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Preparation of future development scenarios of urban landscapes in accordance with natural and socio-economic conditions (on the example of the cities of the Kura-Araz lowland)

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ABSTRACT

Problems Statement and Purpose. More than 50% of the world's population lives in cities. In Azerbaijan, 53% of the population lives in cities. For this reason, almost all global problems originate from urban landscapes. Therefore, it is very important to study the development of cities and prepare the future scenario. Our goal is to study the cities located in the Kura-Araz plain, determine their annual growth rate and forecast future development trends.

Data and Methods. In the article, the development of 17 cities located in the Kur-Araz plain in the central part of Azerbaijan during the historical period and its future forecast were analyzed. Modern methods were especially preferred during the research. Satellite images of cities were processed and the results were analyzed. Satellite images from 1975 and 2023 were used and deciphered in determining the boundaries of cities and studying their dynamics. The dynamics of changes in the areas of the cities were studied by determining the boundaries of the cities, and the dynamics of population growth was studied and analyzed. Statistical analyzes were used in the study of the population.

Results and Discussion. The cities of Kura-Araz lowland cover 25% of the cities of the republic. These rivers are the main source of the formation of cities. However, as these coastal cities grew, the ecological problems of the Kura and Araz rivers increased and the water level decreased. Cities have grown in all directions and are still growing. For the first time in Azerbaijan, urban landscapes were studied based on GIS technologies and Remote Sensing methods. For the first time, the factors of natural conditions, the absolute height, inclination and exposure of the terrain were analyzed based on GIS technologies, and it was determined that 2/3 of the research area is located below sea level, and 1/3 is located in areas up to a maximum of 200 m absolute height. The inclination of the area continues up to a maximum of 5°. Cities have been classified in different directions.

Conclusion. For the first time, issues of territorial management of urban landscapes were conducted and mapped on the basis of GIS technologies. At this time, it was determined that cities have grown more than 2 times during 1975-2023. However, this increase cannot be compared with the dynamics of population growth. Because during these years, the population growth has varied between 10-30%. Urban landscapes have grown mainly in riverside areas, along transport routes.

Keywords: *urban landscape, urban development, GIS, Kura-Araz plain, urban development scenarios, ArcGIS.*

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Introduction. Preliminary Studies. Urban landscape refers to an outdoor environment that is dominated by and influenced by urban features. This includes both natural and man-made elements found in an urban area such as parks, roadways, buildings and other elements that are present in a town or city. An urban landscape is made up of a variety of different elements and it is constantly changing to accommodate the needs of the community [11].

Urban landscapes can take on many different forms. Some urban landscapes may include high rise buildings and modern architecture, while others may focus on parks and green spaces. Other urban landscapes may include monuments and historic architecture, etc [12].

The urban landscape is dynamic and constantly changing. In a modern large city, it is influenced by the following factors [13]:

- Increased population density. Cities are being built up with multi-storey buildings, underground floors and parking lots.

- Need for mobility. Interchanges are being built and roads are being widened. Public transport infrastructure is being built for new areas: bus lanes, stops.

- Need for convenience. The number of pedestrian streets is increasing, and infrastructure for people with disabilities is being developed.

- Request for sustainability. Cities are becoming greener, eco-fuel transport is being launched on bus routes: electricity, methane.

Economic and territorial development of urban landscapes. More than 78% of carbon dioxide emissions in urban ecosystems are related to anthropogenic activities [24]. The ecological footprint of cities can extend beyond the city to agricultural areas, forests and water sources [3,20]. As a result, it has a negative impact not only on the local, but also on the regional and global ecosystem [5].

Urban landscapes are not only centers of consumption of energy, materials and other things, but also sources of waste, greenhouse gases, water and air pollution [26]. As cities grow, their sociological and ecological footprints spread over large areas. In this regard, the area of hard-to-reach places also decreases [7].

The world's population faces important environmental problems such as climate change and pollution [19,30]. The main reason for this is the consumption demand of the population living in cities [2].

Currently, 54% of the world's population lives in cities [29]. It is estimated that this number will be 70% by the end of the century. Thus, cities create and exacerbate two main problems [5]. These are the problems of poverty and environmental degradation [22].

Urban growth greatly affects the quality of water, air and vegetation [28]. In order to cope with the problems that arise as urban areas expand, the countries of the world should implement effective urban planning and planning [9,16].

The most important problems of cities include [8]:

- Strong growth of the territory and population of cities leads to the problem of poverty [27]. City executive power and other state bodies have difficulties in providing services to all residents [11,17].

- Consumed energy causes further air pollution [14,18].

- Gases emitted by vehicles used in urban transport cause high levels of lead formation in the air of the urban ecosystem [21].

- Uncollected waste in urban areas poses a serious threat to the health of living beings [10, 23].

- The number of problems arising during the development of urban ecosystems is endless [17].

Then we can also mention the solutions [6].

- Creating jobs in the suburbs and ultimately fighting poverty [13].

- Use environmentally friendly transport [15].

- Application of green energy [25, 22].

- Increasing the area of greenery, forests and parks, etc.

So, city is an area that is expanding every day. For this reason, it is important to study cities taking into account the environmental problems they create. Our goal is to study the cities located in the Kura-Araz plain, determine their annual growth rate and forecast future development trends. It is important in the management and planning of cities. Our research object covers 17 cities located in the Kura-Araz plain. The subject of the research is the past and future development of these cities.

Material and methods. Decoding of satellite images, mathematical-statistical, historical and mathematical-analysis methods were used during the research.

In order to analyze the dynamics of the boundaries of cities, the boundaries of those cities in 1975 and 2023 were studied. At that time, in 1975, the boundaries of settlements were vectorized based on their topo plans. Topo plans of 1975 were placed in coordinates using ArcGIS software. WGS 1984 coordinate system was used at this time. Then the boundaries of the settlements were vectorized. Later, their Geographic Information Databases were created. The area and perimeter of the territory of the cities are included in the Geographic Information Databases. After the 1975 study of the borders of the cities, the borders of other settlements located around the cities were also studied in the same way, and Geographic Information Databases were created and the information was entered into the database.

The populated areas of cities and their surrounding villages in 2023 were vectorized using Google Earth software. These boundaries were then saved as KML files. The KML file was converted to a feature class using ArcGIS software. At this time, Geographical Information Databases were created to analyze the borders of 2023 and the information was entered into the database. These data include the area and perimeter of the city and surrounding areas.

Based on the Geographical Information Database, the area of cities and surrounding settlements was calculated and the areas that grew over 48 years were analyzed by percentage.

The dynamics of the population of the cities was studied on the basis of mathematical-statistical and mathematical-analytical methods. At that time, analyzes were conducted based on the statistical indicators of the State Statistics Committee of the

Republic of Azerbaijan. The dynamics of the population in 2000-2022 made it possible to monitor the population growth of cities.

Satellite images and their boundaries were superimposed and predicted to analyze the directions in which cities could develop and expand in the future. At this time, the surrounding agricultural areas (crops, pastures) were taken into account.

Results and discussion. Cities have reached their modern state after a long historical journey. This depended on the geographical location of the cities, neighborhood relations, and other factors. If we pay attention to the historical-geographical analysis of the development of these cities, the cities located in our research area are distinguished by their ancient history. Among these cities, we can especially mention Mingachevir, Barda, Beylagan and others.

About 5,000 years ago, it was discovered that there was life in the city of Mingachevir, our research area, whose population was engaged in fishing, handicrafts, agriculture and horse breeding. The Albanian inscriptions belonging to the ancient period, especially the Mingachevir-Sudağilan epitaph, provide extensive information about the occupation of the population at that time. According to some sources, living in this city dates back to B.C. It is mentioned that it belongs to the III millennium. Arshap and Roman coins were also found as evidence of the development of trade among the population during that period. The famous Turkish traveler Evliya Çelebi in his work "Travel" mentioned the settlement of the people on the banks of the river and their weaving. As a result of research conducted in the country, the oldest earrings were found in this city. Although the most extensive studies were conducted after the Second World War, all studies prove that Mingachevir was built in BC. There has been life since the 3rd millennium, and the main occupation of the population here has been agriculture, crafts and trade. The conducted studies show that the population is settled on the right bank of the Kura River in the city of Mingachevir. The settlement of the population on the left bank coincides with recent times. The high level of cultural relations in this city had a strong influence on the formation of the city.

The modern form and structure of the city of Mingachevir dates back to the end of World War II. During this period, the modern city of Mingachevir was built with the participation of 20,000 people. The growth and formation of the city in the next quarter was related to the development of machine-building, electric power, chemical, petrochemical, food and light industries and the expansion of the construction of industrial facilities.

Our other research city is the city of Shirvan,

which, like the city of Mingachevir, is included in the group of medium cities that play an important role in the country's energy production. The name of this city is especially mentioned since the 18th century. At that time, Zubov, who was a Russian general, entered here with a military detachment and called it Yuekaterinaserd, and the relocation of 2,000 Russians led to an increase in the number of Russians who were relocated here. In the 30s of the 20th century, the name of the city was changed to Ali Bayramli. However, in 2008, the name of the city located in this area with historical Shirvan lands was called Shirvan with its historical name. However, a new stage in the city's development began in 1955 when an oil well hit a fountain in the Kurovdag field. Later, in 1956-68, the construction of the first open-type State District Power Station (SDPS) in Europe led to the faster development of the urban landscape.

The city of Yevlakh, which is included in the group of medium cities in the study area, is one of the cities that play an important role in the economic life of the country. The city of Yevlakh began to develop in the 19th century after the Baku-Tbilisi railway, which was built to expand relations between Azerbaijan and Georgia, was commissioned. This area, which used to be a village, received the status of a city in 1939. At the next stage, in the 70s of the 20th century, large-scale industrial enterprises began to be built in the city, including a reinforced concrete plant, a cotton ginning factory, a tobacco fermentation factory, a bakery, a tractor repair plant, an industrial complex, and others.

The construction of Yevlax-Balakén and Yevlax-Khankendi railway lines and the commissioning of the airport in the city have already led to the development of the city infrastructure. In the 70s of the 20th century, the wool processing factory opened in the city further accelerates the development of the city.

There are several reasons for the development of the city. These include its location on the banks of the Kura River, its location on the east-west roads, and others.

The development of the landscape of Agdash city, which was previously called Uchgovak, has been particularly intensive since the 19th century. At the end of the 19th century, looms for the production and processing of cotton were built in Agdash village, which was previously part of the Sheki district, and later became the administrative center of the Aresh district in the 19th century (1873), and 7 factories in this direction began to operate there at the same time. At that time, the population of this area, which had the status of a village, was engaged in cotton growing, cocoon growing and silk growing.

Our other research city is Zardab urban land-

scape. The strategic importance of the Kura River in its creation, formation and development is undeniable. Although the initial stage of the city's development was felt from the beginning of the 16th century, the main development was observed in the 70s of the 20th century. Some sources even associate the name of the city with the flooding of the surrounding area during the flooding of the Kura and Karasu rivers and the development of agriculture in those areas, which indicates the importance of water for irrigation. Like other urban landscapes, this area, which had the status of a village when it was created, is shown to have small-scale workshops producing sugar, licorice root and silk. During the Khanate period, the population was engaged in sericulture, agriculture and cattle breeding.

The city of Ujar, which belongs to medieval cities, is also included in our research area. The city of Barda, distinguished by its ancient history, dates back to BC. It began to develop in the V-IV centuries. At that time, craftsmanship was particularly developed in the city and was the main occupation of the population. This city, which previously had the status of the capital, is surrounded by strong fortress walls. During the Sassanid era, important trade connections were distinguished here by the density of markets and craft districts, as well as public and religious buildings. This city, distinguished by the strength of trade relations in the Middle Ages, changed its location several times as a result of floods in the Tartar River. Already in the XII-XIII centuries, the city existed in its current location.

Beylagan city is another urban landscape that stands out for its history. In the 9th-11th centuries, the main occupation of the population was smithing, blacksmithing, jewelry, and pottery, and tools, weapons, and household items were made in this city. At that time, along with many functions of the cities, the trade function was also distinguished. In this city, which was famous for carpet weaving, metalworking, pottery, silk, woodworking, and glass production even at that time, jewelry was also specially selected.

Another city of ours, distinguished by its history, is the city of Agjabedi, which name was first mentioned in 1593. The city is distinguished by the development of agriculture due to its favorable natural conditions.

In ancient times, there was even a shipbuilding workshop in the city of Salyan, which was formed and developed under the influence of the Kura River. The city was visited by boat and fish was grown. The settlement of Salyan, which used to be a village, received the status of a city in 1916. Our other city, Saatli, which received the status of a city in 1971, received the status of a city-type settlement in 1947.

Territorial growth of cities also increases their management problems. At this time, there are changes in the microclimate. The existing agricultural and pasture areas around the city are increasingly included in the territory of growing cities, and over time, these areas are also involved in construction, as a result of which the problem of food supply of the city and surrounding settlements arises. The growing food problem also destroys the concept of comfortable living expected in cities.

In order to study the territorial development of cities, we studied the dynamics of the borders of all cities included in our research area in 1975, 2020, 2021, 2022 and 2023. For this, the topo plan of the cities from 1975 and satellite images from other years were used. Peko images belong to Landsat 5,8,9 and Azersky satellites. Landsat satellite images were obtained from online resources. The data of the Azersky satellite, which is our country's own satellite, was obtained as a result of the competition.

If we pay attention to the dynamics of the territory of the city of Neftchala, which is part of our research area, we can clearly see that the territory of the city has expanded in the eastern part over the past years.

According to architectural rules, in medium-sized cities, sewage, industrial area, utility-storage, transport and other areas covered a certain percentage of the city. In medium cities, this indicator was 50-67%, 11-15%, 5-15% and 15-22%, respectively. In this regard, after the vectorization processes carried out in the city of Salyan, we have calculated that in 2022, the residential area will be approximately 65%, the industrial area will be 12%, the area occupied by transport will be 12%, and the other part will be parks and other types of areas.

Based on the study of the dynamics of the city area, we can note that in 1975, the area of Salyan city was 8.94 km², and in 2021 it was 14.92 km². During 46 years, the area of the city increased by 5.96 km², that is, the area expanded 1.7 times. This means that the average annual growth is 1.45%.

The rapid expansion of the city of Salyan directly and indirectly affects all components of the landscape separately and the landscape complex as a whole. It was determined that these cities developed in different directions. The main reasons for this are the location at the intersection of transport routes, favorable terrain and climatic conditions, and the location on the banks of the Kura and Araz rivers.

The cities located in our study area have developed in different directions due to their geographical location. This was also influenced by their social and economic status. Its location on transport roads, its location on the banks of Kura and Araz rivers are the main factors that stimulate the development of urban landscapes (Figure 1).

Around the city of Zardab, Gelma, Tazakend, Deli Gushchu, Dakkaoba and other settlements played an important role in the formation and development of the urban landscape. Together with Zardab, these villages played an important role in meeting the needs of the city's population for agricultural products. However, the expansion of the city of Zardab has led to the reduction of the area of these settlements, as well as the reduction of the surround-

ing agricultural areas. As a result, we must be prepared for future problems in providing the population with food. Because these settlements are not only of the city of Zardab, but also of the capital and other cities located close to the region, as well as its share in exported products. This means that in the future we may encounter various problems in exported products (Figure 2).



Fig. 1. Investigation area

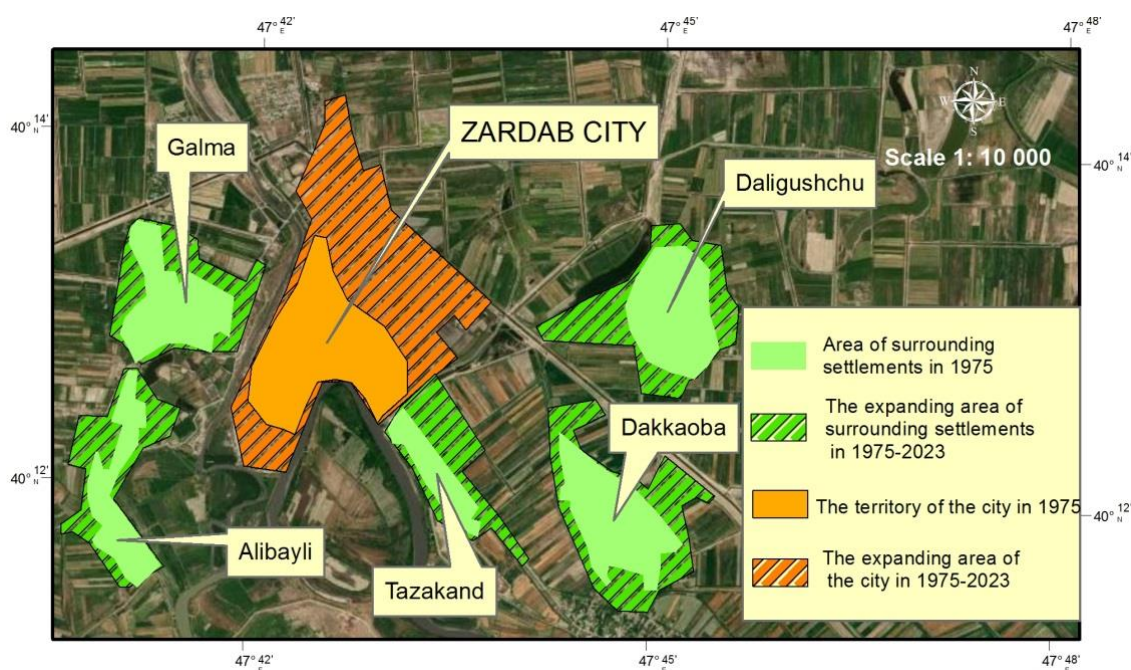


Fig. 2. The role of Zardab city and surrounding settlements in its development

We encounter almost the same scene in the urban landscape of Yevlakh. The surrounding settlements of Upper Garkhun, Jirdakhan, Nematabad, Samadabad, Lower Garkhun and other settlements played an important role in the development and formation of the urban landscape in terms of territory and population. The role of Kura river in the development of this city is also important. So, if we pay attention to the formation of the city over a long period of time, we can clearly see its development along the Kura river in the eastern direction. How-

ever, in addition to this, the location of the city on important transport routes also played an important role in its formation. It is also undeniable that it is located on the roads going from west to east, as well as on the roads connecting the central part of the country with its northwestern part (Figure 3).

The role of Garaybeyli, Garabörk, Alpout, Mushkurlu, Rastaje and other villages from surrounding settlements is important in the formation of Ujar city (Figure 4).

If we talk about the main villages located aro-

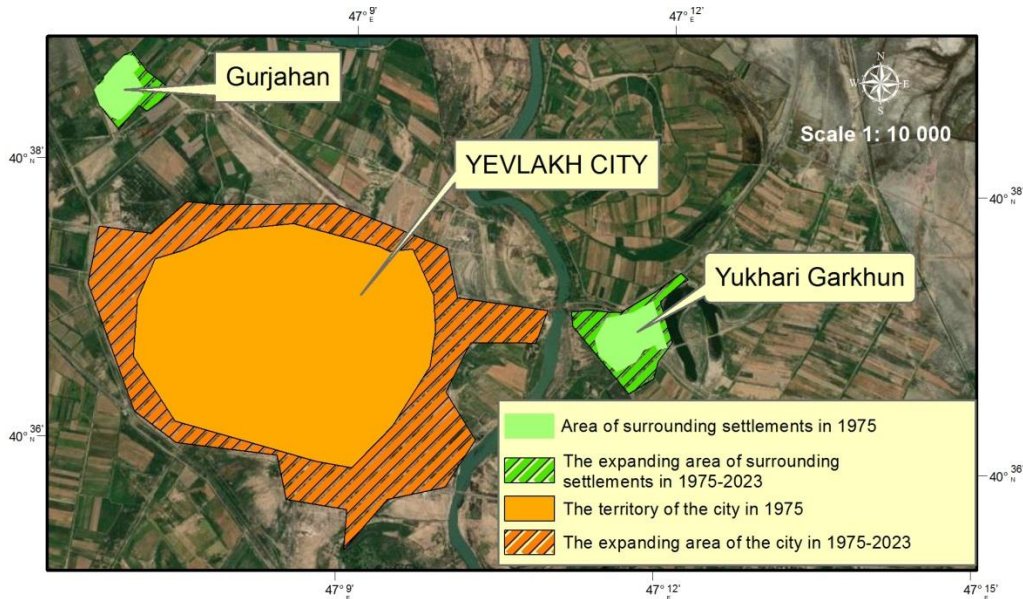


Fig. 3. The role of Yevlakh city and surrounding settlements in its development

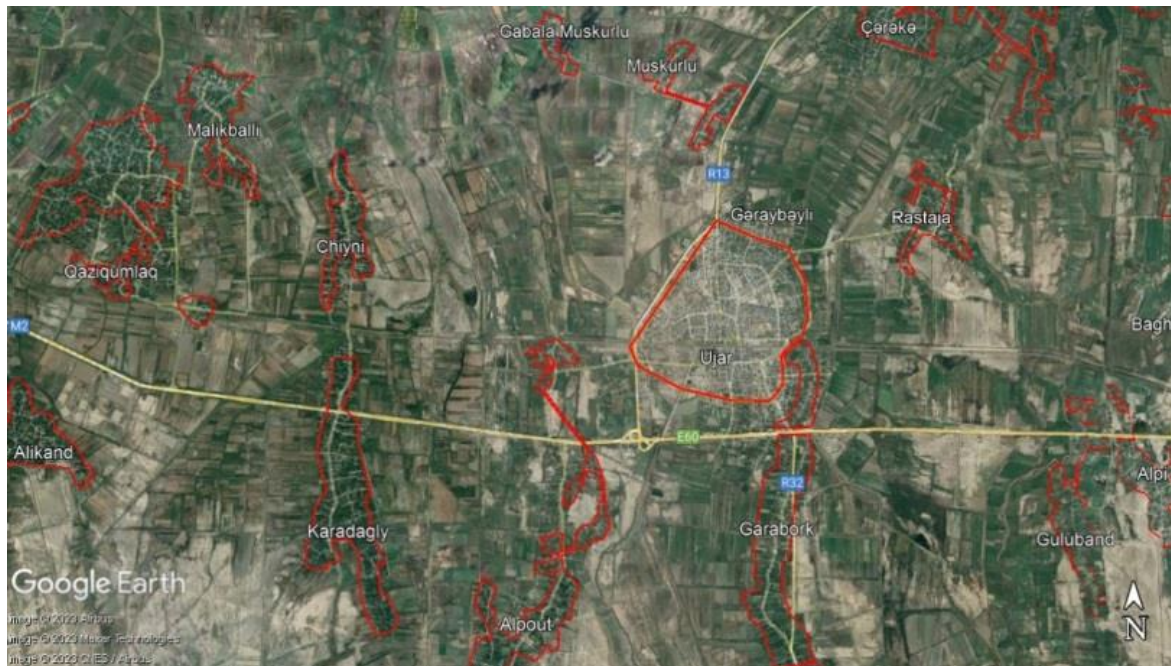


Fig. 4. The role of Ujar city and surrounding settlements in its development

und the urban landscape of Salyan and their role in the formation of this urban landscape, it is necessary to highlight the villages of Garagashli, Kirkh Chirag, Marishli, Seyidsadig, Arabgardashbeyli and

others. These villages play an important role in providing the population with agricultural products in the city of Salyan (Figure 5).

In the formation of the city of Sabirabad, which

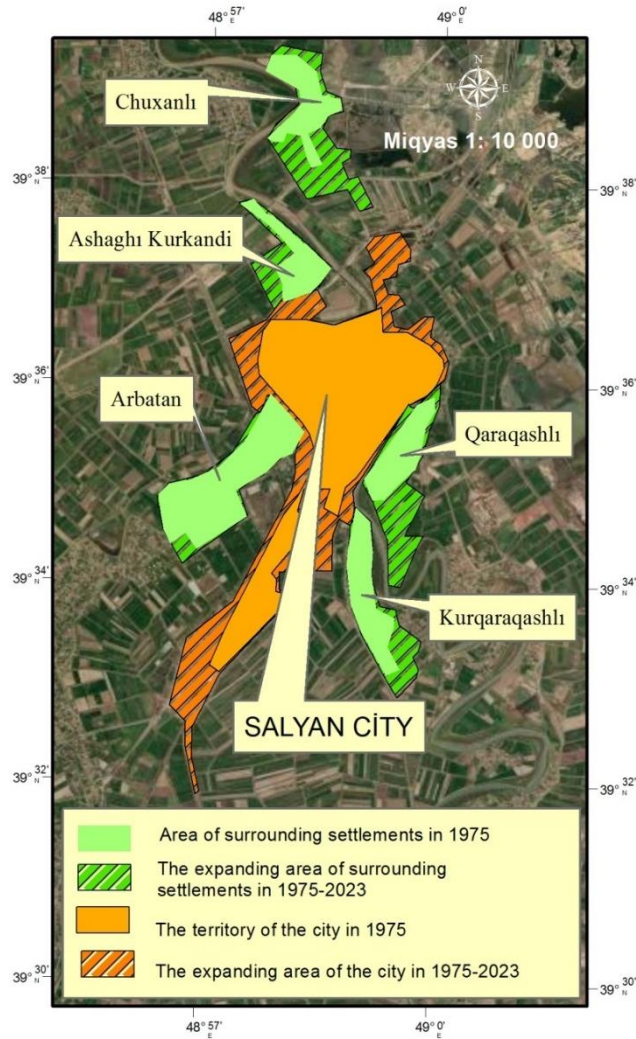


Fig. 5. The role of Salyan city and surrounding settlements in its development

is located at the confluence of the Kura and Araz rivers, along with the Kura and Araz rivers, its location on the transport route, as well as the role of

Sugovushan, Galagayin, Ghafarli, Beylik and other settlements around it is important (Figure 6).

The role of the Kura River, the Caspian Sea

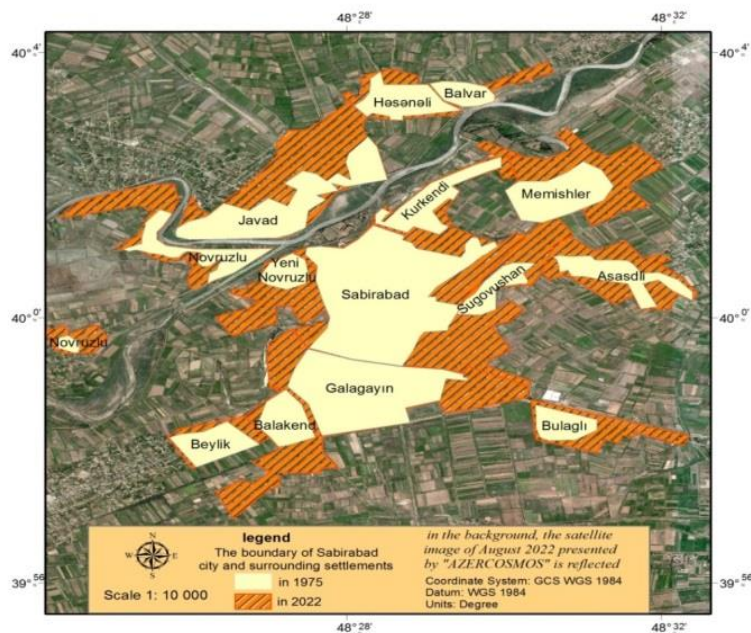


Fig. 6. The role of Sabirabad city and surrounding settlements in its development

and, of course, the surrounding settlements, especially the Banke settlement and the settlements of Garavalli, Yenikend, Uzunbaba, Kirmizi Shafaq,

Ikinki Mayak, is important in the development of the Neftchala urban landscape formed at the mouth of the Kura River (Figure 7).

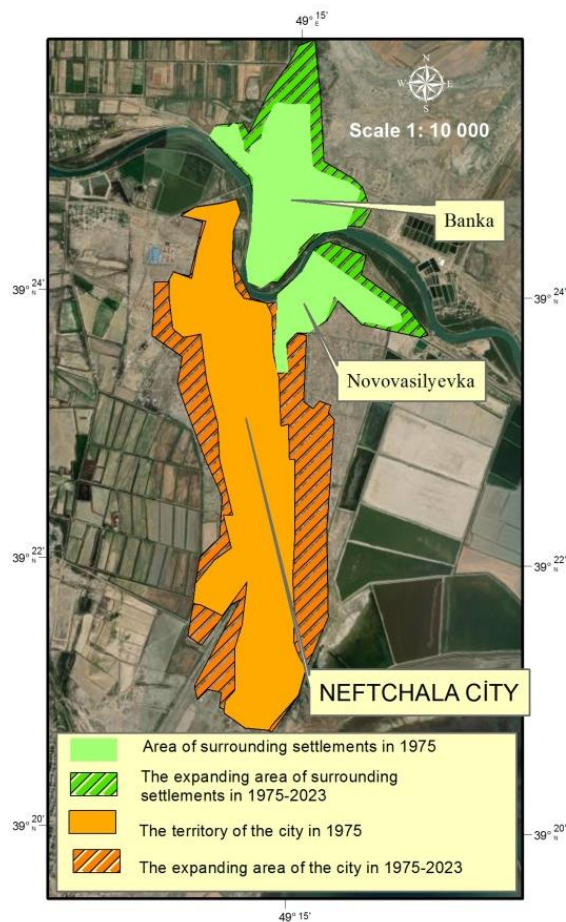


Fig. 7. The role of Neftchala city and surrounding settlements in its development

In the formation of the urban landscape of Mingachevir, which is a large city of the research area, the role of its Kura riverside mpvgei and the Mingachevir reservoir, as well as the role of Havarli, Hüryushagi, Hajiselli, Aksham and other villages located around it and included in the territory of Yevlakh district, is undeniable. If we analyze the

role of the Kura River in the formation of the city, it is necessary to mention its hydropower potential, fishing importance and the recreational importance of the Mingachevir reservoir built on it. In addition, the establishment of recreation areas along the banks of the Kura River plays an important role in the formation of the urban landscape (Figure 8).

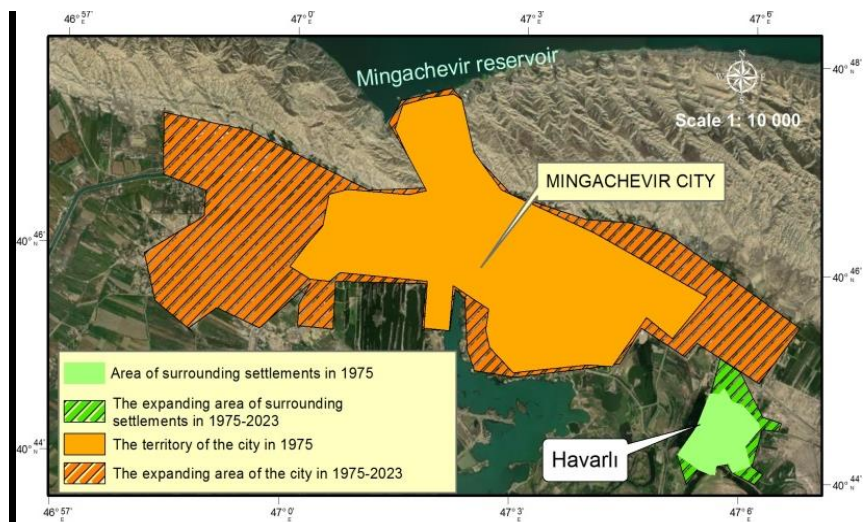


Fig. 8. The role of Mingachevir city and surrounding settlements in its development

The city of Kurdamir is located on the east-west roads. The role of Atakishili, Akhtachi Karabujag, Shahbeyli and other villages from surrounding settlements in its formation is undeniable. But the most important factor is the transport factor (Figure 9).

The first factor in the formation of the urban landscape of Imishli along the coast of the Araz River was, of course, the influence of the Araz River. However, it is necessary to mention Karalar, Otuziki, Murguzali, Baciravan and other settlements from the surrounding settlements (Figure 10).

Kura River has an important role in the formation of urban landscapes of Shirvan and Hajigabul. However, the role of these cities in the ecological problems of water bodies is undeniable. Thus, the first cause of the ecological problems of Lake Hajigabul was related to the development of

these urban landscapes. The water in this lake, which is used for irrigation purposes, has completely dried up. In the development of these cities, the role of Garaguney, Pirsaat, Garatugay, Gudejuhur and others from the surrounding settlements is important (Figure 11).

In the formation of Bilasuvar city landscape, the role of Beydili, Khirmandali, Mokhozabad, Aliabad, as well as Bagbanlar, Chinarli, Chayli, Asgarabad, Ashaghi Jureli settlements located in the north, and Asgarabad, Ashaghi jurali, located in the east, are important (Figure 12).

The most important factor in the formation of the urban landscape of Beylagan is the settlements located around it, such as Shafaq, Mayak, Yukhari Aran, Alinazarli, Bolsulu, Tahikend, Orta Alinazarli, first Ashikli and others (Figure 13).



Fig. 9. The role of Kurdamir city and surrounding settlements in its development

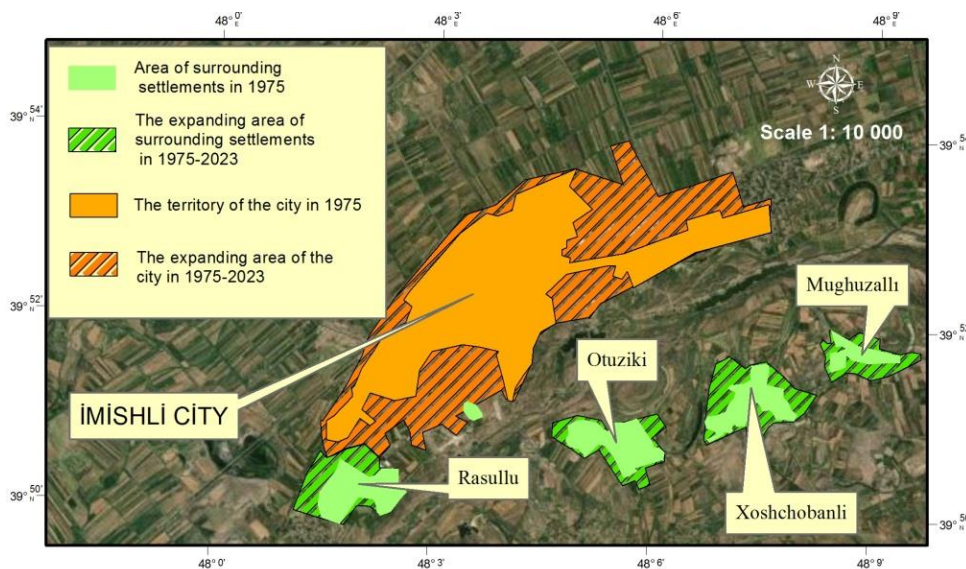


Fig. 10. The role of Imishli city and surrounding settlements in its development

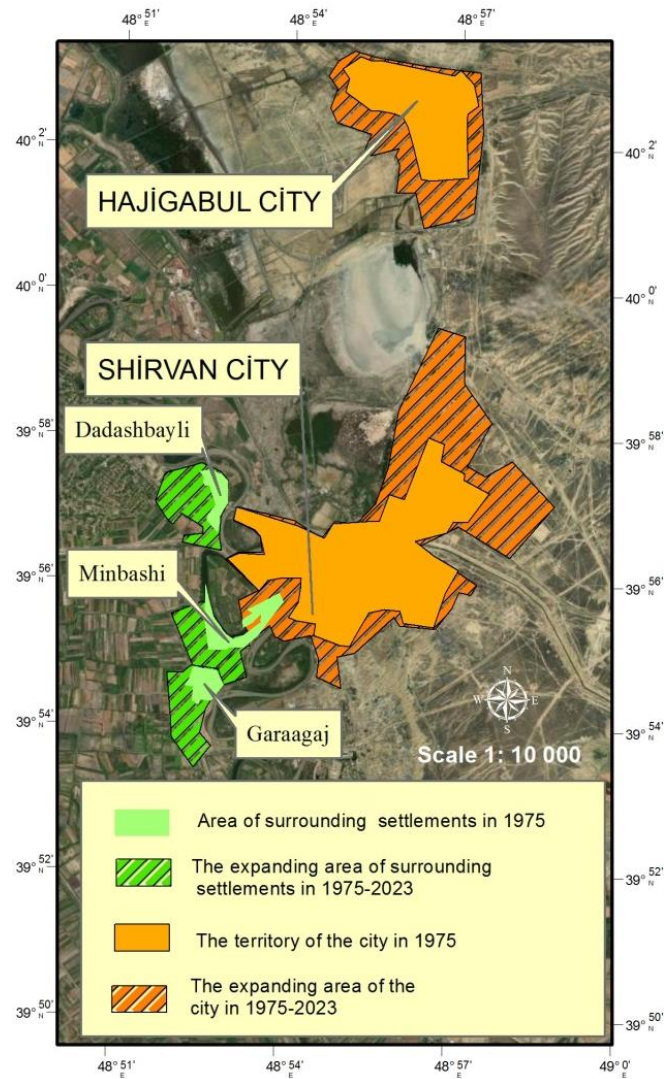


Fig. 11. The role of the cities of Shirvan and Hajigabul and surrounding settlements in its development



Fig. 12. The role of Bilasuvar city and surrounding settlements in its development

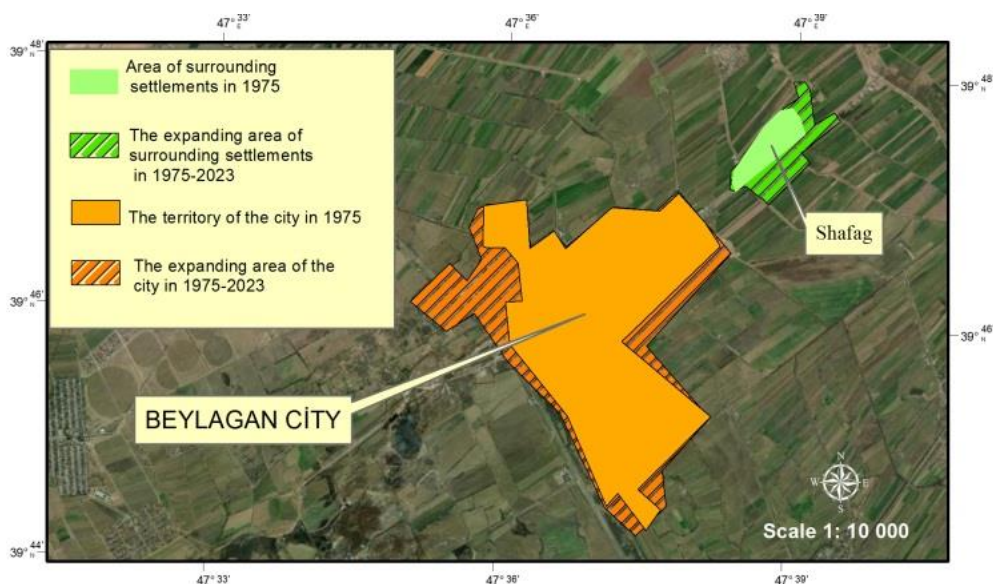


Fig. 13. The role of Beylagan city and surrounding settlements in its development

In the formation of the urban landscape of Barda, which has an ancient history, its economic geographical position, political geographical position, along with its location along the Ancient Silk Road, the surrounding settlements also played an important role. As we know, rural settlements were formed before cities. Of course, the historical place of the city of Barda was not the territory of the current city of Barda. The role of Zumürkhan, Garadağlı, Güloğlular, Gasimbeyli, Mughanli, Kalantarli, Aliyanli, Garademirchilar and others in the formation of the current city of Barda is important (Figure 14).

The role of Turyanchay is important in the formation of Agdash urban landscape. Its location on the river bank, as well as the role of Garadaghli, Gurjuva, Ashagi Zeynaddin, Yeniarch, Golgaty,

Mursal and other settlements from the surrounding settlements is undeniable (Figure 15).

Surrounding settlements also play a role in the formation of the Agjabedi urban landscape, to which we can especially refer to the Agabayli settlement (Figure 16).

We can also group cities by population. At this time, the population plays an important role. The cities of the study area belong to large, medium and small cities. There are also small settlements here, which can become large cities in their future development.

The group of large cities in the study area includes only the city of Mingachevir. He joined this group in 2013. Currently, the number of inhabitants is more than 106 thousand people. The city of Mingachevir performs economic and non-economic

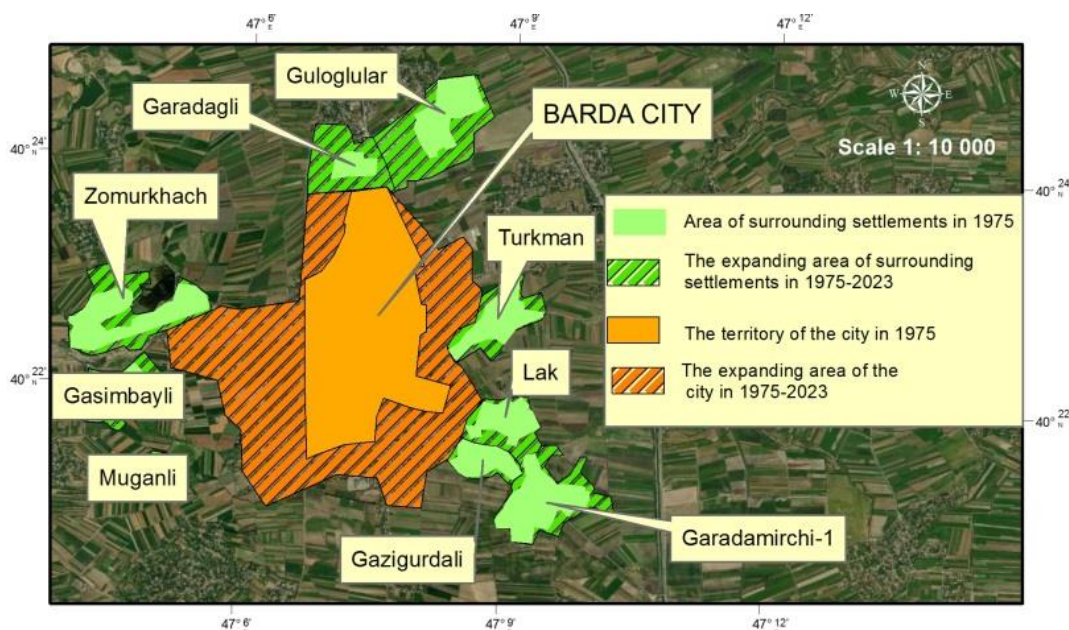


Fig. 14. The role of Barda city and surrounding settlements in its development

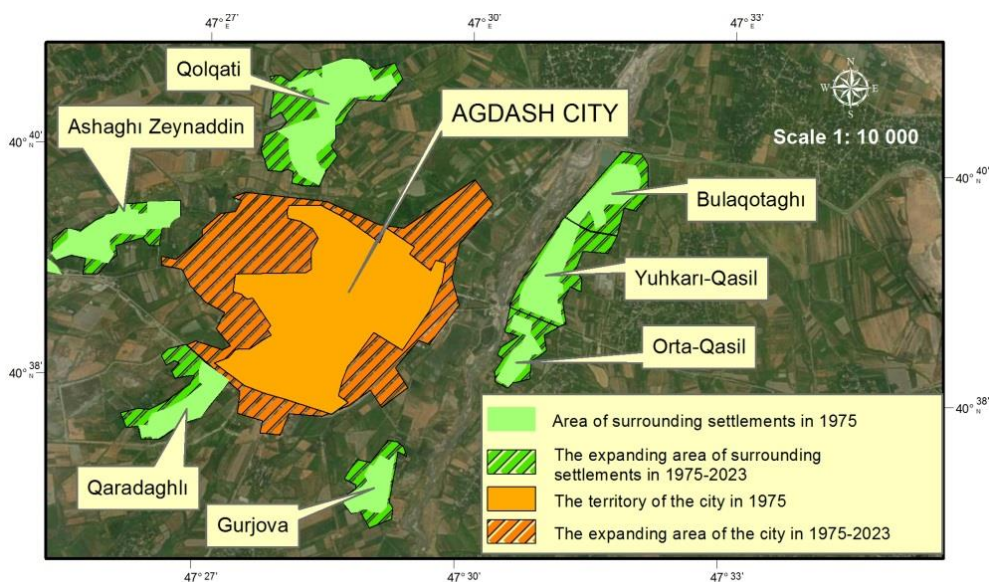


Fig. 15. The role of Agdash city and surrounding settlements in its development

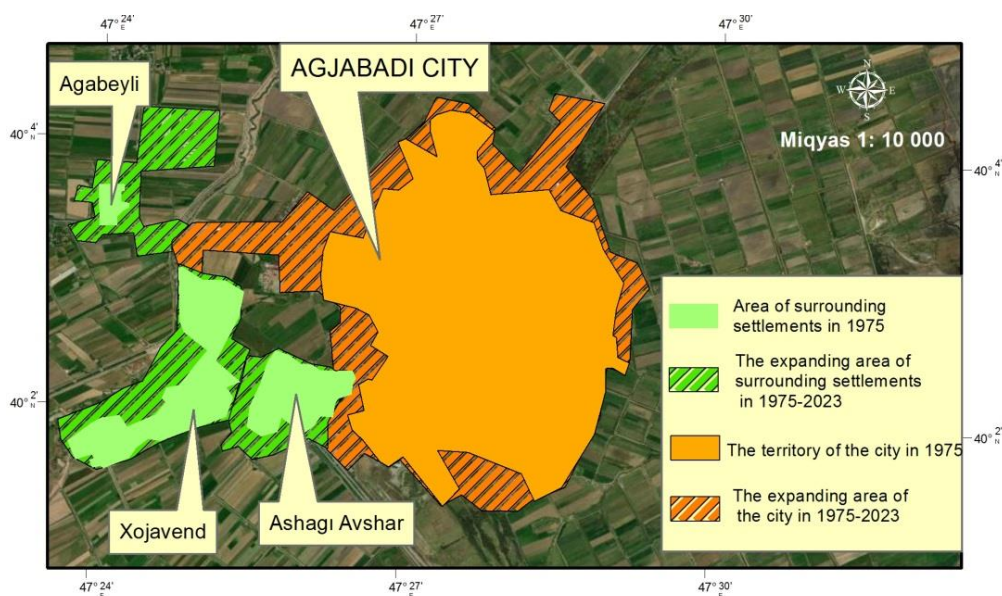


Fig. 16. The role of Agjabadi city and surrounding settlements in its development

functions due to its structural and functional characteristics. Economic functions include light industry, machine building, food industry, construction and chemical industry. Non-economic functions include cultural and educational functions.

The city of Mingachevir belongs to the group of multifunctional cities. This city differs from other cities of the research area due to its organizational-economic, industrial-transportation, scientific, political, cultural-educational and other functions (with the exception of the city of Shirvan). The city of Mingachevir is included in the group of large cities as the administrative center of food and light, electric power, appliance manufacturing, industry and resort.

The group of medium cities includes the cities of Yevlakh and Shirvan. The city of Yevlakh performs economic and non-economic functions ac-

ording to its structural and functional characteristics. Economic functions include light and food industry, transport. Non-economic functions include cultural-educational and administrative functions. The city of Shirvan performs economic and non-economic functions due to its structural and functional characteristics. Economic functions include electricity, oil production, engineering, food industry and transportation hub. Non-economic functions include cultural and educational functions.

The cities of Shirvan and Yevlakh are included in the group of medium cities as the administrative center of food and light, machine building, energy, road transport and railway.

The city of Shirvan belongs to the group of multifunctional cities. This city differs from other cities of the research area due to its organizational-economic, industrial-transportation, scientific, polit-

ical, cultural-educational and other functions (with the exception of the city of Mingachevir). In Shirvan city, processing industry, especially device manufacturing, electrical engineering fields have also developed. This city, together with the city of Mingachevir, is one of the cities where the country's largest power plant exists.

"Arfa" furniture factory, "Dan" bricks, non-alcoholic beverage factories belonging to "Yevlax Qida" LLC, reinforced concrete plant belonging to "Yevlax-Beton" OJSC, "Lala-textil" LLC in Yevlax city there is a sewing factory, "Gilan" leather processing, as well as a seed processing enterprise owned by "Azertoxum" LLC, a canning factory owned by "Karvan-K" LLC, and bakery and pasta shops.

The sewing factory belonging to "Lala-Textile" LLC is located on an area of 10.4 ha and includes 2 sewing, 1 office, 1 weaver, 1 knitter, 1 boiler room, 1 paint shop, 5 auxiliary buildings and 1 canteen. The personnel of this enterprise with 650 employees is planned to be increased to 1200 soon. The equipment available in the enterprise is mainly imported from countries such as Japan, Germany and Turkey.

The annual production capacity of the brick factory, which belongs to "Dan" LLC and is located on an area of 58 ha, is estimated at 30 million units. The manufactured products are suitable for both domestic demand and export to Georgia.

The equipment of "Arfa" furniture factory, which produces furniture for kitchen, office, living room and children's room, was brought from Italy and Germany.

"Lala Tekstil", "Yevlakhtamir" OJSC and ARFA furniture factory also operate in Yevlakh city.

In Shirvan, the Araz plant operating under the Ministry of Defense Industry, the Oil Processing Plant (cotton oil) equipped with the latest technologies, the Shirvan Cotton Processing Branch of LLC operating under the name "Azerpambig Agrarian Industrial Complex" and other enterprises operate.

Other cities of the study area belong to the group of small cities in terms of population.

Small cities also perform economic and non-economic functions according to their structural and functional characteristics. Economic functions include light and food industry, agriculture. Non-economic functions include cultural-educational and administrative functions. However, within this group of cities, chemical and fish processing in Neftchala, transport in Ujar, and construction industry in Sabirabad also perform economic functions.

The cities of Agdash and Barda are included in the group of small cities, which are administrative centers of food and light industry, agriculture, construction materials, as well as agro-industry.

The city of Agjabadi is included in the group of

small cities such as food and light industry, railway and road transport, agriculture, administrative district center cities.

The cities of Salyan and Imishli are included in the group of small cities such as food and light industry, machine building, chemistry, construction, oil and gas extraction, railway and road transport.

Ujar and Neftchala are included in the group of small cities such as food and light industry, oil extraction, agriculture, railway and road transport, administrative district center cities.

Other cities are included in the group of small cities, such as food and light industry, agriculture and administrative district center cities.

The settlements in the study area include Aran settlement of Yevlakh district, Turyanchay and Leki settlements of Agdash district, Karrar settlement of Kurdamir district, Karachala and Kirkhbulag settlements of Salyan district, Bahramtep and Vatega settlements of Imishli district, Bahar, Orconokidze, Kahramanli, Milabad, Orengala, Baharabad of Beylagan district, It includes Gunesh, Shafaq, Sharq, Sarisu, Turkler, Yeni Mil, Yukhari Aran and Mayak settlements, Mugan, Padar and Pirsaat settlements of Hajigabul district, Bayramli and Hajigahramanliq settlements of Shirvan city, Banke, Hasanabad, Khilli settlements of Neftchala district.

According to the population of the cities, the classification was made according to the following classification.

- small towns with a population of up to 50,000 people
- medium-sized cities with a population of 50-100 thousand people
- large cities with a population of 100-250 thousand people
- large cities with a population of 250-500 thousand people
- huge cities with a population of 500,000-1,000,000.
- millionaire cities, the population of which is more than 1 million.

Based on this classification, the cities of the study area are classified as follows. The big city is Mingachevir, the middle cities are Yevlakh and Shirvan, and other cities are included in the group of small cities (Table 1).

Following the development dynamics of urban landscapes, we prepared their future development trend (Table 2). The surrounding areas were studied based on the analysis of satellite images. Areas where the natural conditions are favorable for the future development of cities and where vacant areas are possible for growth are predicted for future development.

The cities located in the study area have grown in all directions due to favorable natural conditions

Table 1

Population of cities in 2000-2022

№	cities	population, thousand people						
		2000	2005	2010	2014	2015	2020	2022
1	Aghjabadi	28,2	30,2	38,8	40,0	40,4	41,4	41,6
2	Aghdash	24,0	26,9	29,2	31,3	31,5	32,5	32,7
3	Beylagan	6,6	9,3	15,3	15,9	16,0	16,8	16,8
4	Barda	36,1	37,2	37,9	38,9	39,3	40,2	40,3
5	Bilasuvar	17,6	18,9	20,3		21,8	23,3	
6	Hajigabul	19,8	23,9	25,2	25,9	26,2	27,4	27,4
7	İmişli	30,7	31,5	32,4	33,9	34,3	36,1	36,2
8	Kurdamir	15,3	17,9	18,1	18,4	18,5	19,2	19,3
9	Neftchala	17,7	20	20,6	21,2	21,4	22,0	22,1
10	Mingachevir	94,5	95,2	96,9		101,6	106,1	
11	Salyan	35,0	44,6	36,4	37,2	37,6	38,9	38,9
12	Saatli	16,6	17,1	17,6	18,8	18,9	20,1	20,3
13	Sabirabad	27,4	27,9	28,4	29,4	29,8	30,9	31,0
14	Shirvan	65,7	68,5	73,1	77,0	78,1	82,4	82,8
15	Ujar	15,6	17,0	16,9	17,3	17,5	18,2	18,3
16	Yevlakh	52,6	54,4	57,9	59,4	60,0	62,5	63,1
17	Zardab	10,0	10,2	10,3	10,7	10,7	11,0	11,0

Table 2

Future development trend of urban landscapes

№	Urban landscapes	Territorial development in 1975-2023	Forecast of future territorial development	Results	Solutions
1	Neftchala	East	East, west, south	The city may develop due to the lowering of the level of the Caspian Sea in the southern direction, but it may cause various socio-economic problems as a result of the rising of the sea level. If the city develops in the east and west directions, the existing farmlands will be destroyed, which will create a threat of facing the problem of food shortage in the future.	Partially restricting the construction of courtyard houses and giving preference to high-rise (3-5 storey) buildings. Applying tax depending on the area to yard houses that are built but not used for a long time.
2	Shirvan	North, northeast	In all directions	There is a danger of entering the construction area of Lake Hajigabul and erasing it from the scene of history, there is a danger of living a life where the rivers of the Araz River in the cities of İmişli and Saatli are destroyed by drying up and turning into a construction site. In the case of its development, the existing agricultural lands will be destroyed, which will create a threat of facing the problem of food shortage in the future.	
3	Hajigabul	West and South	In all directions	The problem related to Lake Hajigabul is urgent.	

4	Mingachevir	Due to its proximity to traffic roads, it is in the south and east direction	West	If it is developed, the existing agricultural lands will be destroyed, which will create a threat of facing the problem of food shortage in the future.
5	Berde	As a result of the proximity to the transportation system and the influence of the nearby Garadağlı, Güloğlu, Zumürkhan, Aliyanli settlements, in all directions	North-west, south, east	
6	Salyan	East	Northwest, southwest, southeast, north, east	
7	Bilesuvar	In all directions	In all directions except the east direction	
8	Sabirabad	In all directions	Only east and southeast	
9	Saatli	In all directions, but more intense in the southern direction	North, south, east	
10	İmişli	East and south due to transport routes	In all directions	
11	Kurdemir	In all directions due to transport routes	In all directions	
12	Ujar	It is more intensive in all directions, as well as due to the presence of the Garaybeyli settlement in the north	All directions except the north, especially in the south due to proximity to the highway, more intense	
13	Yevlakh	In the south, south-east direction due to traffic roads	In all directions	
14	Agdash	South, south-east, south-west due to transport routes	In all directions	
15	Agjabedi	In all directions, especially in the western direction due to transport roads and Agabayli, Jafarbeyli settlements	In all directions except the West	
16	Beylegan	in the south and west direction due to traffic routes	In all directions	
17	Zerdab	Its location in the neighborhood with settlements on all sides has been the reason for development in all directions	East	

and proximity to large rivers. But this growth has also created various problems. The city may develop due to the lowering of the level of the Caspian Sea in the southern direction, but it may cause various

socio-economic problems as a result of the rising of the sea level. If the city develops in the east and west directions, the existing farmlands will be destroyed, which will create a threat of facing the

problem of food shortage in the future. If it is developed, the existing agricultural lands will be destroyed, which will create a threat of facing the problem of food shortage in the future. There are various ways to prevent this. Partially restricting the construction of courtyard houses and giving preference to high-rise (3-5 storey) buildings. Applying tax depending on the area to yard houses that are built but not used for a long time.

Conclusion. As a result of the conducted research, it was found that the cities located on the

banks of the Kura and Araz rivers have grown twice in the last 40 years. The main reason for this is that the river creates a favorable position.

The development of cities has led to the destruction of the surrounding farmlands and pastures. As a result, we may face food shortages in the near future.

There is an opportunity to grow in almost all directions for the development of cities.

To optimize growth in cities, instead of courtyard houses, 3-5-story buildings can be built here.

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Підготовка сценаріїв майбутнього розвитку міських ландшафтів відповідно до природних і соціально-економічних умов (на прикладі міст Кура-Аразької низовини)

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Понад 50% населення планети проживає в містах. З цієї причини майже всі глобальні проблеми походять від міських ландшафтів. Тому дуже важливо вивчати розвиток міст і готувати сценарій майбутнього. Наша мета

– вивчити міста, розташовані на Кура-Аразькій рівнині, визначити їх річний приріст і спрогнозувати перспективи розвитку. У статті проаналізовано розвиток 17 міст, розташованих на Кура-Аразькій рівнині в центральній частині Азербайджану, протягом історичного періоду та його прогноз на майбутнє. Особливу увагу під час дослідження надавали сучасним методам. Супутникові знімки міст були оброблені та проаналізовані їх результати. Міста Кура-Аразької низовини займають 25% міст республіки. Річки є основним джерелом утворення міст. Однак із зростанням цих прибережних міст екологічні проблеми річок Кура та Араз посилюються, а рівень води знижується. Міста росли в усіх напрямках і продовжують рости. Вперше в Азербайджані на основі ГІС-технологій і методів дистанційного зондування досліджено міські ландшафти. Вперше на основі ГІС-технологій проаналізовано фактори природних умов, абсолютну висоту, нахил та експозицію рельєфу, і встановлено, що 2/3 досліджуваної території знаходиться нижче рівня моря, а 1/3 знаходиться на ділянках до 200 м абсолютної висоти. Нахил ділянки продовжується максимум до 5°. Міста були класифіковані за різними напрямками. Вперше проведено та картографовано питання територіального управління міськими ландшафтами на основі ГІС-технологій. На цей час було встановлено, що за 1975-2023 роки міста виросли більш ніж у 2 рази. Однак цей приріст не можна порівняти з динамікою зростання населення. Тому що за ці роки приріст населення коливався в межах 10-30%. Міські ландшафти виросли переважно в прирічкових районах, уздовж транспортних шляхів.

Ключові слова: міський ландшафт, міський розвиток, ГІС, Кура-Аразька рівнина, сценарії міського розвитку, ArcGIS.

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