207, just two sectors have the highest land value, one of them located in this zone. It has affected the agricultural lands near these sectors because people have tried to subdivide valuable agricultural lands and construct new buildings for more profit.

As shown in Table 81, most land use changes happened in the buffer 1000 meters. That was happened in the periphery of this city, in a village quite near the city. These villages are growing and populating because the dwellers tend to work in the city but live outside of the city, away from the daily traffic and sound pollutions of big cities. And the buffer 4000 meters has the second place then in, and the lowest changes have taken place in the Inner-zone.

For this sector, about 83% of the changes happened in the buffer 1000 meters, 13% in the buffer 4000 meters, and 4% in the Inner-zone Figure 222.

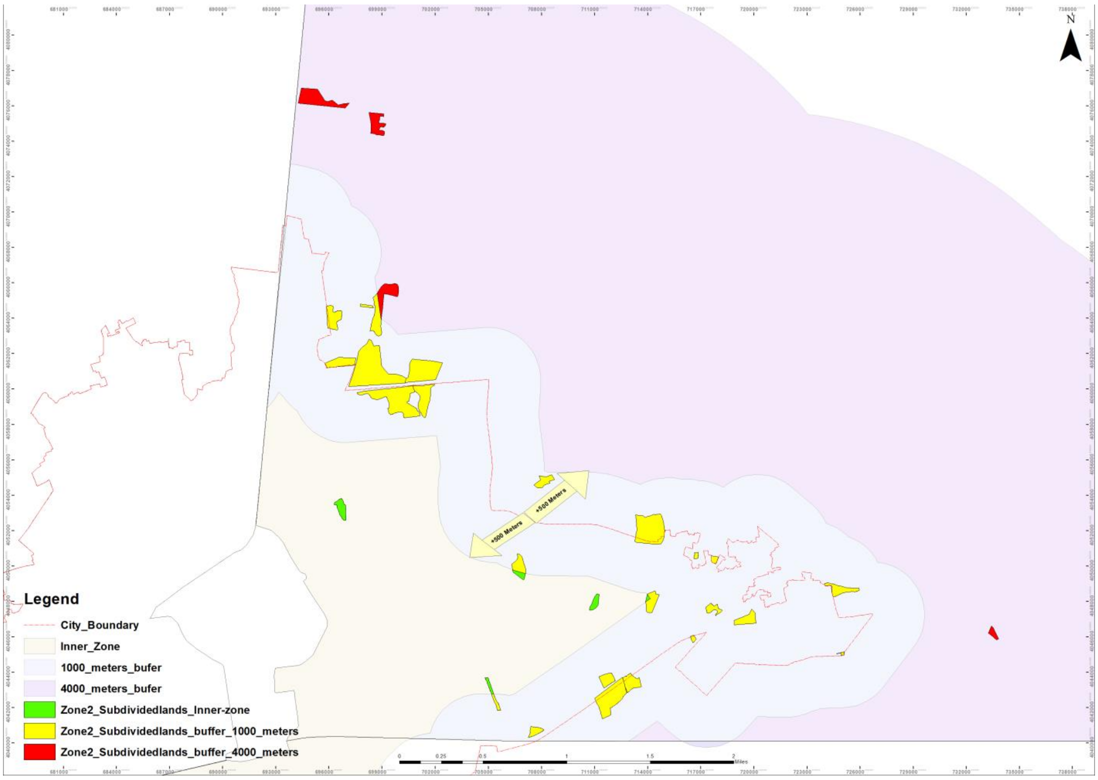

Figure 221 The subdivided land parcels in zone two considering the three classes of buffers (by the author)

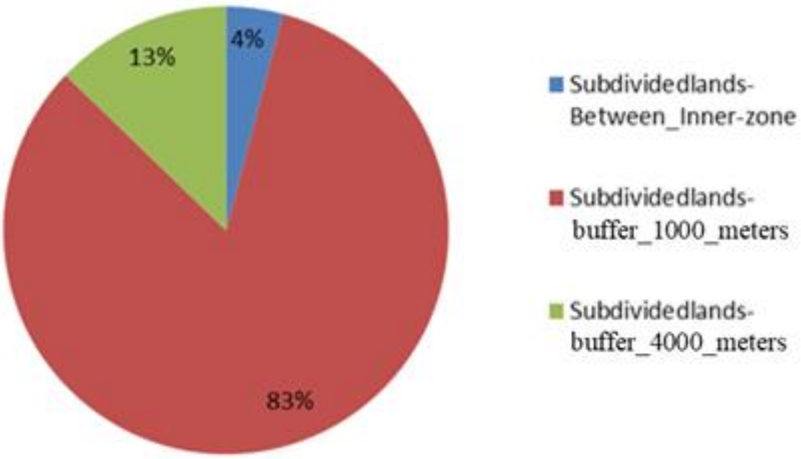

Figure 222 The percent of the subdivided land parcels in zone two (by the author)

Table 81 The area of the subdivided land parcels in zone two considering the three classes of buffers (by the author)

Zone's Class	Classes	Count	Square Meters
Zone2	Subdividedlands-Between Inner-zone	5	31556.23449
Zone2	Subdividedlands _buffer_1000_meters	24	633828.4419
Zone2	Subdividedlands _buffer_4000_meters	4	97743.76954
Sum		**33**	**763128.4459**

The subdivided lands and under construction

The layer of the Subdivided lands and under Construction is the second group of these three classifications Figure 223. In zone two, in terms of area, the largest land subdivisions happened in the buffer 1000 meters, about 1145001.11m2.

As shown in Table 82, most land use changes happened in the buffer 1000 meters. One of the main reasons refers to the villages that are closed to this area. The city has been expanded physically towards the villages that one day had a considerable distance from the city as far as, in some areas, they are going to link together. Also, this area is urban edges where the most and highest building activities have been taking place every day. And the buffer 4000 meters has second place, and the lowest changes have taken place in the Inner-zone.

For this sector, about 82% of the changes happened in the buffer 1000 meters, 15% in the buffer 4000 meters, and 3% in the Inner-zone Figure 224.

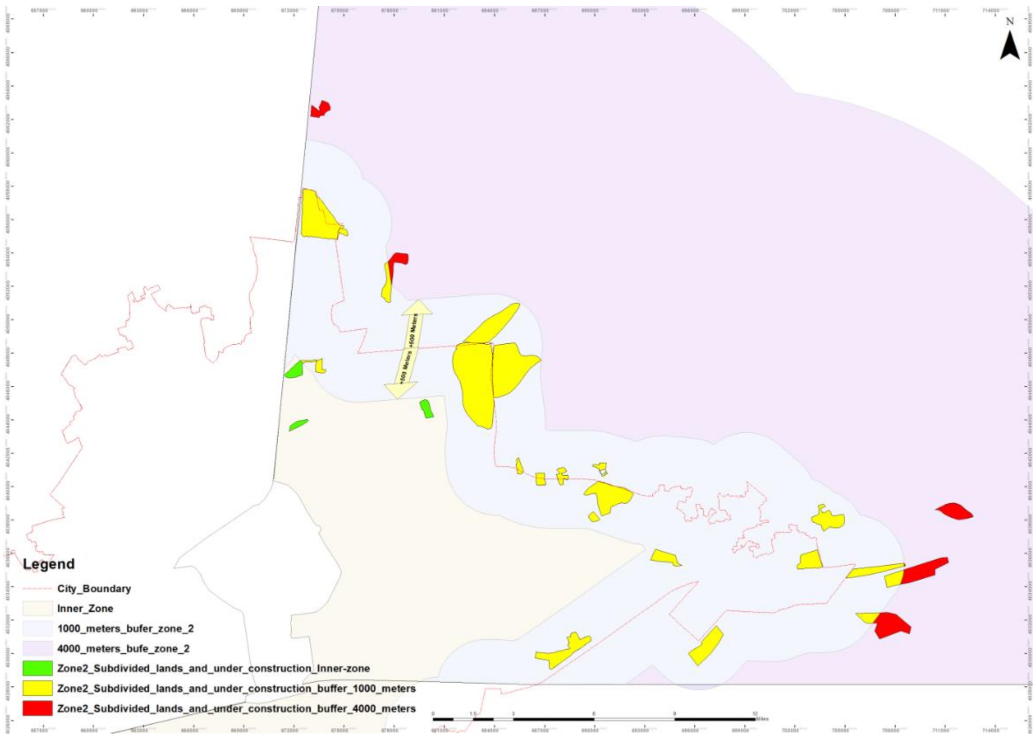

Figure 223 The subdivided and under construction land parcels in zone two considering the three classes of buffers (by the author)

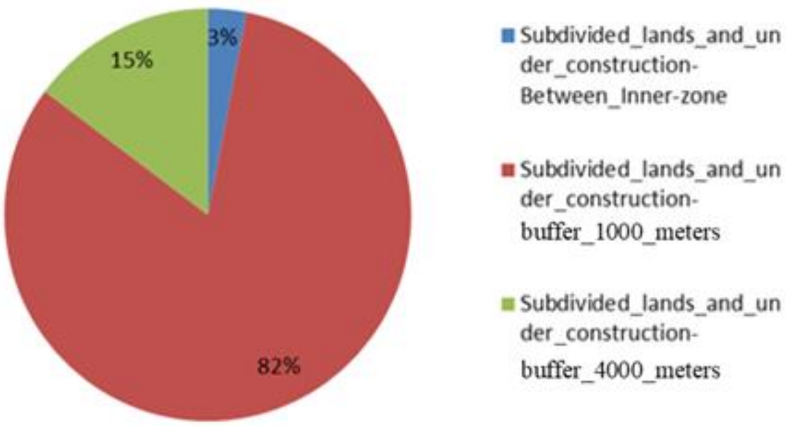

Figure 224 The percent of the subdivided and under construction land parcels in zone two (by the author)

Table 82 The area subdivided and under construction land parcels in zone two (by the author)

Zone's Class	Classes	Count	Square Meters
Zone2	Subdivided_lands_and_under_construction-Between_Inner-zone	3	42657.35672
Zone2	Subdivided_lands_and_under_construction _buffer_1000_meters	22	1145001.117
Zone2	Subdivided_lands_and_under_construction _buffer_4000_meters	6	206010.454
Sum		**31**	**1393668.927**

The subdivided lands and Built-up

The layer of the Subdivided lands and Built-up is the third group of these three classifications Figure 225. In zone two, in terms of area, the largest land subdivisions happened in the buffer 1000 meters, about 226054.86 m2. Interestingly, despite the low number of the land parcels that have changed in the buffer 4000 meters, that were three parcels, but the area is remarkably large. The reason refers to the construction of a big Water treatment center for this city in this area. About 10 Hectares of valuable agricultural lands were used for building this center. The other reason refers to the road networks development policies in this city. As shown in Figure 179, the city has designed proposed roads, especially for this area, to provide a possibility to allow the city to continue physical growth and expansion in this area.

As shown in Table 83, considering the area of land use changes, the buffer 1000 meters has faced the largest changes. And the buffer 4000 meters has second place, and the lowest changes have taken place in the Inner-zone.

For this sector, about 55% of the changes happened in the buffer 1000 meters, 41% in the buffer 4000 meters, and 4% in the Inner-zone Figure 226.

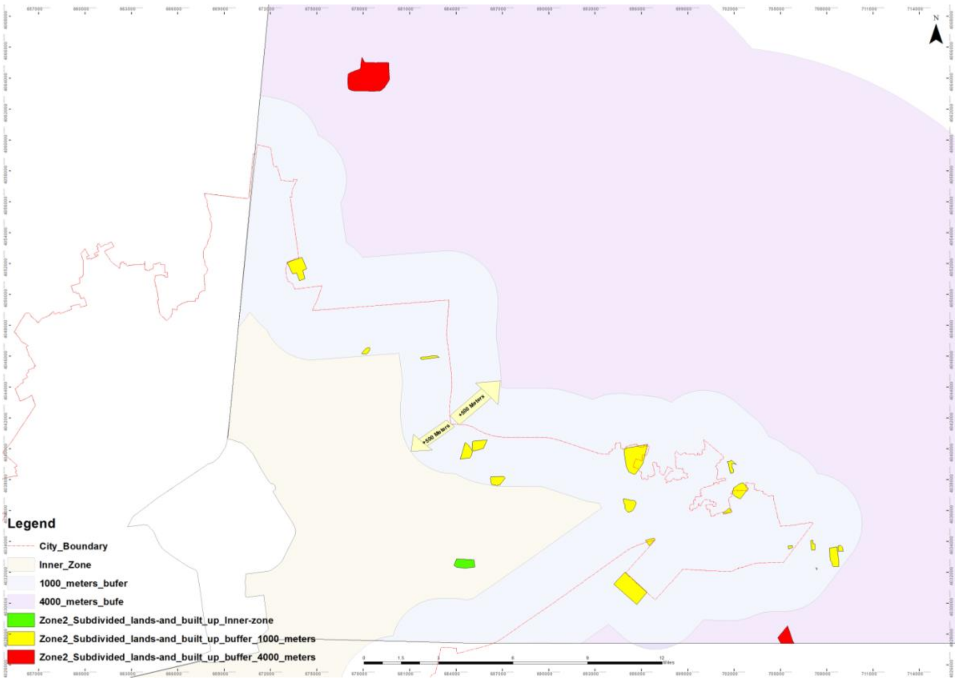

Figure 225 The subdivided and built-up land parcels in zone two considering the three classes of buffers (by the author)

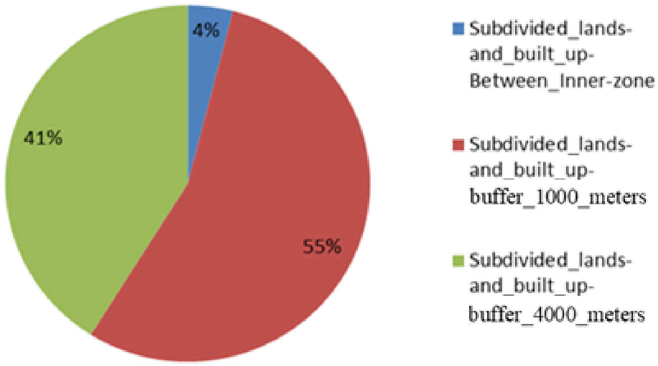

Figure 226 The percent of the subdivided and built-up land parcels in zone two (by the author)

Table 83 The area of the subdivided and built-up land parcels in zone two considering the three classes of buffers (by the author)

Zone's Class	Classes	Count	Square Meters
Zone2	Subdivided_lands-and_built_up-Between_Inner-zone	1	16462.1257
Zone2	Subdivided_lands-and_built_up _buffer_1000_meters	18	226054.8572
Zone2	Subdivided_lands-and_built_up _buffer_4000_meters	3	169104.6135
Sum		**22**	**411621.5963**

Zone 3

This zone encompasses half of both west and east sides, south, southwest, and southeast part of this city Figure 181.

The subdivided lands

The layer of the class of the Subdivided land is the first group of these three classifications Figure 230. In zone three, in terms of area, the largest land subdivisions happened in the buffer 1000 meters, about 146197m2. The subdivided land significantly follows the road networks, especially the proposal roads network Figure 229. But as shown in the figures between 6-29, the proposal roads pass through the agricultural lands. But it should be noted that the city under this strategy has attached about **4,393 Hectares** of agricultural lands and villages to the city Figure 227 and Figure 228.

On the one hand, it provides new opportunities and a big market for home building companies and persons, and on the other hand, it increases consumption of valuable agricultural lands and allows the city to grow horizontally, sprawl and non-sustainable. The continuation of a growth that has no public profit and just secure profits of private sectors. It is just ruining the environment and natural resources. Additionally, physical expansion increases service costs for constructing gas, water, electricity, and swear networks. Also, it increases the use of private cars, resulting in an increase in the consumption of fossil fuels and consequently increases greenhouse gas emissions. In other words, it intensifies climate crisis, global warming, and the earth's vulnerability.

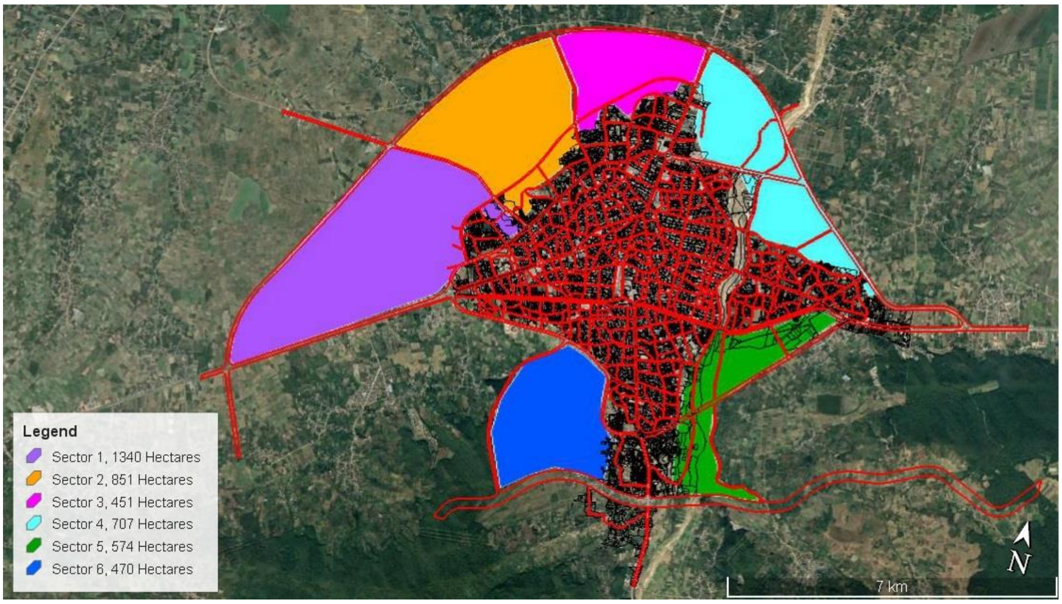

Figure 227 The peripheral areas attached to the physical body of Sari city (by the author)

The above picture presents the periphery areas of Sari city, including villages and agricultural lands attached to the physical body of the city according to the last development plan. The total area of the colored sectors from one to six is about 4,393 Hectares.

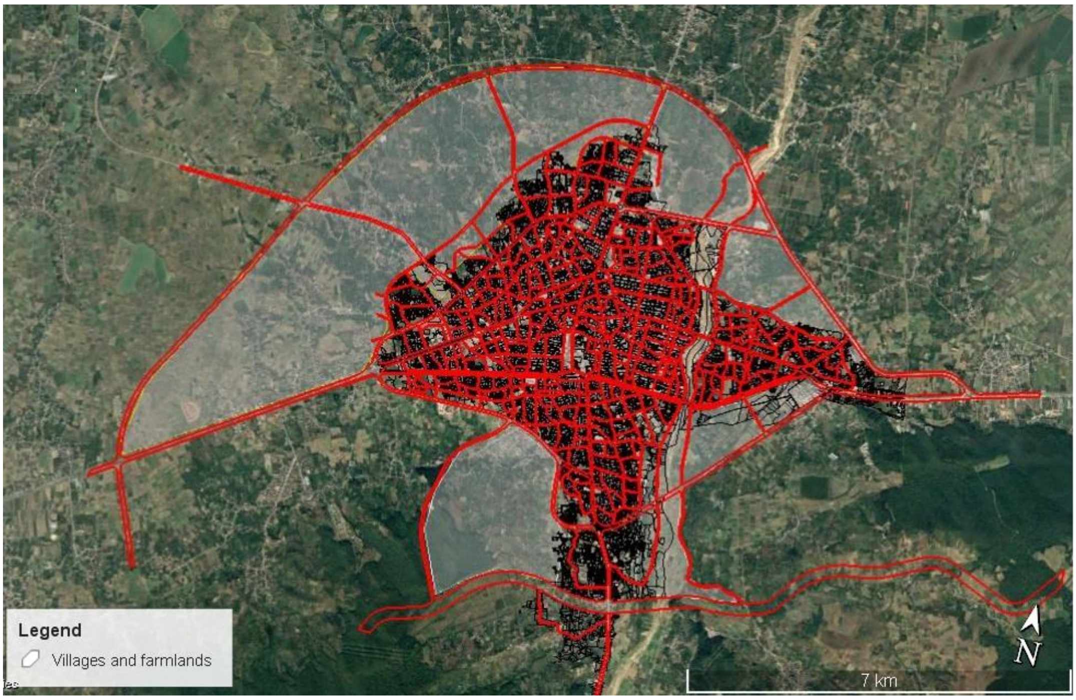

Figure 228 The proposed roads network of Sari city (by the author)

The above picture presents the proposed roads network according to the last development plan of Sari city, which attached many agricultural lands and villages to the physical body of the city.

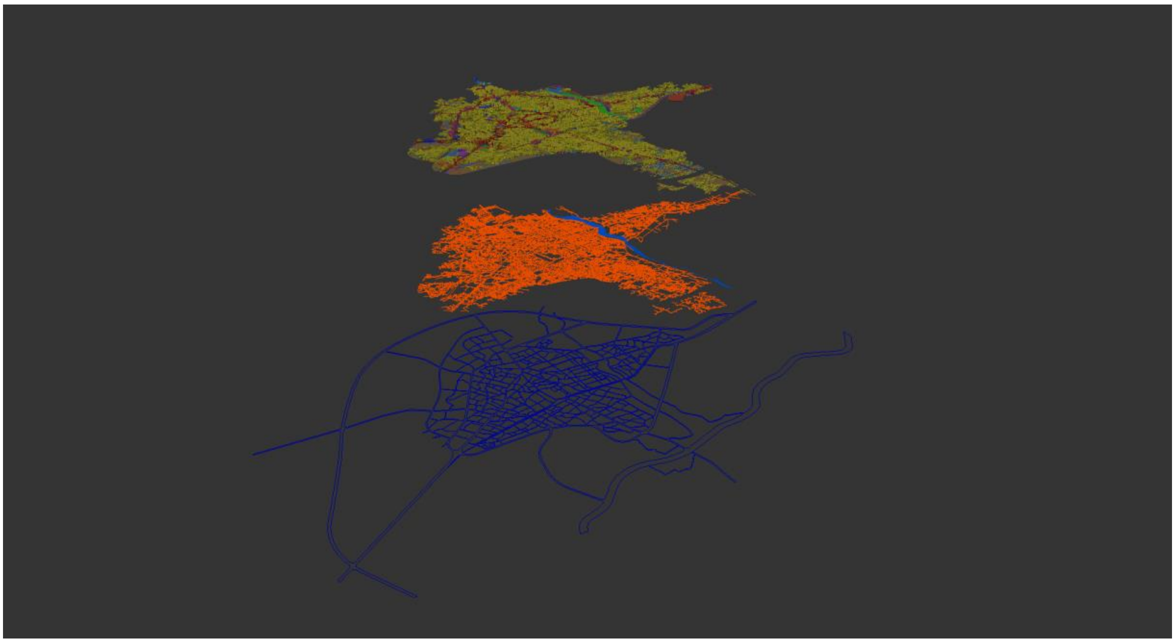

Figure 229 The layers of the physical body of Sari city (by the author)

As presented in the above picture, the first layer from the top is the layer of land use, the second is the layer of the current road networks, and the last is the layer of the proposed road networks.

As shown in Table 84, most land use changes happened in the buffer 1000 meters. And the buffer 4000 meters has the second place then in, and the lowest changes have taken place in the Inner-zone.

Table 84 The area of the subdivided land parcels in zone three considering the three classes of buffers (by the author)

Zone's Class	Classes	Count	Square Meters
Zone3	Subdividedlands-Between_Inner-zone	3	22034.09492
Zone3	Subdividedlands _buffer_1000_meters	8	146197.0115
Zone3	Subdividedlands _buffer_4000_meters	2	43181.75575
Sum		**13**	**211412.8622**

For this sector, about 69% of the changes happened in the buffer 1000 meters, 21% in the buffer 4000 meters, and 10% in the Inner-zone Figure 231.

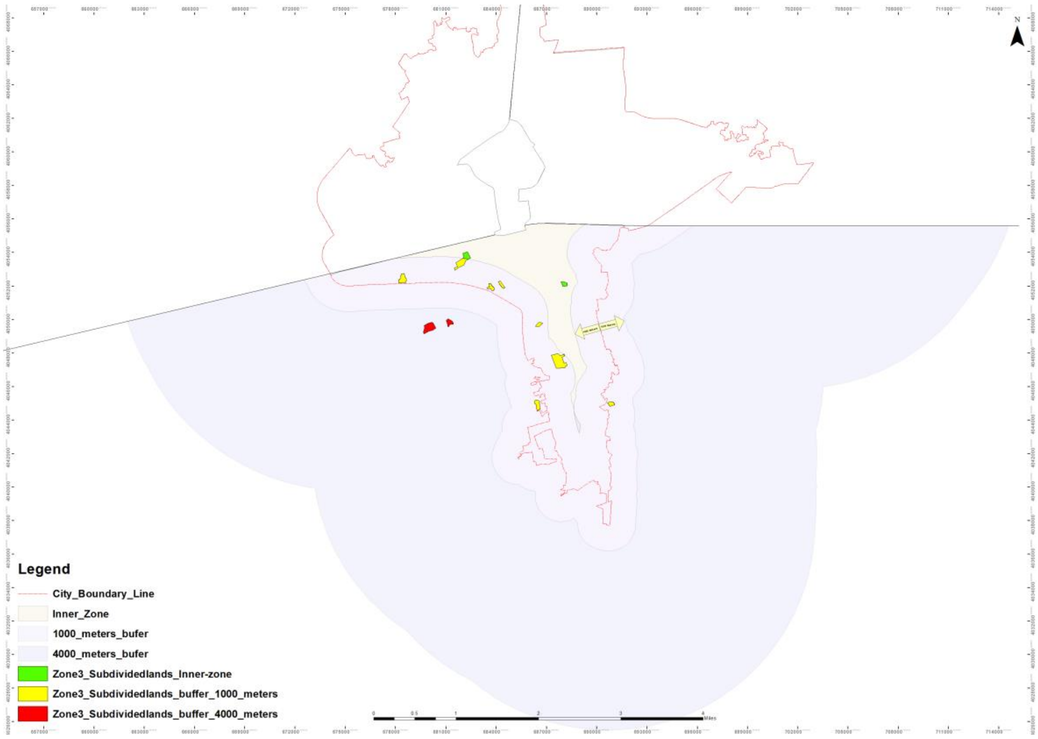

Figure 230 The subdivided land pa rcels in zone three considering the three classes of buffers (by the author)

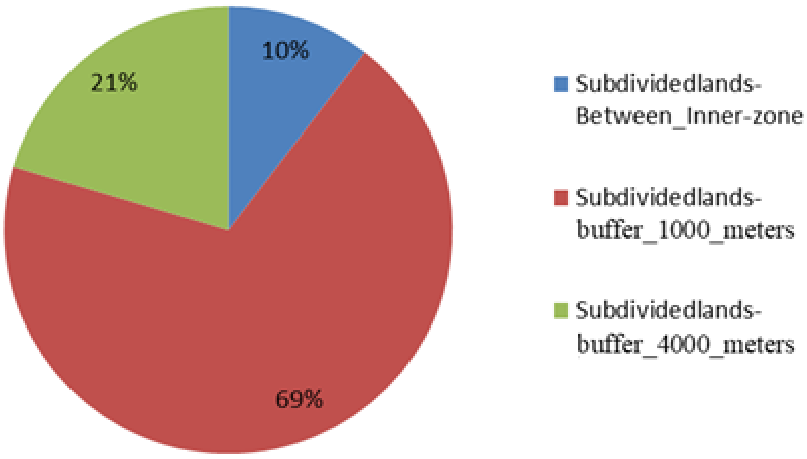

Figure 231 The percent of the subdivided land parcels in zone three (by the author)

The subdivided lands and under construction

The layer of the Subdivided lands and under Construction is the second group of these three classifications Figure 232. In zone three, in terms of area, the largest land subdivisions happened in the buffer 1000 meters, about 2686552.23 m2. The results of these sectors signify the results of the last sector, Subdivided lands. At the same time, locals, landowners, and home building companies are subdividing farmlands and constructing new buildings in this sector. Most of the farmland change cases of this group happened in this buffer, and one of the main reasons refers to the land value. As shown in the map of land value Figure 207, this zone has the lowest land value, and most of the low-income families or between low and middle class trying to settle in this area. This is one of the main reasons that more farmland has changed in this zone.

As shown in Table 85, most land use changes happened in the buffer 1000 meters because this area refers to the urban edges where are under growing process, and most of the new buildings are building in these sectors. And the buffer 4000 meters has the second place, and the lowest changes happened in the Inner-zone.

For this sector, about 62% of the changes happened in the buffer 1000 meters, 31% in the buffer 4000 meters, and 7% in the Inner-zone Figure 233.

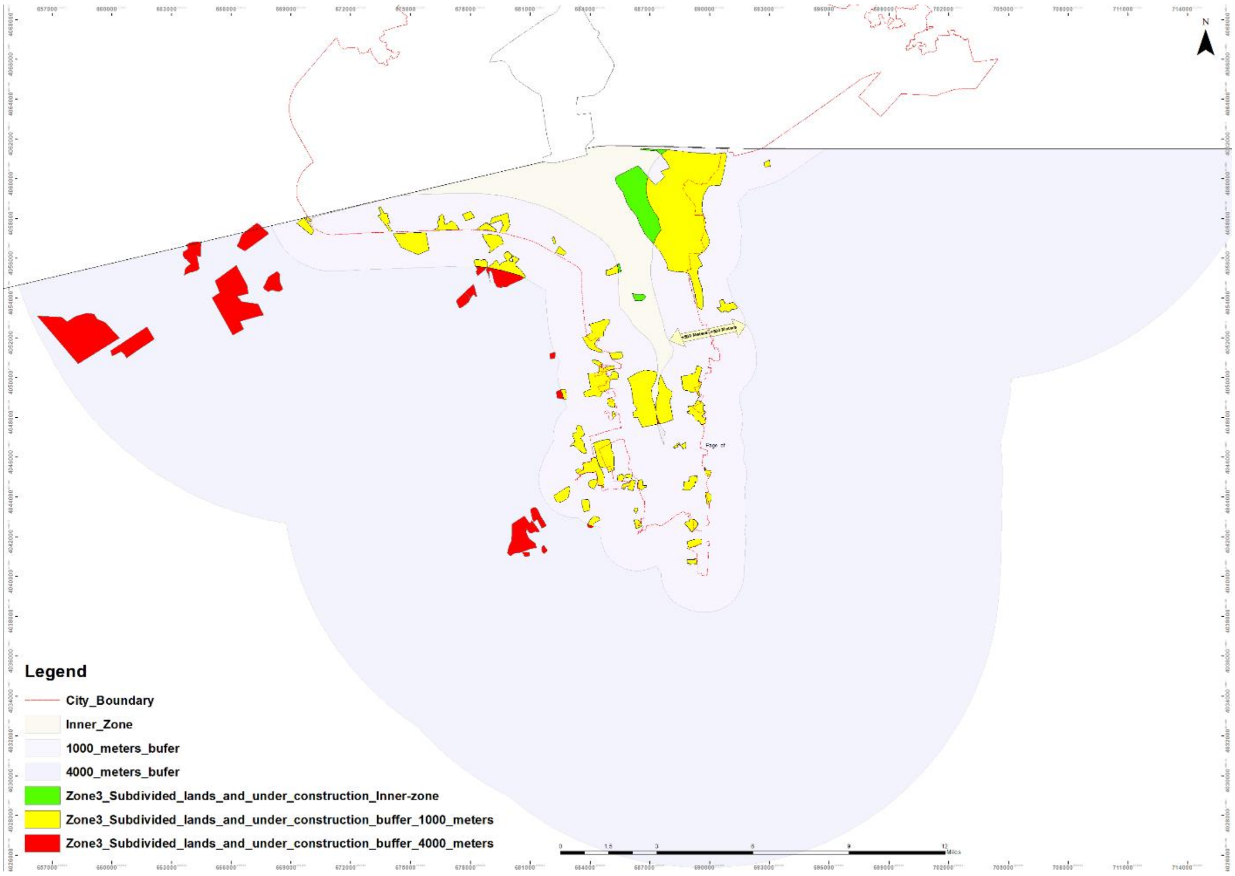

Figure 232 The subdivided and under construction land parcels in zone three considering the three classes of buffers (by the author)

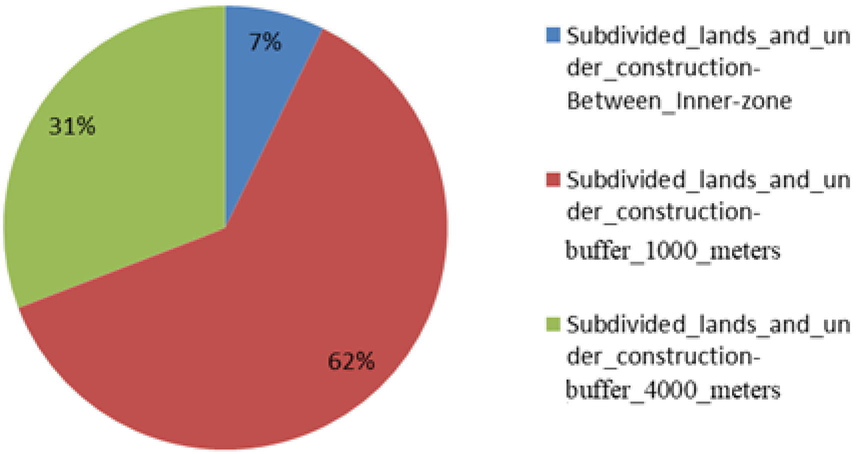

Figure 233 The percent of the subdivided and under construction land parcels in zone three (by the author)

Table 85 The area of the subdivided and under construction in zone three considering the three classes of buffers (by the author)

Zone's Class	Classes	Count	Square Meters
Zone3	Subdivided_lands_and_under_construction-Between_Inner-zone	4	314717.8734
Zone3	Subdivided_lands_and_under_construction-Between_buffer_500_meters	46	2686552.23
Zone3	Subdivided_lands_and_under_construction-Between_buffer_4000_meters	18	1339382.264
Sum		**68**	**4340652.368**

The subdivided lands and Built-up

The layer of the Subdivided lands and Built-up is the third group of these three classifications Figure 234. In zone three, in terms of area, the largest land subdivisions happened in the buffer 1000 meters, about 457797.28m2. One of the main reasons refers to land value as explained before, and the other refers to joining near villages to the city. Zone three has the longest border to the villages and suburbs. This is a big market for the farmers and the easiest way to get money more than all revenues during 20 or 30 years farming on their farmlands.

Also, locating the Shahrak-e-Farhangian as one of the biggest suburbs of this city in this area, a place is still under development and building, effects on the land market and land values in this zone remarkably, which motivates other farmers to subdivide and sell their lands.

As shown in Table 86, considering the area of land use changes, the buffer 1000 meters has been faced the largest changes. And the buffer 4000 meters has the second place and the lowest changes have taken place in the Inner-zone.

For this sector, about 88% of the changes happened in the buffer 1000 meters, 10% in the buffer 4000 meters, and 2% in the Inner-zone Figure 235.

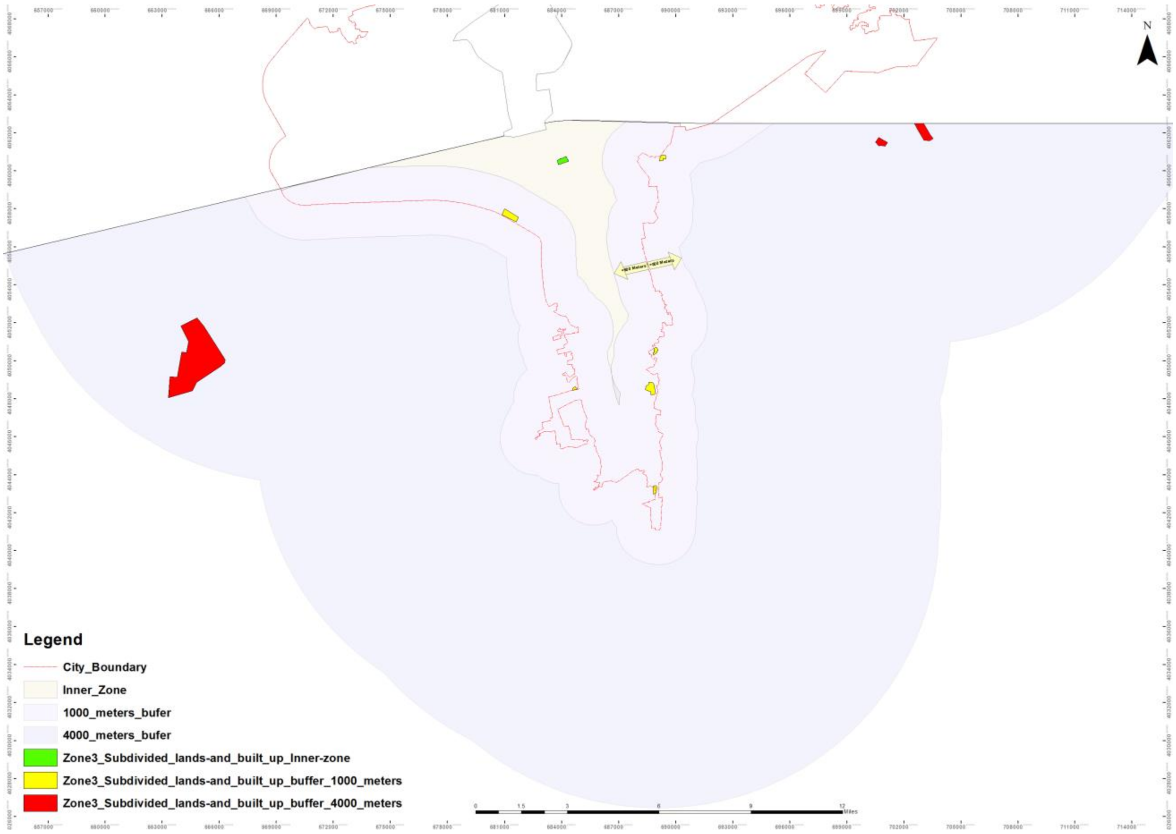

Figure 234 The subdivided and built-up land parcels in zone three considering the three classes of buffers (by the author)

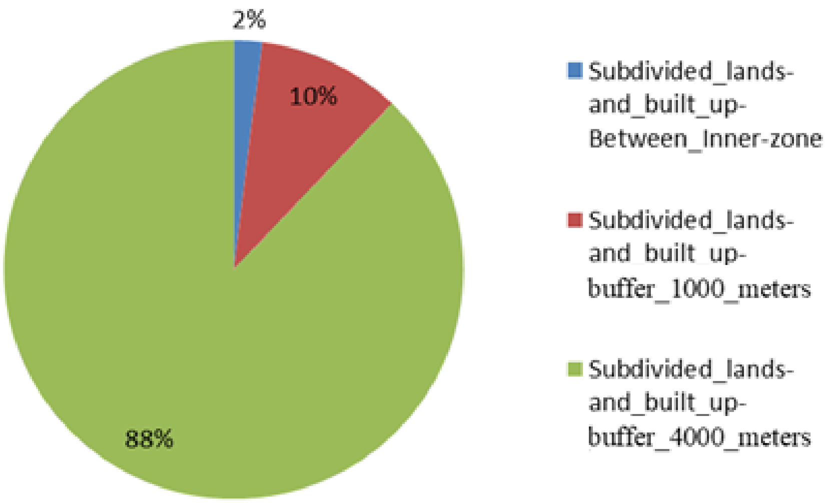

Figure 235 The percent of the subdivided and built-up land parcels in zone three (by the author)

Table 86 The area of the subdivided and built-up land parcels in zone three considering the three classes of buffers (by the author)

Zone's Class	Classes	Count	Square Meters
Zone3	Subdivided_lands-and_built_up-Between_Inner-zone	1	10287.79314
Zone3	Subdivided_lands-and_built_up _buffer_1000_meters	6	52760.88514
Zone3	Subdivided_lands-and_built_up _buffer_4000_meters	1	457797.2822
Sum		**8**	**520845.9605**

Overall view of the three Zones concerning the classified layers

The subdivided lands

Providing a comprehensive view of all three zones and the subdivided and changed lands helps to know how the land-use changes and subdivisions are in the three zones. According to the results, most of the layer Subdivided lands happened in zone two Figure 236. It recognizes that here is the area that has big opportunities for home builders. For zone two, as shown in the map of land value, the land value in the area on the other side of the Tajan river is low Figure 207. And as explained before, in this city, the land value plays a significant role in the land use change and subdivision. It also shows the general trend of the land market that currently is concentrated in this area and will be a massive building field in the following month or years. If you see Table 88, there is a significant difference between the total area of the subdivided land among the three zones. About 68,01 % of the land subdivisions happened in this zone, 76.31 Hectares. About 21,14 hectares 18,84% of the land subdivisions in zone three, and about 14,76 hectares (13,15%) in zone one.

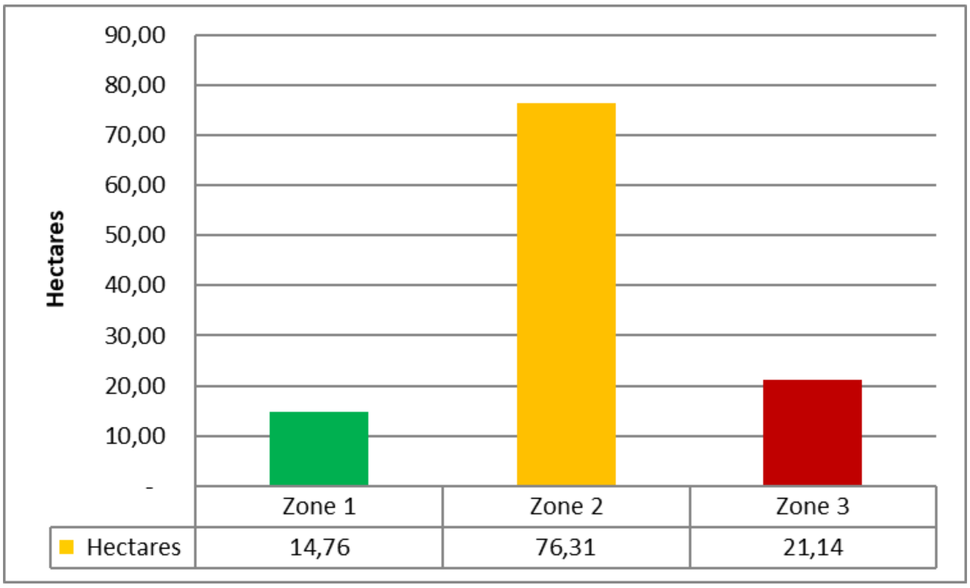

Figure 236 The area of the subdivided land parcels considering the three zones (by the author)

Table 87 The area of the subdivided land parcels considering the three zones (by the author)

Zone's Class	Classes	Count	Square Meters	Hectares
Zone 1	Subdivided lands	11	147.628	14,76
Zone 2	Subdivided lands	33	763.128	76,31
Zone 3	Subdivided lands	13	211.413	21,14
Sum		**57**	**1.122.169**	**112,22**

The subdivided lands and under construction

According to the results, most of the subdivided farmlands and still under construction have been taken in zone one Figure 237. As showed in Table 88, about 236,84 Hectares (46,43%) of changes happened in this zone. It means here is the developing zone, and most building projects have been taken place here.

Also, there is no considerable difference for zones two and three, and 139,37 Hectares (27,32%) of land use changes happened in zone two, and 133,94 Hectares (26,26%) land use changes happened in zone three.

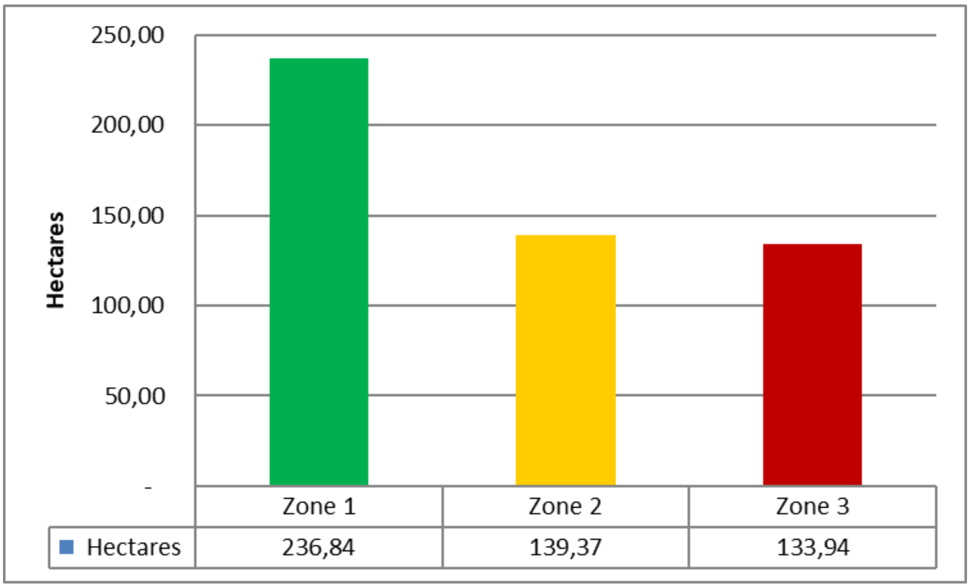

Figure 237 The area of the subdivided and under construction land parcels considering the three zones (by the author)

Table 88 The area of the subdivided and under construction land parcels considering the three zones (by the author)

Zone's Class	Classes	Count	Square Meters	Hectares
Zone 1	Subdivided_lands_and_under_construction	56	2.368.366	236,84
Zone 2	Subdivided_lands_and_under_construction	31	1.393.669	139,37
Zone 3	Subdivided_lands_and_under_construction	18	1.339.382	133,94
Sum		**105**	**5.101.417**	**510,14**

The subdivided lands and Built-up

According to the results, most of the subdivided and built-up farmlands have been taken in zone three Figure 238. As showed in Table 90, about 52,08 Hectares (50,90%) of changes happened in this zone. Because here is the area that the process of building will finish faster than other zones. As explained before, most of between low and middle classes living here. These groups normally try to have a roof over their head, so most of the buildings are small and have one or two floors. Therefore, these small projects are completed faster than big building projects in the other zones. For example, in the zone because of high land value Figure 207, home builders try to increase the height of buildings with more floors to get more profits.

Also, in zone two, about 41,16 Hectares (40,23%) of land use changes happened in zone two, and 09,08 Hectares (8,87%) of land use changes happened in zone three.

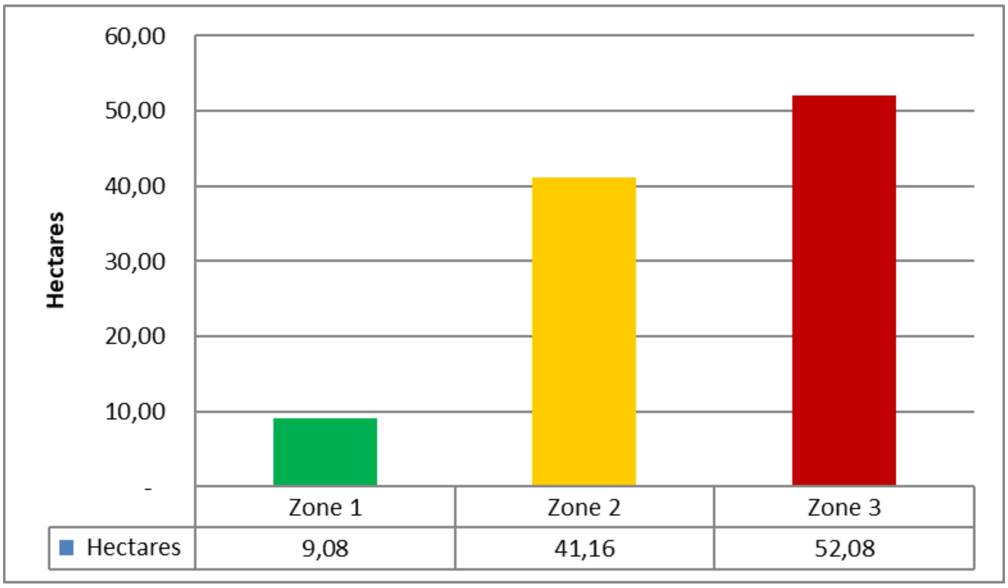

Figure 238 The area of the subdivided and built-up land parcels considering the three zones (by the author)

Table 89 The area of the subdivided and built-up land parcels considering the three zones (by the author)

Zone's Class	Classes	Count	Square Meters	Hectares
Zone 1	Subdivided_lands-and_built_up	4	90.785	9,08
Zone 2	Subdivided_lands-and_built_up	22	411.622	41,16
Zone 3	Subdivided_lands-and_built_up	8	520.846	52,08
Sum		**34**	**1.023.253**	**102,33**

An general view over the changes of the three zones considering the classes

Given the results of this study, in general, most land use changes happened in zone three. About 507,29 hectares of farmland that have been changed in this city occurred in this zone. In other words, about 50% of land use changes occurred here. And between zone two and one, there is no considerable difference. In zone one in total, about 260,67 Hectares of agricultural lands have changed, and in zone two, about 256,84 Hectares (Table 91).

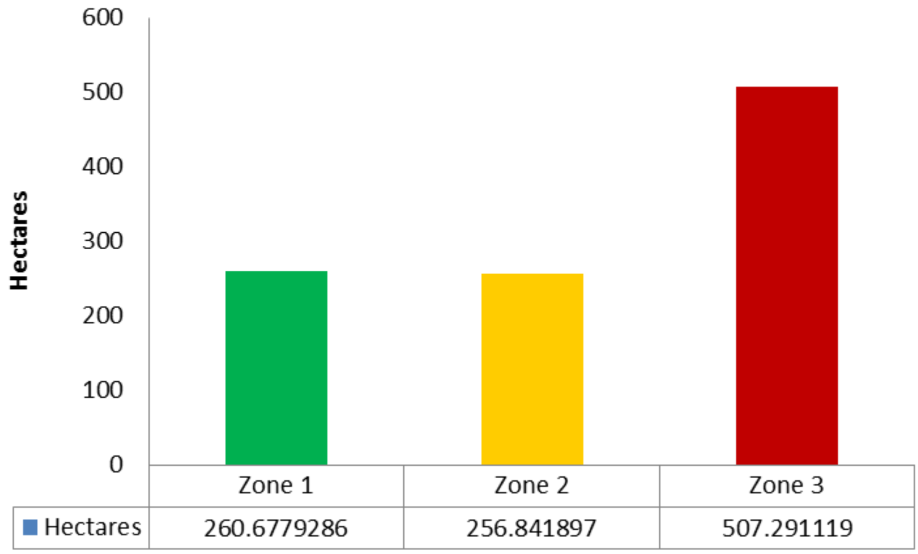

Figure 239 The summed area of the changed land uses considering the three classes (by the author)

Table 90 The summed area of the changed land uses considering the three classes (by the author)

Zones	Classes	Count	Hectares
Zone 1	Subdivided lands Subdivided_lands_and_under_construction Subdivided_lands-and_built_up	71	260.6779
Zone 2	Subdivided lands Subdivided_lands_and_under_construction Subdivided_lands-and_built_up	86	256.8419
Zone 3	Subdivided lands Subdivided_lands_and_under_construction Subdivided_lands-and_built_up	89	507.2911
Sum		**246**	**1024.811**

Chapter Twelve

Conclusions and Solutions

12.1. Conclusions

"Intensifying uncontrolled land-use changes"

Based on this study's results, unfortunately, Iran's planning system has no integrity with the political structure and social system, and there is no coordination and agreement among the players, including enactors, executors, authorities, and planners. The conflict between the political structure and the planning system has failed development plans, and these plans were not executed successfully. Also, this issue has increased inequality because of the unequal distribution of resources and opportunities between urban and rural areas. For example, since the last six decades, the Comprehensive and Detailed Plans have been employed as the main urban development plans in Iran. But according to the results, the nature of these plans contrasts the nature of Iran's political and administrative systems structurally and functionally! Therefore, these plans became passive, and neither couldn't reach their specified goals and have created the following issues:

- massive urban-rural migration
- urban areas, particularly big cities such as Sari became bigger and overpopulated, and resources, services, and capacities are at the limit.
- unequal distribution of resources and infrastructures among the city zones.
- unequal access to the social and health services between the city zones.
- unequal distribution of urban per capita

The other issue is centralization. After the revolution in 1979 occurred many unwelcome changes in the government's functions. As a result, Iran's political and administrative systems became centralized. Accordingly, this issue has imbalanced the national power, created structural problems and disintegrated the planning, political, and public sectors from each other structurally and functionally. Centralization has increased the power of radical Islamists in politics and limited the presence of the majority in the policy- and strategy-making process. The presence of these people in the development policies and strategies making caused incoordination and disagreement among the actors, including authorities, planners, and people. Dictating decisions and orders by the national organizations to the locals and ignoring theirs's opinions have decreased public participation in the planning and execution steps and minimized using local potential in the developing process.

The next issue refers to the ambiguities and weaknesses in enacted legislations and laws, which have negatively affected social-economic orders and activities. For example, the Law of Article 100. This law allows people to construct buildings on a land parcel without permits. Also “The Height of Buildings Act” is the other issue that has intensified land-use changes. Because of this act, high-raised building is not allowed in this metropolitan area and also in Sari. This issue has increased the need for new raw land parcels to construct new buildings.

“The pattern of urban development in the Mazandaran metropolitan area, and distribution of the population”

According to the models' results, Iran's urban population growth will continue in the following decades. Unfortunately, the most significant part of the growth of Iran's urban population and also the Mazandaran metropolitan area resulted from the migration of people from rural to urban areas. And this issue has imbalanced the urban hierarchies of this metropolitan area. And today, we are witnessing a polarized growth in this region, which resulted from the unequal distribution of development opportunities, infrastructures, and facilities between big cities.

Also, the imbalance between the population size of the first big city (Sari) and the smallest city (Gazanak) is too much. Sari has about 347402 population, and Gazanak has about 319 people. Also it should be noted that, the population of Sari is more than the population of 42 cities under 25000, which is about 321,242 people.

Also, according to the regression model results, a strong inverse correlation exists between the rank and size of a cities. Dispersion of logarithm in the cities with a population between 50000-500000 is more imbalanced than the cities under 50000. Among the 60 cities of this metropolitan area, about 31 percent of the urban population has concentrated just in two big cities, and 71 percent of the urban population lives in the rest 58 cities. In other words, 31 percent of the urban population has concentrated just 3.3 percent of the total cities, and 71 percent of the population in 96,67 percent of the total cities.

Between the years 2006-2016 happened a little growth in the population of medium-sized cities in this metropolitan area. If it continues, it helps to decrease the migration of people to the big cities and directs the surplus of the population between the medium-sized cities. Providing more facilities for the both medium- and small-sized cities motivates people to stay in these cities and helps to decrease the concentration of population in the big cities.

Sari has been faced remarkable population growth since the last decades. And the projected demographic models have shown that, this growth will continue for the following decades because of continuing the urban-rural migration. But, the continuation of the population growth is equal to the physical growth of Sari. As shown in Figure 240, the development and physical growth of Sari has followed significantly the main five express roads. Concerning the simulated simple dynamic model in Figure 240, the physical form of Sari looks like an octopus with long arms. For Sari there is a significant interaction between the network development also land use changes over time. And this interaction has progressed a massive physical growth, which happened first along the express roads and later along the arterial streets.

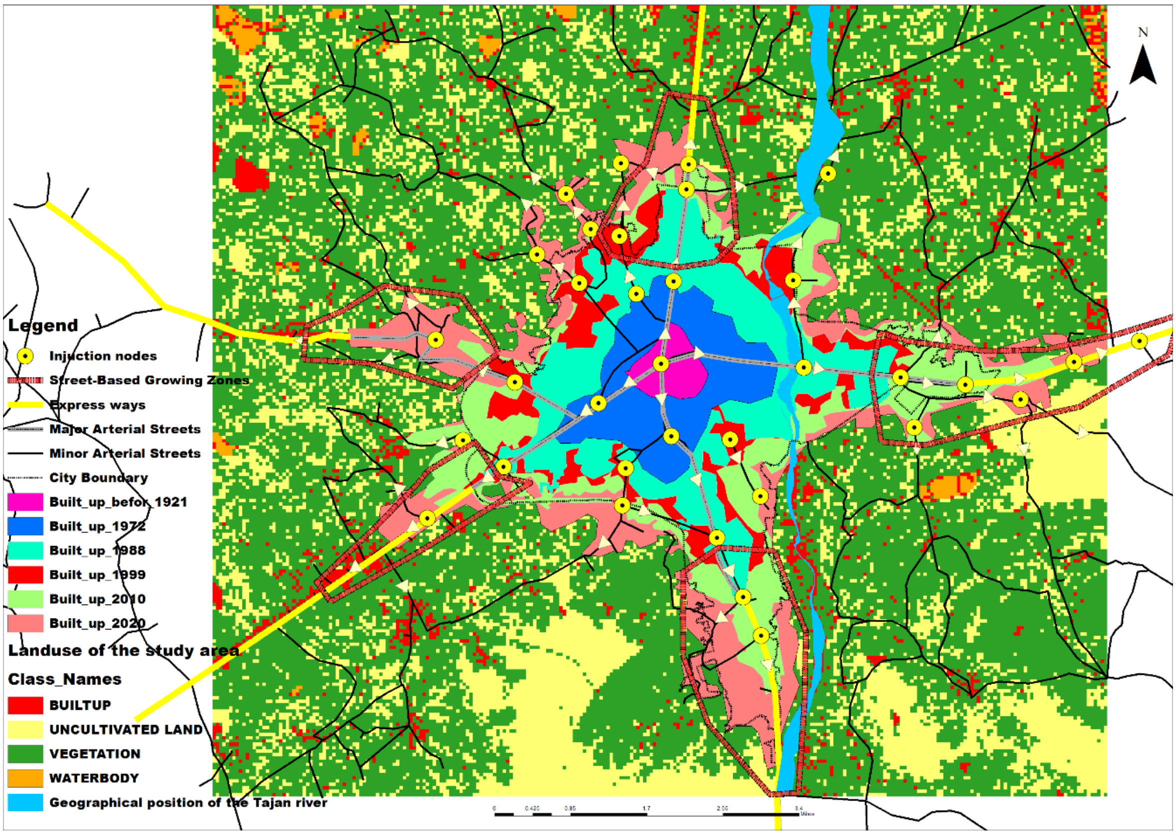

Figure 240 The map of the physical growth of Sari city (by the author)

The map shows the growth of the city from 1921 to 2020. It also illustrated the last land cover changes around the city in the decade 2020. Also, the direction nodes show in which direction is going the city's growth considering road connections.

The results of remote sensing have shown that, sari has grown uncontrolled and scattered, and such non-sustainable land-use changes have faced Sari with many issues. The city physically became seven times bigger than in the year 1972. About 85% growth of the city happened between 1972-2020. In 1972 the area of the city was about 757.08 hectares, but in 2020, the area expanded dramatically to about 5013.37 hectares.

In other words, about 4.256 hectares of valuable farmlands have changed into urban areas during the last five decades. The Built-up area became ten times bigger than in the year 1972. Which was in the year 1972 was about 338.96 hectares, but in 2020, has expanded dramatically to about 3144.36 hectares. And it should be noted that, about 90% of the growth of the built-up area has happened during the last five decades!

According to the results of the aerial images analyzed by ArcGIS, most of the uncontrolled land use changes happened near the official border (buffer 1000 meters) and in the peripheral area (buffer 4000 meters). About 68,01 % of the subdivided land parcels happened in zone two, about 18,84% of in zone three, and about 13,15% in zone one. So, most of the subdivided lands are identified in zone two. Because for this city, land value plays a significant role in land-use change and subdivision, and the land value for the area located on the right side of the Tajan river is remarkably low. Concerning the current situation and the mentioned factors, this thesis predicts massive building projects in zone two in the following month or years!

According to the results of the projected land use changes, the Built-up area will increase as follow:

- about 4154 hectares up to 2030 (about 24.31% growth)
- about 4873 hectares up to 2040 (about 35.48% growth)
- about 5548 hectares up to 2050 (about 46.66% growth)

“Development, economic forces and the intensification of land use changes and consumptions”

Iran, particularly since 2012, has been facing many extreme economic problems. But, as far as the government has access to enormous oil resources and can easily earn millions of dollars, they will not be motivated to care about the other economic sectors. And this issue has affected the urban markets directly and indirectly. Because the enormous wealth of oil resources has increased the centralization of power and wealth in the public agencies. Oil revenue has gradually expanded the government's role in all parts of daily life, and today, the government can nationwide control market forces and players. As a result, today's government became the main and absolute employer of the market. And when the job market like today is unstable and millions of people are jobless, so the people have no chance out of working for the government. In such a condition, the government is gives the job to whoever is with the government and not against it! So, it increases the power of the government in the society. Therefore, today's government does not need more the surplus of rural goods and the flow of wealth and capital from rural to the cities. Billions of revenue from selling under-earth oil have changed the flow of wealth and capital from rural toward the cities. And through commercializing urban capitals and consolidating the government's position as an the main employer in the cities, they have restricted rural development and pushed the villagers towards cities to find a job.

At the national level, Sari city has played a considerable role in providing agricultural goods also services, and industrial activities in the second and third places. However, in the Mazandaran metropolitan area, Sari city has a dominant role in the service activities, especially in areas under the direct sphere of influence of this city. So, this fact clears that, Sari as a capital city, has the most service centers, financial centers, administrations, health and education centers, and recreational activities. According to the results, the following factors have played substantial roles in developing Sari at the local, regional, and even national levels: historical background, geographical location, environmental potentials, administrative functions, and being the capital of the Mazandaran metropolitan area.

On the one hand, these above functions have provided many economic opportunities for Sari city and have developed Sari's role in the region. On the other hand, the unequal distribution of resources, facilities, capital, and job opportunities in this metropolitan area have faced Sari city with the following problems. For example, in the last decades, thousands of people have been migrated to this city to find new jobs, and today this city is overpopulated. So, today's capacities and infrastructures of the city cannot meet the needs of dwellers. Sectoral growth and prioritizing one place over other places have expanded suburbs and sprawl growth, which forced people, especially low-income families, to find cheaper land parcels without any basic service near the official borders, urban fringe, or hinterland.

Also, constructing new road networks has changed the valuable farmlands. These new roads have grown the economic activities and resulted in the construction of massive commercial buildings along the periphery of the main roads. These strategies have progressed the transportation system but also generated environmental issues.

Additionally, economic interests have motivated people to build new houses close to the borders of commercial activities. Economic interests have played a significant role in progressing sprawlization and have surrounded the city with low-density of population and buildings.

According to the results, agricultural and service activities account for the majority of employment. Industrial activities got third place. In the agricultural and service activities, Sari is independent and regarded as a supplier or exporter of services and products. The city is not a supplier of industrial activities and has a dependency.

12.2. Solutions

One of the main drivers of urban growth is economic activities, and according to the results, there is a significant relationship between urban growth and the growth of economic activities. The growth of economic activities is equal to the growth of cities, so difficulties in economic activities at the regional or national levels face the local urban economic activities and markets with issues. And national development affects local and regional development directly and indirectly. So, if decision-makers provide some policies with adverse effects on national development and economic activities; as a result, the urban-rural activities will be affected negatively at the local and regional levels. In this regard, after the revolution of the year 1979, Iran's economic structure has changed because of some dramatic changes in the political structures and centralization. Which changed the suply chain, imbalanced and changed the urban-rural economic activities. As a result, these issues stopped small economic activities, affected rural development negatively and forced people to migrate from rural to urban areas. Therefore, this thesis proposes reducing the presence of government, semi-governmental agencies, and military forces in economic activities. Additionally, it is necessary to increase the presence of private sectors in economic actvities regardless of small or large businesses. Because, for national economic development and realizing urban-rural development, is necessary to have a safe market with equal opportunities. This strategy boosts the market and increases job opportunities in both urban and rural areas. This study is for the presence of government in the economy, but just as a controller and supporter of the market, and not more. The government should monitor all activities, enact required and supportive rules, and supervise during the implementation and execution of development plans and projects.

In the following, further solutions were presented considering the aims of this thesis.

So, the next solution is for Iran's planning system. First, updating the urban development plans' guidelines and principles are required at the national level. Just copying and using planning theories and principles from the industrialized countries to develop Iranian's cities, is not a good idea. Because each country has its own social and political structures. For example, "Comprehensive Plan" and "Detailed Plan," have been used for more than seven decades the for development of Iranian cities. But according to the results, neither could implement successfully in Iran. this study belives, successful implementation of these plans depends on doing some required structural changes in Iran’s planning system and political structure concerning the nature of these plans.

And second, making development plans policies and strategies according to the local conditions by the local governments helps these plans to be implemented with more success. The local governments must have the main role in the planning and executing process. And national organizations must concentrate on the process of providing development plans, also monitoring during the execution.

In this regard, for the city of Sari, it is required to provide a sustainable model of development plan by the local government considering the local potentials, weaknesses, opportunities, and threats. Otherwise, these plans could not be implemented successfully. Since the last decades in Sari have been implemented many development plans, but no one could be implemented completely and successfully. Because, this problem reffers to the structural issues that were explained especificlly in chapter nine.

The next solution is, decentralizing the current massive centralized political system of Iran. Decentralization increases social-political participation in the processes of development, and this is the right way to decline polarization and provide equal opportunities for the development of urban and rural areas. Because, it is necessary to provide a safe space for social-political activities and enhance the role of private sectors and NGOs in the process of development.

In the following, further solutions were presented for controlling the sprawl growth and contributing vertical growth instade of horizental growth. It is absolutely necessary to amend the legal barriers of the high-rise building. Because, in the detailed plans, constructing big buildings and contributing vertical growth is not allowed in this city. And this issue has reduced the density of buildings, distributed the population horizontally, and increased demands for getting permits to construct new houses and apartments. As a result, these issues has increased land consumption because of increasing demands for new raw land parcels to construct new buildings. Therefore, amending this rule is neccessary to contribute High-rise buildings. It helps to have a compact model of city development, and reduces land-use changes and land consumptions.

In the following, further solutions were presented to control the population growth of Sari city, which will be effective to decrease the massive migration from other areas to this city considering the position of Sari in this metropolitan area. According to the results, the urban system of the Mazandaran metropolitan area is imbalanced. There is a remarkable imbalance between the size and rank of cities, particularly in the group of the big- and medium-sized cities. But, fortunately, there is no remarkable imbalance in the group of small-sized cities (group A)! Hence, this thesis belives, the **small-sized cities** can play a significant role **in realizing balance** in this metropolitan area and promoting sustainable development.

"The small-sized cities are sustainability friendly and
attention to this group of cities is necessary!"

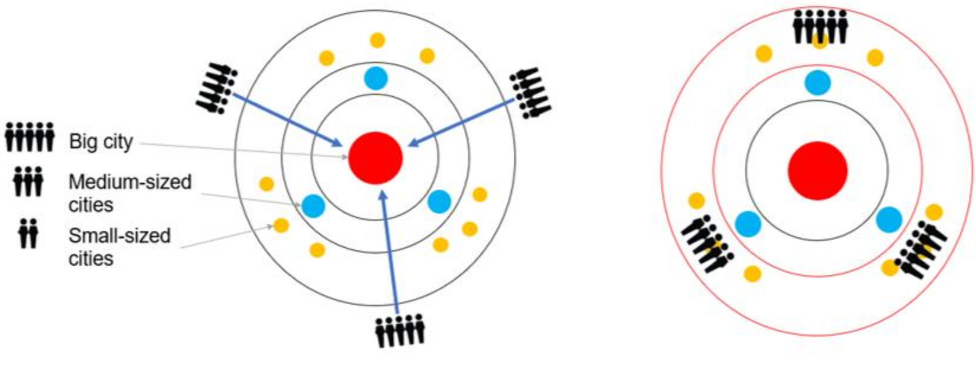

Figure 241Controlling the rapid regional migration to the big cities by the small-sized cities (by the author)

But for this aim, the required infrustructures, facilities, and job opportunities must be provided for the small-sized cities. Because, finding a job is one of the main reason of the migrtation in this metropolitan area. So, if the small-sized cities besides the required infrustructures will be able to provide more job opportunities, it movtivates people to stay in this cities instate moving to the big cities.

The next solution is addressed to the legal barriers. According to the results, some legal barriers have created new propbelms in the city of Sari. So, the following amendments are necessary in the urban laws:

1- Eliminate the law of (“ Article One Hundred” or Maddeh Sad”). As it was deiscussed before, this law allows people to construct new buildings or change land uses without getting before a permit. Therefore, untill this law exists, urban development plans and land use plans could not be emplimented successfully. So, It is necessary eliminate this law to stop this destructive and non-sustainable process.

2- Reviewing The Height of Buildings Act. As it was deiscussed before, this act do not allow high-raised building. And this issue has increased the needs to the new land parcels. So, this thesis propopses about 30% or 40% Increase in the height of buildings. Increasing the density of hight is better than increasing the density of land parcels! It helps to use land resources efficiently and control this non-sustainable trend.

And the last solution is addressed to the controlling unplanned small or big building projects. The people building on land parcels without respect to the road network plan or land use plan. Even they have started building projects in places without any accessibility to the water, gas and electricity networks.

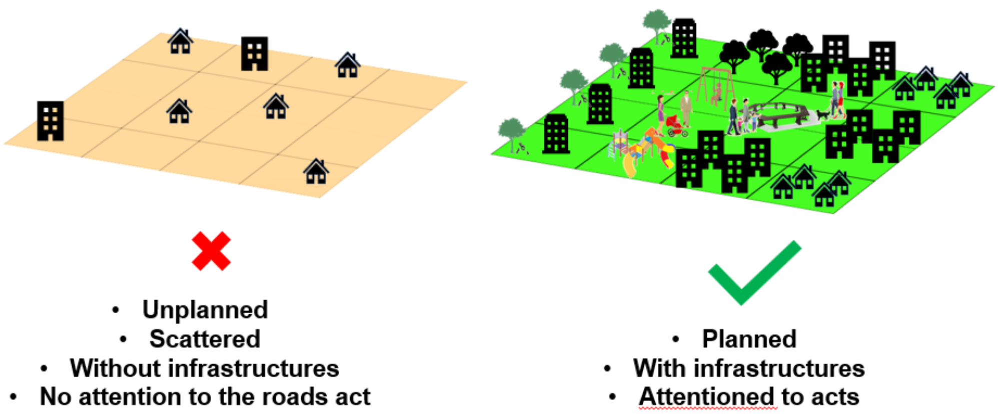

Figure 242 A planned building progect to control unplanned land use changes (by the author)

In this regard, this thesis proposes building new planned suburbs with affordable apartments and houses exemplarily for two or three thousand residents to control unplanned land subdividing and building progects.

But this project must have the following criterias:

- Providing an accessible and effective transportation system,
- Providing essential required urban services and infrastructures considering per capita,
- Considering environmental limitations in this project,
- Promoting mixed-use activities considering compatibility, proximity, capacity, accessibility, and type of activities,
- Increasing the density and height of buildings to use land recourse more effectively,
- Building homes and apartments at an affordable price for low- and middle-class families.

Answer to the research questions considering the results and solutions:

What are the causes of instability and increasing land-use changes in the big city of Sari, and what factors play a role in exacerbating it?

Iranian cities since the last decades have been faced with uncontrolled land use changes issues and this challenge it is not just limited to the city of Sari. The following factors are the main reasons that have intensified land use changes in this city:

- Disintegrity amon Iran's planning system, political structure, and social system
- Incoordination and disagreement among the players, including enactors, executors, authorities, and planners,
- Structural and functional contrasts between the nature of urban development plans with the nature of Iran’s political and administrative systems,

- The centralized political structure has imbalanced the national power, created structural problems and disintegrated the planning, political, and public sectors from each other structurally and functionally,
- The ambiguities and weaknesses in the urban legislations and laws.

How is the pattern of urban development in the Mazandaran metropolitan area considering the distributions of the population in the cities and place of Sari city in this region?

According to the models' results, Iran's urban population growth will continue in the following decades. Unfortunately, the most significant part of the growth of Iran's urban population and also the Mazandaran metropolitan area resulted from the migration of people from rural to urban areas. Sectoral development strategies and the unequal distribution of development opportunities, infrastructures, and facilities between big cities have intensified noncontrolled urban-rural migrations.

The following items indicate the current situation of the Mazandaran metropolitan area:

- The urban hierarchies are imbalanced,
- Also, the imbalance between the population size of the first big city and the smallest city is too much,
- There is a strong inverse correlation between the rank and size of cities. About 31 percent of the urban population has concentrated in just 3.3 percent of the total cities, and 71 percent of the population in 96,67 percent of the total cities,
- Sari has been faced uncontrolled population growth since the last decades,
- Sari has grown uncontrolled and scattered, and such non-sustainable land-use changes have faced Sari with many issues,
- Most of the uncontrolled land use changes happened near the official border,
- Land value plays a significant role in land-use change and land subdivision in this city.

What development forces have intensified land use change and consumption in this city, and how?

Generally, economic forces play significant roles in the development process. Iran's centralized political structure has weakened private sectors in economic activities and powered the Government. On the one hand, and this issue has increased the presence of the government particularly in cities. And on the other hand, it decreased the attention of the government to the development of rural areas. And his issue has increased urban-rural migrations and big cities like Sari have become more populated. The uncontrolled migrations have intensified land use changes and land consumptions in the city of Sari since the last decades.

The following items have increased the migration from Medium- and Small-sized cities also rural areas to the big city of Sari and intensified land use changes and consumptions:

- Sari city has a considerable role in providing agricultural goods also services and industrial activities at the national and regional levels,
- Sari as a capital city, has the most service centers, financial centers administrations, health and education centers, and recreational activities,
- Also, constructing new road networks because of economic activities have changed the valuable farmlands, and created environmental issues,
- Low-density building has progressed sprawl growth.

How can drive the uneven and destructive spatial pattern of urban development and intense land-use changes of Sari city toward a balanced and sustainable path?

According to the results, the abovementioned issues are the main reasons for this city's sprawl growth and uncontrolled land use changes. Therefore the following solutions can help to drive the uneven and destructive spatial pattern of urban development and intense land-use changes in Sari city toward a balanced and sustainable path:

- Decentralizing the political and administrative systems and distributing power between all players and relevant organizations in order to decrease the structural and functional contrasts between the nature of urban development plans with the nature of Iran's political and administrative systems
- Increasing the structural resiliency and effectivity by maximizing participation in the planning, management, and policy-making process.
- Increasing the coordination and agreement among all actors, including enactors, executors, authorities, and planners.
- Increasing the structural integrity of the planning system, political structure, and social body.
- Giving more power to the local organizations and authorities during the planning, decision-making, and execution of development projects.
- Increasing the local participation in the planning and execution steps benefits their support to implement plans more successfully; and reduces the risk of failure by paying attention to the locals' wishes in the planning process!
- Equal distribution of resources, budget, development projects, and opportunities between the regions to control the migration from non-developed areas towards more developed areas, particularly big cities.
- By controlling the migration, we would be able to control the growth of housing demand, control pressure on the housing market, control population density in the inner zones, which has pushed the surplus of population towards the outside, control subdividing farmlands, and control sprawl growth.
- Paying more attention to small-sized cities is necessary. Considering the imbalance in the urban system of the Mazandaran metropolitan area, particularly in the big- and medium-sized cities, the small-sized cities can play a significant role in realizing balance in this metropolitan area.
- Eliminate the law of (" Article One Hundred" or Maddeh Sad"). It is necessary to stop constructing new buildings, or applying any changes in buildings, or even changing types of activities without permits.

- Reviewing The Height of Buildings Act. About 30% or 40% Increase in the height of buildings can help to use land resources efficiently and control this non-sustainable trend.
- Building new planned suburbs with affordable apartments and houses exemplarily for two or three thousand residents can be one of the leading solutions to control uncontrolled land subdividing and building.

And finally, the author hopes that, this thesis could provide valid and reliable results considering the questions and aims of this thesis. If someone want work on this topic in the future, I propose them to concentrate on the medium- and small-sized cities of the mazandaran metropolitan area. It helps to have a more hollestic view on the urban growth and deveopment of this metropolitan area.

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