ЕКОНОМІЧНА ТА СОЦІАЛЬНА ГЕОГРАФІЯ І ТУРИЗМ

UDC: 911.332
DOI: 10.18524/2303–9914.2023.2(43).292728

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STUDY OF URBANIZATION PROCESS AND TERRITORIAL PLANNING (A CASE OF SHAKI DISTRICT)

The article is dedicated to the urbanization process of Shaki City and the change in land use in territorial planning over the years. During the years 2016–2022, the growth of the population in the region and the increase of the specific weight of the urban population were studied, the population growth trend was analyzed for twenty years, a comparative analysis was made by years and a forecast was given. In order to determine the direction and extent of land use in the city, the relationship between the city population's growth rate and the city's expansion was determined, and the changes that occurred in the region during the use of the land were analyzed. Statistical data were also used for this purpose along with Azersky satellite data. The machine learning (ML) method, which is widely used in remote sensing systems, was used, support vector machine learning (SVM) was applied, and the image classification and processing process was carried out. Based on the obtained data, a comparative analysis of the previous and current conditions was given, and the area of changes in the area between the classified areas was calculated. At the same time, the transitions between the categories during the use of the territory and the recent changes in the direction of land use are indicated. The classification performance was evaluated, user and producer accuracy analyses were determined and the Kappa coefficient was calculated. In the end, the direction of the city's expansion and its reasons were touched upon.

Keywords: urbanization, Shaki city, Azersky, kappa coefficient, population growth, spatial planning, land use

INTRODUCTION

The process of urbanization is leading to sprawling development all over the world today, which is gradually becoming a concern of researchers and planners. In recent times, the rate of urbanization is expected to accelerate and by 2050, two-thirds of the world's population will live in metropolitan centers (Brears, 2018). More than half of the world's population lives in cities, and it is unevenly distributed across the globe (Fitawok, 2020). Thus, cities emerge from the common understanding and exhibit a new feature: reduced density, dispersed development, poor accessibility, and monofunctionality. However, the concentration of population in cities, in its turn, includes a number of problems as well. As a result, issues such as the use of scarce natural resources, the level of food supply, communication, energy, and transportation arise. While all this is being done, land use is affected, so the problem of the reduction of land reserves has also arisen in parallel.

From this point of view that there is a need for territorial planning in the region, determination of the development level of urbanization, and the scale, quantity, and quality of land use in the region. The majority of the studies carried out on the region are based on the issues of territorial organization, the studies are determined according to the tendency of the urban population to increase and decrease according to statistical data. In terms of the content of the research, for the first time, the following research questions were put forward for the purpose of studying the direction and scale of the use of the territory in the city, as well as the habits of the population.

1.What is the relationship between urban population growth and urban sprawl?

2. What changes occurred in the region during the use of the territory?

Literature review. Existing land use refers to the land used by humans for its functional role such as economic activity, while land cover is the distribution of biophysical properties such as vegetation, water, and soil on the earth's surface. These two are mostly related to the sustainable economic development of the city (Liping etc., 2018). Human activities on land are known as land use but are not always related to land cover. Land use dynamics affect the availability of a number of important resources, including water, soil, and vegetation. In many cases, this effect is characterized as negative. Soil erosion occurs during land use, and it has been determined that agricultural land cultivation at the expense of grasslands and shrubs results in the greatest change in soil erosion intensity (Wassie, 2020).

Research on urban sprawl emerged in the 1960s and the term “urban sprawl” was first proposed by Whyte (1958) in 1958. The process of urban sprawl originated in France in the 1960s and since then has spread to peri-urban areas regardless of city size with the growth of the economy, the rate of expansion has been gradual from region to region.

In the early 21st century, governments at all levels greatly accelerated urban sprawl by investing heavily in transportation and other public facilities. (Carruthers, 2002). There are a number of approaches to urban sprawl, and most research focuses on four aspects. The first aspect is the delimitation of urban sprawl. Whyte defined urban sprawl as the therapeutic development of suburban areas. According to Gottmann, sprawl is continuous expansion along the periphery of a metropolis. Anderson etc. (1996) divides urban sprawl into the following categories by characterizing it as the separation of the residential area from other land uses due to its location on the outskirts of the city:

a) General reduction of land use intensity;

b) Developed transport network;

c) Expansion of city boundaries.

Summarizing the mentioned ideas, expansion: low density, inaccessibility, scattered development, and functional inefficiency are manifested.

The second aspect is the measurement of urban sprawl. Two types of metrics are commonly used to measure urban sprawl, a single index, and a composite index method to measure multidimensional aspects of sprawl. The most popular single index is the sprawl index, which was used to measure the sprawl ranking status of metropolitan areas in the United States in 2000 (SI) (Lopez & Hynes, 2003). Ewing etc. (2002) used principal component analysis to examine 22 highly correlated variables, from which he formed four factors: residential density, the extent of land use, the intensity of economic centers and urban centers, and accessibility of neighborhood networks.

Later, new measurement models were developed by adding other factors to measure the spreading coefficient. Torrens (2008) measured urban sprawl with seven aspects, including urban growth, with a total of 42 factors. The composite index method also includes a dynamic model, spatial model, measurement model, statistical model, and integrated model. Zhou etc, (2021) investigated the factors influencing vertical urban expansion by building regression models from the perspectives of government, developers, and residents. Das and Angadi (2021) combined spatial landscape metrics and the Shannon entropy model to analyze the spatial assessment of urban sprawl.

The third aspect is the study of the factors influencing the expansion of cities mainly from two aspects: natural conditions and socio-economic conditions. Wang etc. (2021) studied urban decentralization and urban renewal as socio-economic factors behind urban expansion. Fan and Zhou (2019) believed that the expansion of fiscal competition among governments in cities, competition for investment, and competition for environmental promotion are factors that positively influence cities. Multiple scenario simulations were used to explore the potential impact of population growth and job sector expansion and planning on urban growth (Domingo etc. 2021, Guite, 2019). With increasing population density in residential areas, Koprowska et al. (2020) used hotspot analysis to demonstrate the relationship between urban sprawl and increased accessibility of urban green areas. In general, factors affecting urban expansion include natural conditions, governance, history, population, economy, etc The fourth aspect involves the study and measurement methods of controlling urban sprawl. Based on the model of least resistance, Guan, etc. (2020) simulated urban expansion conditions under different scenarios considering resource level, environmental barriers, environmental resistance, and urban expansion, and made suggestions to guide sustainable urban development. Gavrilidis et al. (2019)

used hierarchical analysis to evaluate green space proposals in urban areas and proposed a methodological framework for controlling urban sprawl. Menzori etc. (2021) argued that governance capacity affects the geographic location of urban growth and in turn the level of urban expansion. Tan etc. (2021) concluded that innovation policies do not promote urban sprawl.

Research on urban sprawl is comprehensive and covers diverse areas such as quantity, mechanism, impact, and regulation. The concepts put forward in these studies are mainly in the direction of the expansion of cities with the provision of social economic development, the creation of new jobs, and the improvement of the quality of life. Ensuring regional and local development is based on the principles of proper planning of the territory. The main issue is that the scarce territory and land should be taken according to the above-mentioned requirements. The size of the city affects population growth (Efendiyev, 2002, p. 65), and as a result, the expansion of the city takes place. In other words, urbanization and the expansion of the city should be dealt with in a complex way.

MATERIAL AND METHOD

Study area. Shaki district is one of the largest regions of Republic of Azerbaijan with a total area of 2488 km2 (Fig 1). The administrative region is surrounded by the Dagestan Republic of the Russian Federation from the north, Oguz from the east, Yevlakh from the south, and Gakh from the west. The city of Shaki belongs to the group of middle-sized cities (Efendiyev, 2002, p. 211) and lags behind the cities of Baku, Sumgait, and Ganja in terms of the level of social and economic development and the number of its population.

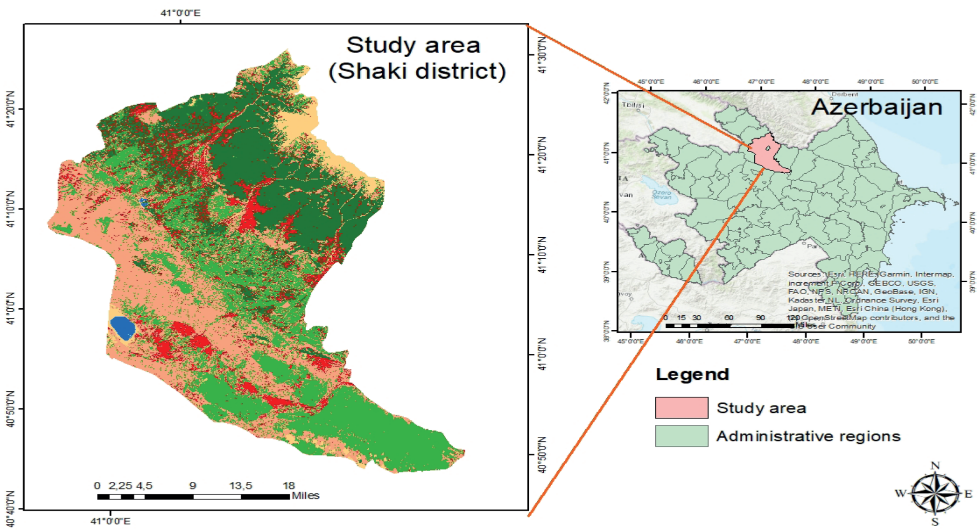

Figure 1. The area of the research

Nevertheless, Shaki is considered a regional city center in the classification of cities. However, in recent times, due to the increase in population, the formation of large industrial areas, and the multi-sectoral industrial structure, it has been removed from the group of medium cities and included in the group of big and large cities.

Data analysis. In the process of measuring the level of urbanization in the region and determining the expansion area of the city, let's first look at the statistical indicators of the district. In the database, the indicators of the Shaki population for the years 2010 and 2020 were taken for analysis, and calculations were made on it. It should be noted that the census of the population of the Republic was carried out twice (1999 and 2009) and the information of 2020 is of an intermediate nature and does not reflect the latest statistical information.

The population of Shaki district continued to increase in the years 2010–2020. So, in 2010, the population was 173.5 thousand people, in 2015, this indicator reached 182.7 thousand people, and in 2020, it reached 189.1 thousand people, which means a 3% increase compared to the previous year. During the mentioned period, a sharp decrease in the growth rate of the population is observed. In 2015, the natural increase in the region decreased from 1852 people to 864 people in 2020, which is a total decrease of 53%. Also, the natural increase of the population per thousand people decreased from 10.2 to 4.6 people. On the other hand, the difference between births and deaths is decreasing. In 2015, the number of births in the region was 3,003, while the number of deaths was 1,151.

In 2020, the interval between them gradually decreased, the number of births reached 2208, and the number of deaths reached 1344 people, which is a factor that directly affects the natural growth of the region (Fig 2).

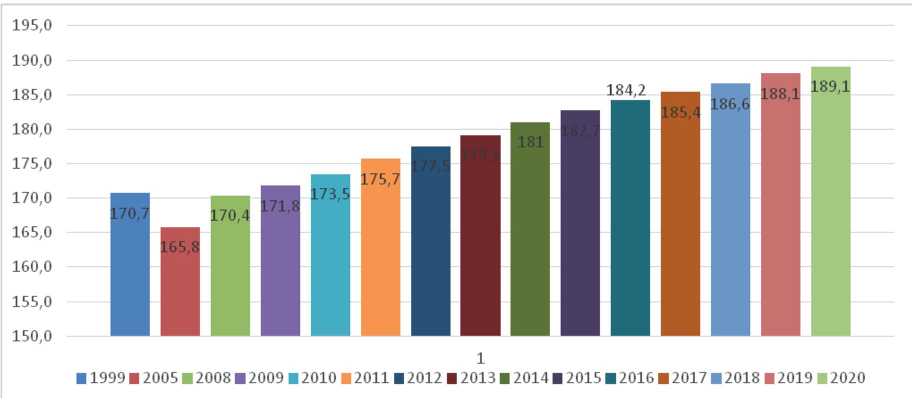

Figure 2. Population growth indicator of Shaki region over the years (thousands of people)
Source: Prepared based on statistical data (Statistical review (2021))

Most of the population of the region lives in villages and settlements. The total number of urban population was 68.5 thousand people or 36.2%, and the rural population was 120.7 thousand people or 63.8%.

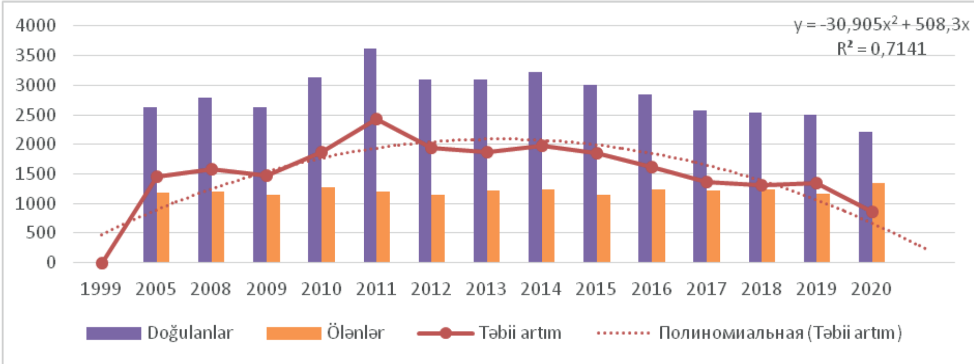

Figure 3. Prediction of natural growth in Shaki district (people) using mathematical method and statistical data (ASSC2021)

Looking at the natural growth rate of the region's population, we see that natural growth is expected to decrease and growth per thousand people in 2021 is predicted to decrease. This indicator is expected to drop below 500 people (Fig 3.) In accordance with the natural growth rate, the process of building new settlements, commissioning service areas and opening new workplaces is taking place in Shaki district. At this time, the expansion of the city and the corresponding changes in the use of the area occur.

Method

The study of territorial planning in the research district was conducted based on the results obtained from satellite images (Table 1) and their processing. At the same time, according to the information of the Statistics Committee, the dynamics of the population, the trend of increase and decrease were studied and the population forecast was given. The software used is ArcGis pro 2.8.4 version.

The sequence of the process and the development methodology are carried out in Figure 4. Although the approach is the same, some parameters and/or additional calculations may be performed later. It depends on the number of data used, the indicators of the parameters, and the applied methods. For this purpose, the Azersky satellite was used, and controlled classification was performed using the SVM (support vector machine) method. The aforementioned SVM method is considered the highest level of machine learning (ML) and is often used in the process of processing satellite images.

Table 1

Satellite images were used. Source: Satellite images provided by Azercosmos to support scientific research.

Name	Achieved	Name of Platform	Type	Band number
Azersky	2016	SPOT6	Orthophoto	4
Azersky	2022	SPOT7	Orthophoto	4

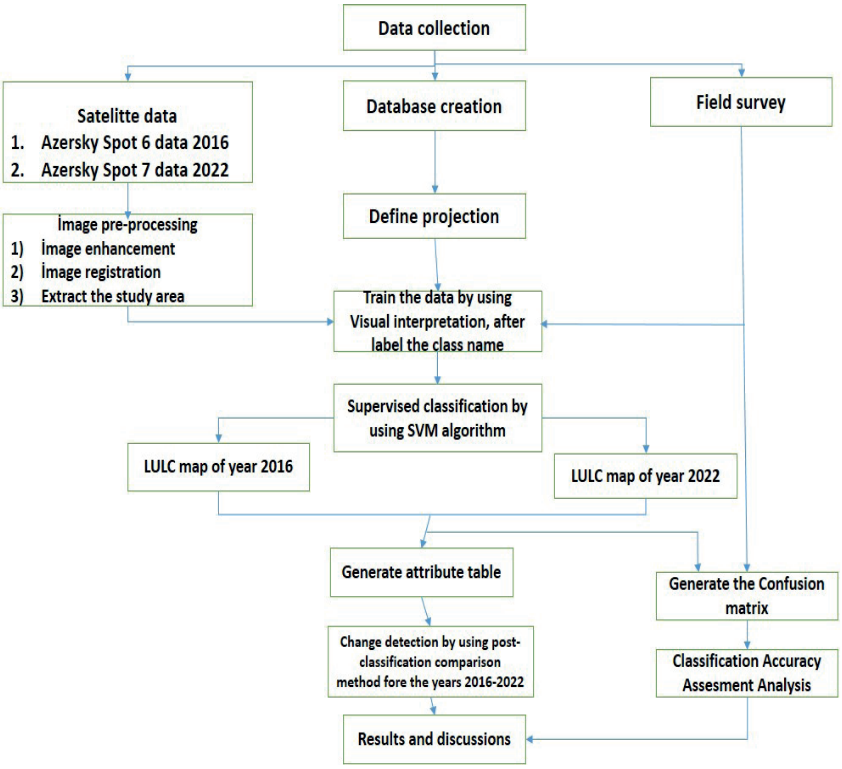

Figure 4. The methodology and sequence of the satellite image decoding

The classification of the obtained data was carried out in the following way:

Settlement: it includes residential areas of the population, social infrastructure areas, transport infrastructure and its units, industrial enterprises, and agricultural production areas;

Forest: Greenery, park areas, trees, and bushes in backyards were classified as forest areas during image processing;

Bareland: Areas classified as low productivity, areas with no vegetation or broken areas, temporarily formed due to the reduction of the flow area of rivers and not suitable for any agricultural area, are included in this category;

Agriculture: This category includes agricultural fields and vineyards around the city;

Water: Classification of the river flowing in the city of Shaki was carried out.

DISCUSSION

Analysis of classification results. After deciphering the distribution images obtained in the region, it can be seen that there have been significant changes in the share of individual areas in the general area (Fig 5).

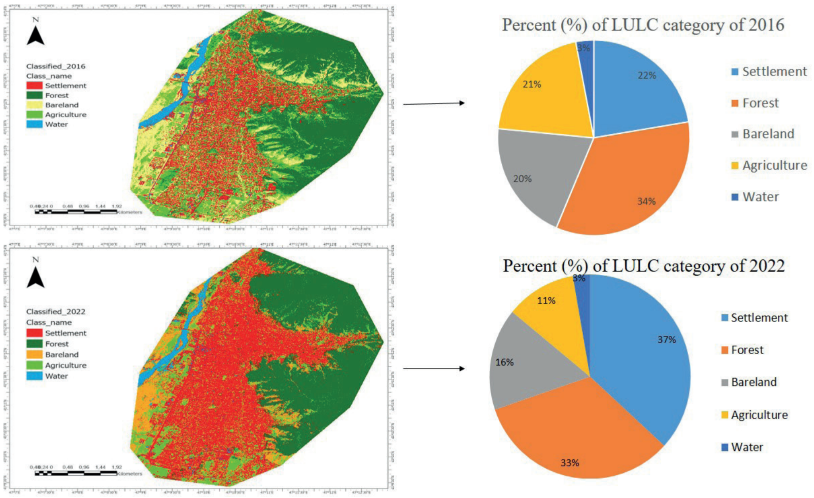

Figure 5. Satellite images of the Shaki region in 2016 and 2022
An image decoded by the SVM method by Author

Thus, the area of the settlements began to increase in the six-year period. In 2016, residential areas (including residential areas, social infrastructure areas, industrial enterprises, and buildings) covered 22.4% of the city, and in 2022, this indicator increased by 39% (Table 2). However, during classification, some areas such as football pitches, airport grounds, and outdoor sports fields are classified as residential areas. However, these areas can also be considered fallow areas and agricultural areas.

Although GIS information systems are considered an important planning tool in spatial planning, they cannot explain change or substitution in detail. Thus, the physical changes occurring in the area are explained by social and economic processes along with geographical components. For example, it can be justified by the measures taken within the framework of the «Social and economic development of Regions» State program implemented in the region during the years 2016–2022, including the newly commissioned facilities and service areas.

Table 2

Quantitative Indicators of land use (2016–2022)

S.No	Class name	2016		2022	
		Area(ha)	% of area	Area(ha)	% of area
1	Settlement	727,7	22,4	1196,7	36,8
2	Forest	1104,7	34	1071	32,9
3	Bareland	654,4	20,1	525,5	16,2
4	Agriculture	665,4	20,5	367,6	11,3
5	Water	98	3	89,6	2,8
Total		**3250,2**	**100**	**3250,4**	**100**

A reduction in the total area of forest reserves is observed. So, if forests covered 34% or 1105 ha of the total area in 2016, in 2022 this number has sharply decreased to 32.9% in urban and surrounding areas. In the decoding of the forest area in the study region, the classification according to the category of sparse and dense forest was not carried out and it was evaluated as a single forest area.

A decrease in the extent of arid and unusable areas was recorded in the city of Shaki. In 2016, these areas, which were 654.4 ha, covered 20.1% of the city, but in 2022, this indicator decreased sharply to 128.9 ha, which constituted 16.2% of the area. One of the factors affecting the increase and decrease in the area of wasteland is the recent decrease in the water level of the river flowing in the region, resulting in the formation of areas in the form of small fields, which have been recorded in dry areas or unused areas. On the other hand, as a result of the social economic development programs of the regions, the provision of gas to the population in the area has been accelerated and a large part of the gas needs of the region has been completely met, as a result, the destruction of forest resources has been prevented. In areas classified as unusable and arid, there is a decrease in the total share of arid areas due to the natural formation of bushes. In the indicated period, the number of areas without wounds decreased by 20%.

The most serious change in the use of the territory was recorded in agriculture.

Thus, a decrease in the agricultural use of the territory is seen during the years 2016–2022. The general indicators of agriculture, including arable land, were 665.4 ha in 2016, and decreased to 367.6 ha in the next six years. This means a 45% or 297.8 ha decrease in the mentioned period.

There was no significant change, replacement or decreasing trend in the total area of water basins. In 2016, the area of the river flowing in the urban area was 3% (98 ha), but in 2022 these indicators were 2.8% (89.6 ha), which is quite weak and not to an appreciable extent.

The extent and direction of change. During the use of the area in the Shaki region, a transition or change between areas was observed. Figure 6 shows the categorical change, which shows the transition of land use in which sector to which sector during 2016–2022 after classification. No changes have been recorded in the areas shown in white on the map, and the areas that have changed are marked with color intensification. Although you see a transition in all areas, except for the sharp change in the above-mentioned areas, the changes in other categories are insignificant or negligible.

Performance Evaluation and Accuracy Analysis

Accuracy assessment is considered the last step in the data analysis in the remote sensing method, which allows you to check how accurate the obtained results are and is carried out after the decoding of satellite images. The main goal here is to evaluate the accuracy of the thematic maps or classified images known as asthmatic or classification accuracy. During the accuracy analysis, 100 points were determined by the Random Forest method in the classified area, its user (UA) and producer

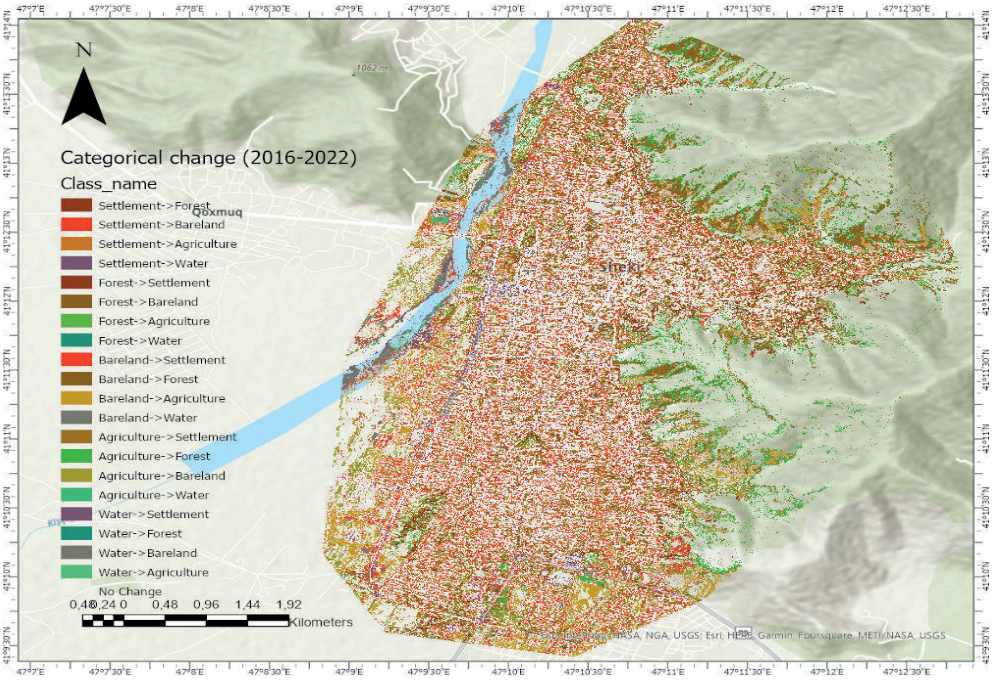

Figure 6. Areas that have changed and remained stable during the use of land in Shaki region (2016–2022)

accuracy (PU) were calculated, and the average accuracy and Kappa effect value for the area were obtained. For this, a confusion matrix (Table 3) has been constructed for the area.

Confusion and Error Matrix

A confusion matrix is a multiple array of rows and columns used to evaluate the accuracy of a processed image. It has a two-dimensional structure, where rows represent reference data and columns represent classified data. The manufacturer's accuracy is defined as the probability of correctly classifying any pixel in that category (Equation 1).

$$\text{Accuracy (Producer's Accuracy)} = \frac{\text{Total number of correct pixels in a category}}{\text{Total number pixels of that category derived from reference data}}$$

Equation 1. Calculation of Producer's accuracy

For example, the water category in Table 3 has an accuracy of 0.93, which means that about 93% of the pixels in the watershed classification appear as classified water pixels.

$$\text{Accuracy (User's Accuracy)} = \frac{\text{Total number of correct pixels in a category}}{\text{Total number pixels of that category derived from reference data}}$$

Equation 2. Calculation of user accuracy

After the user accuracy is calculated (Equation 2), we can see that the forest cover areas are correctly classified (Table 3). The general accuracy analysis (Equation 3) is expressed as follows:

$$\textbf{Overall Accuracy} = \frac{\textbf{Sum of the diagonal elements}}{\textbf{Total number of accuracy sites (pixels)}}$$

Equation 3. Calculation of the overall accuracy analysis

The average accuracy after classification was found to be 0.88% (Table 3), indicating that the land use map was correctly classified in 88%.

Table 3

Confusion Matrix obtained from classification

ClassValue	Settlement	Forest	Bareland	Agriculture	Water	Total	U_Accuracy	Kappa
Settlement	19	0	0	0	1	20	0,95	0
Forest	0	20	0	0	0	20	1	0
Bareland	2	0	18	0	0	20	0,9	0
Agriculture	0	2	0	18	0	20	0,9	0
Water	6	0	1	0	13	20	0,65	0
Total	27	22	19	18	14	100	0	0
P_Accuracy	0,703704	0,909091	0,947368	1	0,928571	0	0,88	0
Kappa	0	0	0	0	0	0	0	0,85

Kappa analyses

Error and Confusion matrix is a discrete multivariate method used to evaluate classification accuracy. Kappa analysis produces a kappa coefficient, or K_{hat} statistic, with values ranging from 0 to 1. The kappa coefficient (K_{hat}) is a measure of agreement between two maps that takes into account all elements of the error matrix and is defined by the following equation:

$$K_{hat} = (\mathrm{Obs} - \mathrm{exp})/(1 - \mathrm{Exp})$$

Here,

Obs = Observed accuracy shows the overall accuracy reported in the error matrix

Exp = The expected accuracy coefficient represents the accuracy of the classification.

Looking at the Kappa coefficient after the classification of satellite images, we see that this number is equal to 0.85 (Table 3) and according to the rating criteria (Table 4) it is quite high and considered near perfect (Landis, Koch, 1977).

CONCLUSION

During the conducted research, it was determined that the share of the urban population increased with the increase of the population in the Shaki region, and the expansion of the city with the concentration of the rural population in the urban and

Table 4

Ranking criteria of Kappa statistics (Landis & Koch, 1977)

S. No	Kappa statistics	Strength of agreement
1	<0.00	Poor
2	0.00–0.20	Slight
3	0.21–0.40	Fair
4	0.41–0.60	Moderate
5	0.61–0.80	Substantial
6	0.81–1.00	Almost perfect

suburban areas. The expansion of the city was recorded more in the south and south-east direction, where the population lived sparsely before. The main reason for this is the construction of new residential areas in these areas, the commissioning of the building of the Central Hospital, Asan Service, and Regional Education Departments. In accordance with the growth rate of urbanization and economic development, a "flight to the center" was observed, and as a result, there were noticeable changes in the structure of land use in 2016–2022. The most changes were recorded in the increase of residential areas, correspondingly, the decrease of agricultural areas and forest cover is observed.

The available satellite images for the study area cover only two years. This is not enough to predict the future. Also, the borders of the city itself (city area) are not specifically defined. That is, during the research, it was analyzed together with the surrounding villages, including Okhut, Kish, Gishlaq. When the aforementioned is fully provided, it is possible to make accurate calculations on the growth index (SI) of the city, and for this, more information is needed.

REFERENCES:
(СПИСОК ВИКОРИСТАНОЇ ЛІТЕРАТУРИ)

ADSK. (2021). *Regionların sosial-iqtisadi inkişafı.* Statistik məcmuə, 728./ ASSC (2021). Socio-economic development of regions. Statistical collection, 728, in Azerbaijan https://www.stat.gov.az/source/regions/

Anderson, W.P.; Kanaroglou, P.S.; Miller, E.J. . (1996). *Urban Form, Energy and the Environment: A Review of Issues, Evidence and Policy. Urban Stud., 33, 7–35. [CrossRef].*

Brears. (2018). *Natural Resource Management and the Circular Economy, Palgrave Studies in Natural Resource Management, XVI, PP 349, https://doi.org/10.1007/978–3–319–71888–0.*

Carruthers, J. (2002). *The Impacts of State Growth Management Programmes: A Comparative Analysis. Urban Stud.,39, 1959–1982. [CrossRef].*

Das, S.; Angadi, D.P. (2021). *Assessment of urban sprawl using landscape metrics and Shannon's entropy model approach in town level of Barrackpore sub-divisional region, India. Modeling Earth Syst. Environ., 7, 1071–1095. [CrossRef].*

Domingo, D.; Palka, G.; Hersperger, A.M. (2021). *Effect of zoning plans on urban land-use change: A multi-scenario simulation for supporting sustainable urban growth. Sustain. Cities Soc., 69, 102833. [CrossRef].*

Domingo, D.; Palka, G.; Hersperger, A.M. (2021). *Effect of zoning plans on urban land-use change: A multi-scenario simulation for supporting sustainable urban growth. Sustain. Cities Soc., 69, 102833. [CrossRef].*

Ewing, R.; Pendall, R.; Chen, D. *Measuring Sprawl and Its Impact; Smart Growth America: Washington, DC, USA, 2002.*

Əfəndiyev V.Ə. (2002). *Urbanizasiya və Azərbaycanda şəhər yaşayış məntəqələri, Bakı, Bakı Universiteti.* 395.// Efendiyev V.A. (2002). Urbanization and urban settlements in Azerbaijan, Baku, Baku University. 395

Fan, J.; Zhou, L. (2019). *Three-dimensional intergovernmental competition and urban sprawl: Evidence from Chinese prefectural-level cities. Land Use Policy, 87, 104035. [CrossRef].*

Fitawok, M.B.; Derudder, B.; Minale, A.S.; Van Passel, S.; Adgo, E.; Nyssen, J. (2020). *Modeling the Impact of Urbanization on Land-Use Change in Bahir Dar City, Ethiopia: An Integrated Cellular Automata–Markov Chain Approach. Land, 9, 115.*

Gavrilidis, A.A.; Nit, a, M.R.; Onose, D.A.; Badiu, D.L.; Nastase, I.I. (2019). *Methodological framework for urban sprawl control through sustainable planning of urban green infrastructure. Ecol. Indic., 96, 67–78.*

Guan, D.; He, X.; He, C.; Cheng, L.; Qu, S. . (2020). *Does the urban sprawl matter in Yangtze River Economic Belt, China? An integrated analysis with urban sprawl index and one scenario analysis model. Cities, 99, 102611.*

Guite, L. (2019). *Assessment of urban sprawl in Bathinda city, India. J. Urban Manag., 8, 195–205. [CrossRef].*

Koprowska, K.; Łaszkiewicz, E.; Kronenberg, J. . (2020). *Is urban sprawl linked to green space availability? Ecol. Indic., 108, 105723. [CrossRef].*

Landis, J.R. and Koch, G.G. (14977). *A One-Way Components of Variance Model for Categorical Data. Biometrics, 33, 671–679, https://doi.org/10.2307/2529465.*

Liping C, Yujun S, Saeed S. (2018). *Monitoring and predicting land use and land cover changes using remote sensing and GIS techniques – A case study of a hilly area, Jiangle, China. PLoS ONE13(7): e0200493. https://doi.org/10.1371/journal.pone.0200493.*

Lopez, R. & Hynes, H.P. (2003). *Sprawl in the 1990s: Measurement, Distribution, and Trends. Urban Aff. Rev., 38, 325–355. [CrossRef].*

Mansour, S.; Al-Belushi, M.; Al-Awadhi,. (2020). *T. Monitoring land use and land cover changes in the mountainous cities of Oman using GIS and CA-Markov modelling techniques. Land Use Policy, 91, 104414. [CrossRef].*

Menzori, I.D.; Sousa, I.C.N.d.; Gonçalves, L.M. (2021). *Urban growth management and territorial governance approaches: A master plans conformance analysis. Land Use Policy, 105, 105436.*

Paşayev N.Ə, Əyyubov N.H, Eminov, Z.N. (2010). *Azərbaycan Respublikasının iqtisadi, sosial və siyasi coğrafiyası, Bakı,.* 410./ Pashayev N.A, Ayyubov N.H, Eminov, Z.N. (2010). Economic, social and political geography of the Republic of Azerbaijan, Baku,. 410

Statistik Məcmuə. (2021). *Azərbaycanın demoqrafik göstəriciləri.* 560./ Statistical Review. (2021). Demographic indicators of Azerbaijan. 560.

Tan, R.; Zhang, T.; Liu, D.; Xu, H. (tarixsiz). *How will innovation-driven development policy affect sustainable urban land use: Evidencefrom 230 Chinese cities. Sustain. Cities Soc. 2021, 72, 103021. .*

Torrens, P. (2008). *A Toolkit for Measuring Sprawl. Appl. Spat. Anal. Policy, 1, 5–36. [CrossRef].*

Wang, X.; Shi, R.; Zhou, Y. (2020). *Dynamics of urban sprawl and sustainable development in China. Socio-Econ. Plan. Sci., 70, 100736. [CrossRef].*

Wassie, S. (2020). *Natural resource degradation tendencies in Ethiopia: a review. Environ Syst Res 9, 33. https://doi.org/10.1186/s40068–020–00194–1.*

Whyte, W. (1958). *The Exploding Metropolis; Doubleday: Garden City, NY, USA,.*

Zhou, D.; Li, Z.; Wang, S.; Tian, Y.; Zhang, Y.; Jiang, G. (2021). *How does the newly urban residential built-up density differ across Chinese cities under rapid urban expansion? Evidence from residential FAR and statistical data from 2007 to 2016. Land Use Polic.*

Надійшла 10.09.2023 р

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ВИВЧЕННЯ ПРОЦЕСУ УРБАНІЗАЦІЇ ТА ТЕРИТОРІАЛЬНОГО ПЛАНУВАННЯ (НА ПРИКЛАДІ ШЕКІНСЬКОГО РАЙОНУ)

Стаття присвячена процесу урбанізації міста Шекі та зміні землекористування в територіальному плануванні протягом багатьох років. Протягом 2016–2022 років було вивчено зростання чисельності населення в регіоні та збільшення питомої ваги міського населення, проаналізовано тенденцію зростання населення за двадцять років, проведено порівняльний аналіз за роками та дано прогноз. Щоб визначити напрямок і масштаби землекористування в місті, було визначено взаємозв'язок між темпами зростання міського населення і розширенням міста, а також проаналізовано зміни, що відбулися в регіоні за час використання землі. Для цієї мети також використовувалися статистичні дані поряд з даними супутника Azersky. Був використаний метод машинного навчання (ML), який широко використовується в системах дистанційного зондування, застосовано машинне навчання з опорними векторами (SVM), а також здійснено процес класифікації та обробки зображень. На основі отриманих даних було проведено порівняльний аналіз попередніх та поточних умов, а також розраховано площу змін між класифікованими районами. У той же час вказані переходи між категоріями в процесі використання території і недавні зміни в напрямку землекористування. Була оцінена ефективність класифікації, проведено аналіз точності користувачів і виробників і розрахований коефіцієнт Каппа. Зрештою, було зазначено напрямок розширення міста та його причини.

Ключові слова: урбанізація, місто Шекі, Азербайджанський, коефіцієнт Каппа, приріст населення, територіальне планування, землекористування.