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«ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ» РҚБ
«ХАЛЫҚ» ЖҚ

ХАБАРЛАРЫ

ИЗВЕСТИЯ

РОО «НАЦИОНАЛЬНОЙ
АКАДЕМИИ НАУК РЕСПУБЛИКИ
КАЗАХСТАН»
ЧФ «Халық»

N E W S

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NAS RK is pleased to announce that News of NAS RK. Series of geology and technical sciences scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of geology and technical sciences in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of geology and engineering sciences to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы «ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы» ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Webof Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия геологии и технических наук» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия геологии и технических наук в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по геологии и техническим наукам для нашего сообщества.

ЧФ «ХАЛЫҚ»

В 2016 году для развития и улучшения качества жизни казахстанцев был создан частный Благотворительный фонд «Халык». За годы своей деятельности на реализацию благотворительных проектов в областях образования и науки, социальной защиты, культуры, здравоохранения и спорта, Фонд выделил более 45 миллиардов тенге.

Особое внимание Благотворительный фонд «Халык» уделяет образовательным программам, считая это направление одним из ключевых в своей деятельности. Оказывая поддержку отечественному образованию, Фонд вносит свой посильный вклад в развитие качественного образования в Казахстане. Тем самым способствуя росту числа людей, способных менять жизнь в стране к лучшему – профессионалов в различных сферах, потенциальных лидеров и «великих умов». Одной из значимых инициатив фонда «Халык» в образовательной сфере стал проект Ozgeris powered by Halyk Fund – первый в стране бизнес-инкубатор для учащихся 9-11 классов, который помогает развивать необходимые в современном мире предпринимательские навыки. Так, на содействие малому бизнесу школьников было выделено более 200 грантов. Для поддержки талантливых и мотивированных детей Фонд неоднократно выделял гранты на обучение в Международной школе «Мирас» и в Astana IT University, а также помог казахстанским школьникам принять участие в престижном конкурсе «USTEM Robotics» в США. Авторские работы в рамках проекта «Тәлімгер», которому Фонд оказал поддержку, легли в основу учебной программы, учебников и учебно-методических книг по предмету «Основы предпринимательства и бизнеса», преподаваемого в 10-11 классах казахстанских школ и колледжей.

Помимо помощи школьникам, учащимся колледжей и студентам Фонд считает важным внести свой вклад в повышение квалификации педагогов, совершенствование их знаний и навыков, поскольку именно они являются проводниками знаний будущих поколений казахстанцев. При поддержке Фонда «Халык» в южной столице был организован ежегодный городской конкурс педагогов «Almaty Digital Ustaz.

Важной инициативой стал реализуемый проект по обучению основам финансовой грамотности преподавателей из восьми областей Казахстана, что должно оказать существенное влияние на воспитание финансовой грамотности и предпринимательского мышления у нового поколения граждан страны.

Необходимую помощь Фонд «Халык» оказывает и тем, кто особенно остро в ней нуждается. В рамках социальной защиты населения активно проводится

работа по поддержке детей, оставшихся без родителей, детей и взрослых из социально уязвимых слоев населения, людей с ограниченными возможностями, а также обеспечению нуждающихся социальным жильем, строительству социально важных объектов, таких как детские сады, детские площадки и физкультурно-оздоровительные комплексы.

В копилку добрых дел Фонда «Халык» можно добавить оказание помощи детскому спорту, куда относится поддержка в развитии детского футбола и карате в нашей стране. Жизненно важную помощь Благотворительный фонд «Халык» оказал нашим соотечественникам во время недавней пандемии COVID-19. Тогда, в разгар тяжелой борьбы с коронавирусной инфекцией Фонд выделил свыше 11 миллиардов тенге на приобретение необходимого медицинского оборудования и дорогостоящих медицинских препаратов, автомобилей скорой медицинской помощи и средств защиты, адресную материальную помощь социально уязвимым слоям населения и денежные выплаты медицинским работникам.

В 2023 году наряду с другими проектами, нацеленными на повышение благосостояния казахстанских граждан Фонд решил уделить особое внимание науке, поскольку она является частью общественной культуры, а уровень ее развития определяет уровень развития государства.

Поддержка Фондом выпуска журналов Национальной Академии наук Республики Казахстан, которые входят в международные фонды Scopus и Wos и в которых публикуются статьи отечественных ученых, докторантов и магистрантов, а также научных сотрудников высших учебных заведений и научно-исследовательских институтов нашей страны является не менее значимым вкладом Фонда в развитие казахстанского общества.

С уважением,
Благотворительный Фонд «Халык»!

Бас редактор

ЖҰРЫНОВ Мұрат Жұрынұлы, химия ғылымдарының докторы, профессор, ҚР ҰҒА академигі, «Қазақстан Республикасы Ұлттық ғылым академиясы» РҚБ-нің президенті, АҚ «Д.В. Сокольский атындағы отын, катализ және электрохимия институтының» бас директоры (Алматы, Қазақстан) **H = 4**

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ECO-GEOGRAPHICAL ASSESSMENT OF URBAN LANDSCAPE DEVELOPMENT DYNAMICS ON THE BASIS OF GIS

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Abstract. In the article, we have analyzed the territorial and population development of the Saatli urban landscape located in the Mugan plain in the territory of the Republic of Azerbaijan, and we have shown the results of its impact on the environment. For this purpose, a 1:10 000 scale topographic plan of the city dated 1975, and satellite and space images of the XX and XXI centuries were used. As a result of the analysis of the territorial development of the urban landscape, it was determined that the arable lands in the surrounding areas were replaced by construction sites, and even the 30-hectare oxbow lake of the Araz River was turned into a construction site. Population dynamics show that the city was included in the group of medium-sized cities in 2020.

Keywords: Urban landscape, environment, Saatli city, construction density coefficient

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ГАЖ НЕГІЗІНДЕГІ ҚАЛА ЛАНДШАФТЫ ДАМУЫНЫҢ ДИНАМИКАСЫНА ЭКО-ГЕОГРАФИЯЛЫҚ БАҒА БЕРУ

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Аннотация. Мақалада Әзірбайжан Республикасы аумағындағы Мұған жазығында орналасқан Саатлы қалалық ландшафтының аумақтық және халықтық дамуын талдап, оның қоршаған ортаға әсерінің нәтижелерін көрсеттік. Осы мақсатта қаланың 1975 жылғы 1:10 000 масштабты топографиялық жоспары, XX және XXI ғасырлардағы спутниктік және ғарыштық суреттер пайдаланылды. Қала ландшафтының аумақтық дамуын талдау нәтижесінде іргелес аудандардағы егістік алқаптары құрылыс алаңдарына ауыстырылғаны, тіпті Араз өзенінің 30 га алқапты көлі құрылыс алаңына айналғаны анықталды. Халық санының динамикасы қаланың 2020 жылы орташа қалалар тобына енгенін көрсетеді.

Түйін сөздер: Қала ландшафты, қоршаған орта, Саатлы қаласы, құрылыс тығыздығының коэффициенті

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ЭКОГЕОГРАФИЧЕСКАЯ ОЦЕНКА ДИНАМИКИ РАЗВИТИЯ ГОРОДСКОГО ЛАНДШАФТА НА БАЗЕ ГИС

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Аннотация. В статье был проведен анализ территориального и популяционного развития Саатлинского городского ландшафта, расположенного в Муганской равнине на территории Азербайджанской Республики, и показаны результаты его воздействия на окружающую среду. Для этого использовались топографический план города масштаба 1:10 000 1975 года, спутниковые и космические снимки XX и XXI веков. В результате анализа территориального развития городского ландшафта было установлено, что пашни на прилегающих территориях были заменены строительными площадками, и даже 30-га старица реки Араз была превращена в строительную площадку. Динамика численности населения показывает, что город вошел в группу средних городов в 2020 году.

Ключевые слова: городской ландшафт, окружающая среда, город Саатлы, коэффициент плотности застройки

Introduction

Cities cover 2 % of the Earth's surface (Arnaiz-Schmitz et al., 2018). However, more than 50 % of the world's population lives in cities (Cheshmehzangi, 2015). By the end of the century, this figure is forecasted at 70 % (Mikadze, 2015). From this point of view, the study of cities, monitoring the dynamics of their development, and forecasting the future can be considered a topical issue of our time.

With increased urbanization worldwide, an urban perspective is progressively needed to understand human-nature interactions to improve research, design, planning, and management of cities, towns and urban regions (Breuste et al., 2011).

In urban landscapes, land is highly exposed to rapidly increasing consumption, making it a scarce and precious resource. Therefore, there is a close relationship between land use and environmental pollution. At this time, there are changes in soil cover, vegetation, air quality and other indicators (Banzhaf et al., 2017). Urban ecology is a rapidly growing research field that has to keep pace with the pressing need to tackle the sustainability crisis (Forman, 2016).

Along with traditional methods, modern methods, especially Remote Sensing, are important in urban research. Remote sensing is a unique technology in its ability to analyze spatial and temporal data, especially when conducting surveys over a larger area (Hu et al., 2018).

What is the city? This concept is perceived differently in different countries. For example, in Azerbaijan, a city is a settlement with a population of more than 15,000 and non-agricultural activities. There are 79 cities in the country. One of these cities is Saatli, which we studied in the article.

Cities are the most intensively developed settlements on the Earth (Zhu et al., 2019). In this regard, their study is very important. Factors affecting urban settlement are classified as follows (Klopp et al., 2017).

- historical factors
- use of natural resources
- construction of industrial enterprises
- administrative-management and trade-distribution function
- Establishment of resort-sanatorium economy
- labor resources

Cities have been studied both in terms of territory and population (Amanova, 2022). The city of Saatli is located on the Mughan plain and forms the administrative center of the Saatli region.

Methods and materials

Our research is based on the processing of satellite and space images. In addition, a 1:10,000 scale topographic plan dating back to the 1970s was used to track the city's territorial development.

In order to determine the anthropogenic impact on the urban landscape, aerospace images for 1989, 2014 and 2022 were detected, construction sites were vectorized and analyzed. For the analysis of the level of urban development, satellite images for 2022 were detected by us and the surface cover was studied.

Images from Landsat 5 and 8 satellites were used to analyze the current and past situation in the vegetation and water basins.

Based on the Digital Elevation Model of the city, maps reflecting the absolute height and exposure were prepared, analyzed in conjunction with the construction site map, and the role of these factors in the creation of construction sites was analyzed.

Results and discussion

The city of Saatli belongs to a group of cities descended from villages due to its favorable economic and geographical position due to its genetic characteristics (Fig. 1).

Fig. 1. Location of the investigation area within the Republic of Azerbaijan

There is also a negative impact of plain relief on the urban landscape. The low slope makes it difficult to build sewerage and sewage disposal, which leads to deteriorating sanitation, flooding of individual settlements during heavy rains (Amanova, 2022).

The flatness of the Earth's surface allows for the wasteful use of land resources under construction. As a result of the spontaneous growth of the city, a large area of land was spent without charge. Rapidly growing cities are already removing the fertile lands around them from agricultural use, while these lands meet the needs of those cities for agricultural products.

Climatic conditions also affect settlement. High temperatures in the summer months require adaptation of the construction, operation of industrial enterprises and population to these conditions. High temperatures overheat the streets and walls of buildings, creating discomfort. In this case, the way out is to plant greenery, especially on the banks of the Araz River, it would be more expedient to increase the area of greenery.

The climatic factor affects the maintenance of the housing stock, the operation of enterprises, the cost of production processes. We come to the conclusion that the urban planning process should be linked to the climate.

The city of Saatli, located in the northern part of the Mugan Plain, has a temperate-hot semi-desert and dry steppe climate with dry summers. The total annual amount of total radiation is 133 kcal/cm^2, and the amount of radiation balance is 45 kcal/cm^2. The average annual temperature is 14 °C. The average temperature of the coldest month is 1,4 °C, and the temperature of the warmest month is 26,2 °C. During the summer months, the absolute maximum temperature sometimes rises to 40° C. The average annual minimum temperature is -12° C. In the coldest months, the absolute minimum temperature is -26° C.

Temperatures above 5° are only 4900–5000°, and temperatures above 10° are only 4400–4500 °C. The average annual relative humidity is 74% and varies between 60–85 % during the year. Possible evaporation is 900-1000 mm per year. The average annual wind speed is 2,2 m/s.

Such favorable climatic conditions are among the factors contributing to the development and expansion of the Saatli urban landscape in the lowlands. The combination of temperatures above 5 and 10 ° C, the low number of snow and hail days, and the low average annual wind speed create favorable conditions for agriculture in the city. At the same time, the large number of sunny days in the plain relief makes it convenient to build solar power plants within the green economy. Taking into account the hydropower potential of the Araz River, we can say that there are favorable opportunities for the construction of small hydropower plants. However, due to the recent drought, it would be appropriate to delay this work to some extent.

The level of groundwater in the city is also one of the factors influencing the development of the area and the territorial organization of the economy.

The relief of the plains makes the slopes less sloping, which creates conditions for the development of agriculture and animal husbandry. From this point of view, we can note that Saatli is one of the cities of agricultural purpose.

If the area of Saatli city was 8,9 km^2 according to the topo plan of 1975, in 2022,

based on the decoding of aerospace images, it was found that the city area expanded to 18.4 km^2 (Fig. 2). This means that the average annual area growth is 2,27 %. If we look at the direction of expansion of the city, we see that it is expanding mainly in the south-west and north-west. This is due to the existence of rural settlements in other directions, resulting in limited opportunities for expansion and the water canal passing through the area. If we look at the space image, we can see that the city has arable land in the south and south-east. This will lead to problems with food supply, destruction of fertile lands, provision of fodder base for livestock in urban landscapes.

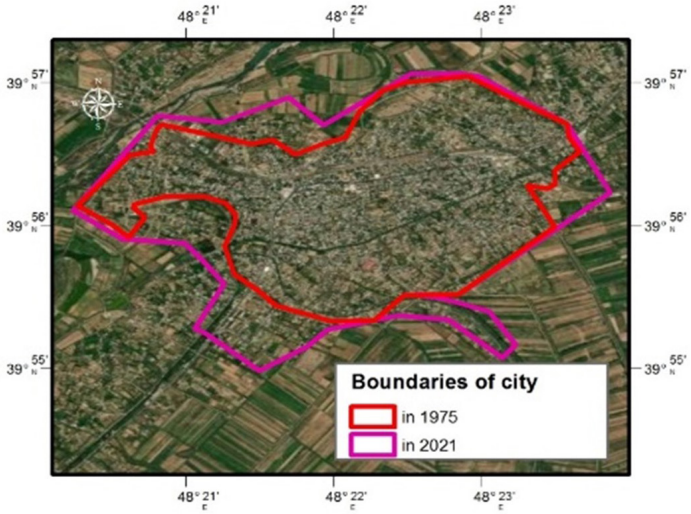

Fig. 2. Dynamics of boundaries of Saatli city in 1975–2021

To analyze the relief conditions of the area and its impact on land use, we have compiled a map showing the absolute elevation of the relief in the city (Fig. 3).

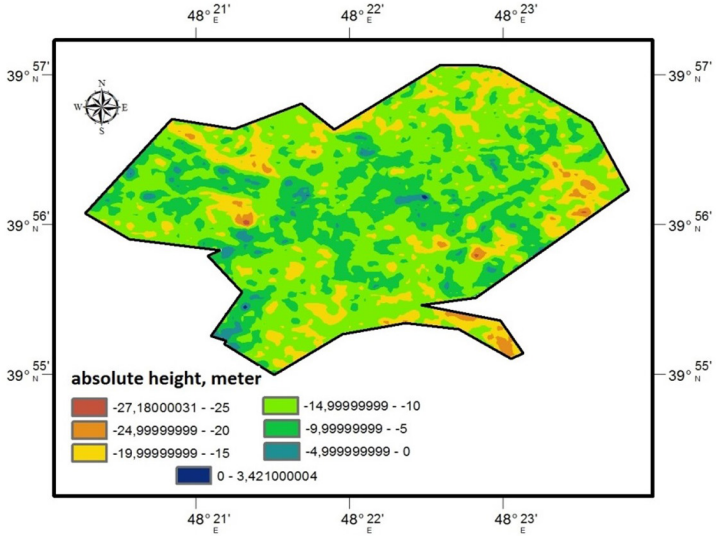

Fig. 3. Absolute height of elevation in Saatli city

The exposure of slopes, which is one of the elements of the relief, is also one of the factors influencing the density of constructions. For this purpose, we have compiled a map showing the aspect of the slopes in the area (Fig. 4).

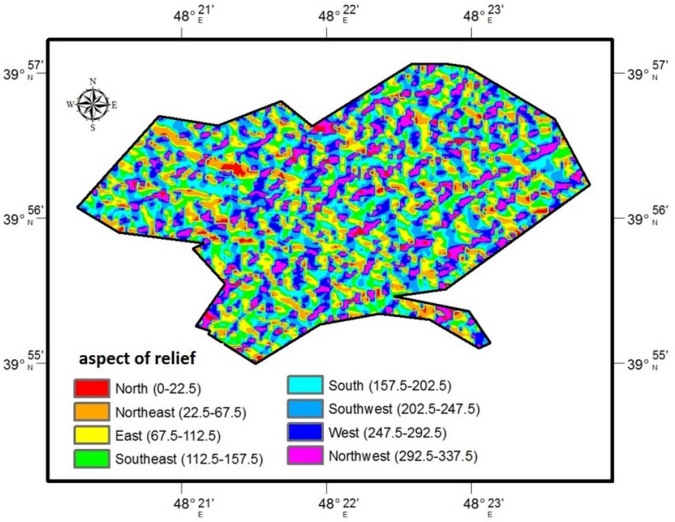

Fig. 4. Aspect of relief in Saatli

Most area of Saatli urban landscape is below sea level. Based on the results of the map compiled on the basis of the Digital Elevation Model of the area, we determined that 0,5 % of the urban area is below (-25) m, 1,6 % at a height of (-25) - (- 20) m, 17,4 % at a height of (-20) - (-15) m, 51,2 % at a height of (-15) - (-10) m, 2,7 % at a height of (-10) - (-5) m, 26 % at a height of (-5)-0 m, and 0,5 % at a height of 0–3.4 m. The most optimal height for the population is the area with an urban landscape (15) - 0 m (Table 1).

Based on the DE model, a map showing the espect in the urban landscape was compiled. Based on the results, we can say that the urban area is almost evenly distributed on all aspects.

Table 1.Statistics of elevation and aspect of relief in Saatli city

Elevation (m)	Area		aspect	Area	
	Km^2	%		Km^2	%
(-27)–(-25)	0,1	0,5	N	2,4	13
(-25)–(-20)	0,3	1,6	N-E	2,3	12,5
(-20)–(-15)	3,2	17,4	E	2,4	13
(-15)–(10)	9,4	51,2	S-E	2,3	12,5
(-10)–(-5)	0,5	2,7	S	2,3	12,5
(-5)–0	4,8	26,1	S-W	2,2	12
0–3,4	0,1	0,5	W	2,2	12
Total	18,4	100	N-W	2,3	12,5
			Total	18,4	100

Saatli city is the administrative center of Saatli district. It is located on the right bank of the Araz River. Saatli village belonged to Javad district of Baku province. By the Decree dated May 25, 1943, a new district with Saatli as its center was separated from Sabirabad district. Saatli village was assigned to the category of urban settlements on September 24, 1947. In 1971 it received the status of a city. In 1910, 307 people lived in Saatli village of Javad district of Baku province, and 323 people in 1912. By 1915, Saatli's population had fallen to 235. In 1959 it was 6,000, in 1970 it was 6,6 thousand, in 1979 it was 11,000, and in 1989 it was 14,2 thousand, the average annual population growth in 1959–70 was 0,9 %, 7,4 % in 1970–79, and 2,9 % in 1979–89. The population is mainly Azerbaijanis.

If we pay attention to the population dynamics of Saatli city in the XXI century, we can see that the population has increased from 16 thousand to 20.1 thousand in the last 20 years, which shows that in 2020 the city has received the status of a medium city. Over the past 20 years, the average annual population growth was 1.2 %.

Urban development has a strong impact on the environment. Developing cities affect water, land, vegetation and the atmosphere. For this purpose, we have studied the damage caused to the environment by the dynamics of the territory and population within the urban landscape.

As a result of our analysis, we have determined that the 30 hectares area of the unnamed lake, which is a axbow lake of the Araz River inside the city, has dried and turned into a construction and residential zone (Fig. 5). Over time, the drying up of oxbow lakes and the destruction of water bodies and the expansion of construction and individual plantings will lead to microclimate change and warming. It should be noted that, based on our other research, we have determined that the territory of the 25-hectare unnamed lake in the city of Imishli, located on the banks of the Araz River, has been replaced by buildings.

a)

b)

Fig. 5. Dynamics of oxbow lake of the Araz River in a) 2002 and b) 2023

For a comprehensive analysis of the urban landscape, for the first time in Azerbaijan, we have calculated and mapped the coefficient of construction density in the urban landscape. To do this, we used aerospace images of the city for 2000 and 2022 (Fig. 6).

As a result of decoding the aerospace images of Saatli for 2000 and 2022, we found that the number of constructions has increased in 22 years. In 2000, the area with a construction density coefficient of 0–1 was 7,78 km^2, but in 2022 it was reduced to 3,33 km^2. Areas with a coefficient greater than 1, on the other hand, have increased. For example, areas with a coefficient of 1–2 increased by an average of 50 %, areas with 2–3 increased by 200 %, areas with 3–4 increased by 7 times, areas with 4–5 increased by 5 times, and areas with more than 5 increased by 2 times (Table 2). These figures show that construction in the Saatli urban landscape, which is the study area, has been growing rapidly for 22 years. If we look at the map of the density of construction, we can see that the number of buildings in the central part of the city, where the main infrastructure is located, increased faster due to the proximity to public catering and other facilities, as well as water canals and highways.

Table 2. Construction density coefficient in Saatli (square km)

Years	Construction density coefficient					
	0-1	1-2	2-3	3-4	4-5	5-yuxarı
2000	7,78	2,21	1,3	0,2	0,09	0,02
2022	3,33	3,1	3,3	1,4	0,5	0,04

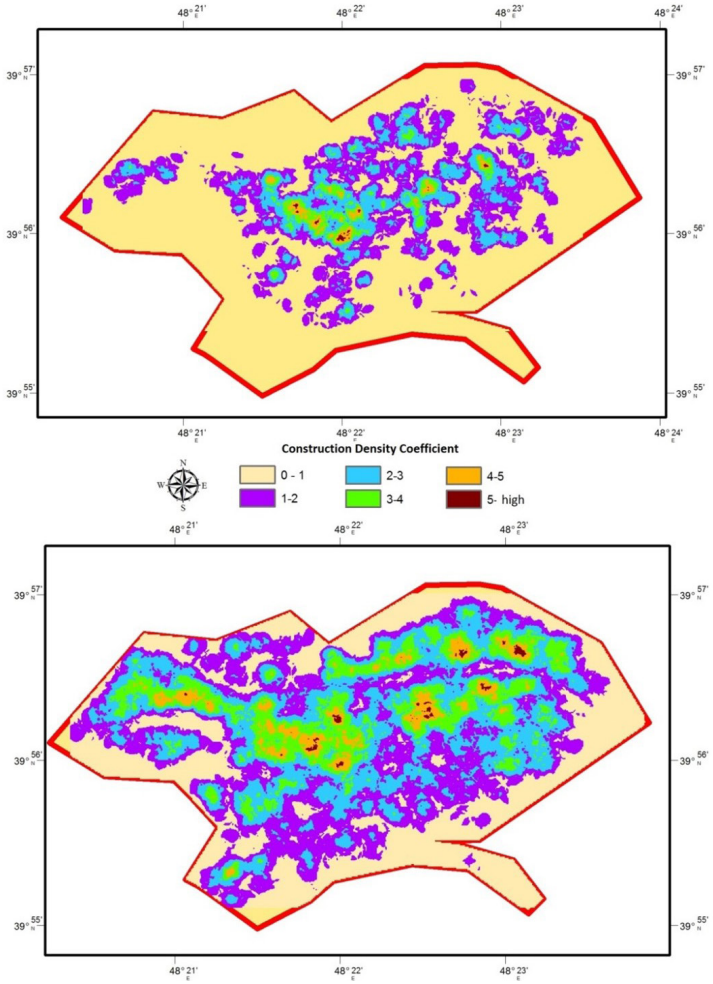

Fig. 6. Construction density coefficient in 2000 and 2022 in Saatli city

Water scarcity is a global problem. Especially the development of cities makes this problem even more urgent. For these purposes, we have analyzed and mapped the NDW index within the urban landscape. To do this, we used Landsat 5 and 8 satellite images of the city for June 1989, 2014 and June 2021 (Fig. 7).

Green and Near Infrared bands play a special role in determining this index. In Landsat 5 satellite images, the Green band shows Band 2, the near-infrared band shows Band 4, and the Landsat 8 satellite shows Band 3 and Band 5, respectively.

The visible green wavelengths maximize the typical reflectance of the water surface. The near-infrared wavelengths maximize the high reflectance of terrestrial vegetation and soil features, while minimizing the low reflectance of water features.

The result of the NDWI equation is positive values for water features and negative ones (or zero) for soil and terrestrial vegetation.

Values of water bodies are larger than 0.5. Vegetation has much smaller values,

which results in distinguishing vegetation from water bodies easier. Built-up features have positive values between 0 and 0.2.

Whenever there is a need to detect a water body, sharpen its outline on the map, and monitor changes in its clarity, the NDWI index is applied. Beyond the visible spectrum towards the infrared, water reflects almost no light. The NDWI makes use of this property to successfully outline water bodies on the map and monitor water's turbidity.

Data extracted from a satellite image using the NDWI index is visualized as maps using a color palette and graphs to show how values change over time as a curve. On a map, the higher values approaching +1 usually appear blue and correspond to either a high water content or a water surface, while the lower values all the way to -1 are the tell-tale signs of drought conditions, unless the area of interest is a non-aqueous surface.

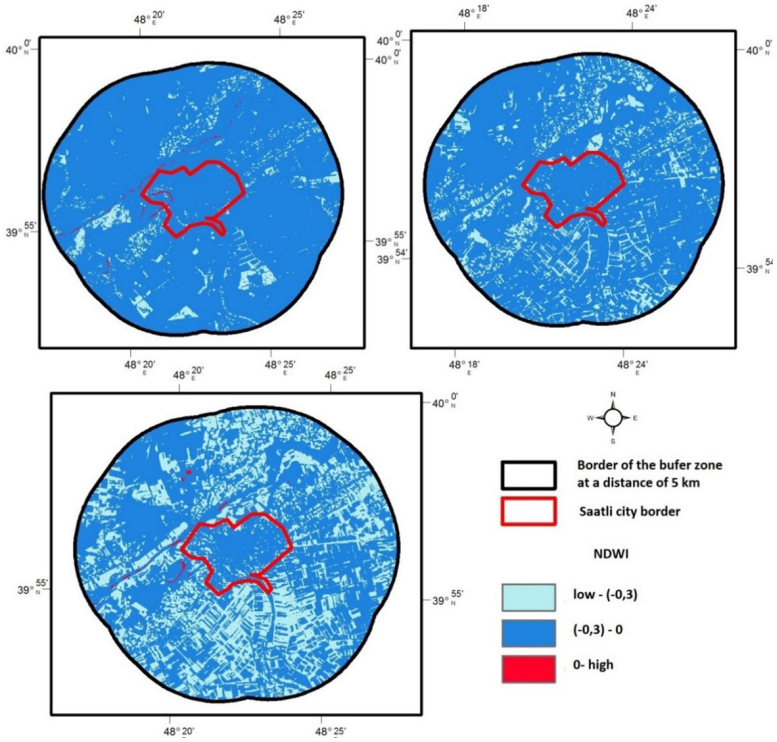

Fig. 7. Dynamics of NDV indexes in 1989, 2014 and 2021 years

Areas with an index of 0.2 - 1 cover the water surface, areas with an index of 0 - 0.2 flood areas, humidity areas, (-0.3) - areas with an average drought, dry surfaces, (-1) - (-0.3) areas show drought and arid surfaces.

Areas with an NDW index of less than -0.3 increased almost threefold between 1989 and 2014, but decreased fivefold by 2021. The area of (-0.3) -0 index areas has been reduced by 50% since 1989 (Table 3). If we look at the dynamics, the areas with an index higher than 0 were previously observed to decrease, but later increased again and reached the previous level.

Table 3. Statistics of NDW indexes in Saatli city (square km)

Years	NDW index		
	low- (-0,3)	(-0,3) - 0	0-high
1989	9,9	153	0,5
2014	24,8	138,6	0,03
2021	5,5	107,8	0,5

We have calculated NDV indexes based on satellite images and mapped those (Fig.8).

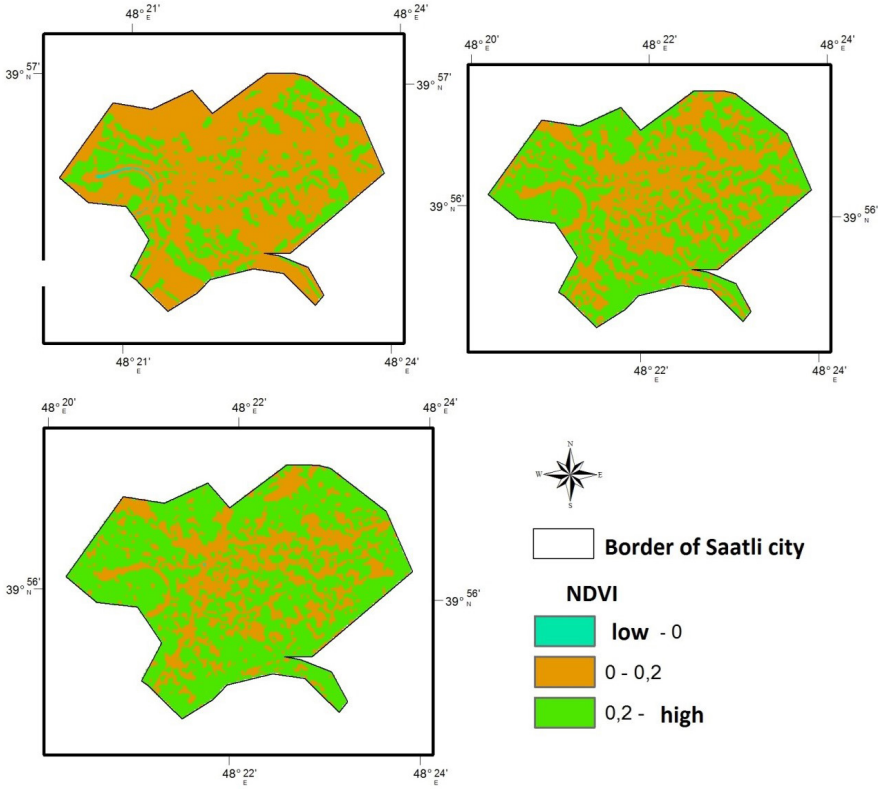

Fig. 8. Dynamics of NDW indexes in 1989, 2014 and 2021 years

Areas with an index below 0 are water basins, snow and cloudy areas, areas with an index of 0-0,2 are mainly vacant areas, construction sites, infrastructure areas, and areas with an index above 0,2 are partially covered with vegetation along with construction covers (Table 4). According to the analysis of the images based on this division, as the urban landscape developed, the vegetation was destroyed on the one hand, and on the other hand, the increase of crops and gardens in the backyards expanded significantly. However, if we pay attention to the analysis of the previous images, we can see that the sown and pasture areas have a wider area.

Table 4. Statistics of NDV indexes in Saatli city (square km)

Years	NDV index		
	low-0	0-0,2	0,2-high
06/1989	0,1	8,1	3,4
06/2014		5,3	6,3
06/2021	0,005	4,1	7,4

The amount of water consumed for agriculture and irrigation in the eponymous region, which includes the city of Saatli, decreased from 289 million m^3 in 2005 to 211 million m^3 in 2021. Positive results have been achieved in wastewater disposal. Thus, if in 2005 this amount was 1 million m^3, in 2021 there will be no sewage disposal.

Conclusion

The area of the urban landscape has increased by 106 % in 47 years, which means that the average annual growth is 2,27 %.

The average annual population growth in the city was 0,9–7,4 % in the XX century, but dropped to 1,2 % in the XXI century.

During 2000–2022, the number of constructions in the city increased by 1162 units and reached 2124 units.

Analysis of water and vegetation indexes shows that vacant areas, arable and pasture areas in the area have been replaced by construction and individual farms.

In order to prevent environmental pollution in the city, it is expedient to clear the forest strip along the banks of the Araz River.

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