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EVOLUTION OF ANTHROPOGENIC IMPACT ON ECOGEOMORPHOLOGICAL CONDITIONS (CASE STUDY OF THE EASTERN KURA DEPRESSION)

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The article analyzes in detail the anthropogenic factors affecting the ecological conditions in the The Eastern Kura depression (Kura-Araz lowland and surrounding areas). According to the reviewed literature theoretical base of human effects on geomorphological environment, the evolution of anthropogenic impacts, mutual development of natural and anthropogenic relief froming processes, and modern situation of human activity were analyzed in the studied area. Chronological and geochronological analysis of anthropogenic impacts on the ecogeomorphological environment of the study area was conducted. It has been established that most of the ecological problems that emerged in the modern period were created and developed precisely as a result of the exploitation of Natural Resources and improper management of farm works. The research work also proposed measures aimed at solving ecological problems and eliminating the consequences of them.
Keywords: Anthropogenic impact, ecogeomorphological condition, irrigation, canal, salinization .

INTRODUCTION

At the early stage of society, human impact on the environment has been of biogenic character, and the magnitude and intensity of anthropogenic impact with the development of society and economy since the Industrial Revolution in the eighteenth century, coincident with increased release of greenhouse gases to the atmosphere has significantly increased [1]. Specially past five or six decades humans have become an increasingly important agent of geomorphological change through settlement and widespread industrialization and urbanization [1, 2]. Human society can influence any of the geomorphic processes by sculpting and transforming the landscape through the physical modification of the shape and properties of the ground in significant quantities and the relief is modified to the needs of urban development or for agricultural purposes [1, 3, 4]. In this way anthropogenic geomorphological process along with the Earth's internal and external forces has gradually become an important agent in modern geomorphological processes [5]. The scale of anthropogenic relief generator processes and landforms and the bulk of anthropogenic sedimentological record characterizing the Anthropocene depends on the extent and duration of human impact and it varies in degree spatially and between geomorphic domains [1, 3, 6].

Urban regions are the most typical areas of anthropogenic geomorphological processes and geomorphic evolution and important areas in studying and exploring them. Urban expansion displaying urban man-made landform is a result of multiple factors that changes at different stages of urban development. Since the appearance of the cities urban man-made landform evolution has developed. Because, with the rapid growth of city population, the construction area of urban man-made landforms increases correspondingly. As urban man-made landforms also respond to the population growth through raising the height of buildings, the correlations between population distribution and construction area in central city areas and suburbs are inconsistent [5].

As a result of the direct effects of global warming, and other related atmospheric changes (e.g. precipitation change, rainfall) and moderated changes in major geomorphologically significant variables (e.g. vegetation cover) climate change has important influence on geomorphological processes and phenomena [7]. Thus, most studies conducted in the field of anthropogenic effects on environment express their theoretical provisions and are focused on individual components. However, studies on the anthropogenic impacts on ecological conditions with the application of ecogoemorphological amalyse have not been conducted sufficiently. From this point of view, the presented research work is of significant scientific and practical importance.

The Eastern Kura depression which is an important agricultural region and constitutes more than 30% of the territory of the Azerbaijan Republic, with a number of international and regional transport corridors (International Silk Road, North- Southern corridor, Baku-Tbilisi-Jeyhan oil pipeline, TANAP gas pipeline, etc.), communication lines, Kura-Baku drinking water pipeline require detailed ecogeomorphological researches here. Various types of endogenous (mud volcanism, modern tectonic movements, seismicity) and exogenous (fluvial, arid-denudation, thalassogenic, swampy and salinity) relief formation processes, including anthropogenic factors (irrigation erosion, intensive grazing, exploitation of oil and gas deposits, construction materials, etc.) create more complicated ecogeomorphological conditions and increase the relevance of the research [8, 9, 10, 11, 12, 13, 14, 15, 16, 17].

MATERIALS AND METHODS

The study area covers the eastern part of the Kura depression to the east of the Mingachevir meridian, and lies in the northern hemisphere between latitudes 38°49'09" - 40°51'48,71" N and longitudes 46°40'53,61" - 49°35'23,41" E in the east of Greenwich (Figure1). According to the scheme of the geomorphological division of the territory of Azerbaijan Republic, the studied area consists of Shirvan, Southeastern Shirvan, plains along Kura river, Mugan, Salyan geomorphological districts of the sub region of Kur-Araz lowlands and the districts of Alat, Harami of the sub region of Jeyranchol-Ajinohur range and the Mil, Garabagh district of the Lesser Caucasus sloping plains sub region of the region of the Kura depression of the South Caucasus province (Alizade et al., 2014-18). For economic-geographical zoning parts the Eastern Kura depression includes most of the Aran's economic-geographical region and the parts of Baku, Absheron, Gobustan, Shamakhi, Agsu, Ismayilli, Gabala, Shaki, Goranboy, Tartar, Aghdam, Khojavand, Fuzuli administrative regions.

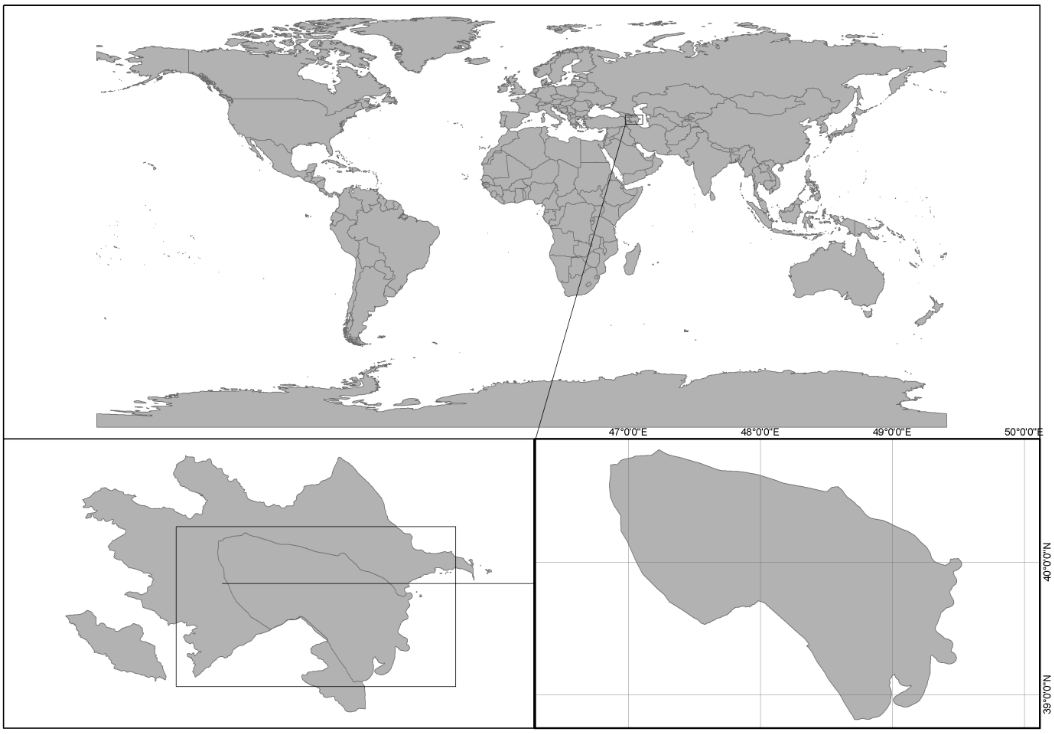

Fig. 1. The location map of the Eastern Kura depression

In the research work the geodatabase of anthropogenic factors was created with the application of GIS technologies which include: canal and collectors, oil gas, drinking water pipelines, roads, railways, settlements, oil drills, sand and gravel quarries and etc. During the study land use-land cover map of the territory was compiled on the base of classification of satellite images (Landsat 8 OLI&TIRS, 2019). It was distinguished six land cover types with geomorphologic interpretation: water, green, bare land, salinity and parcel.

PRESENTATION OF THE MAIN MATERIAL

The appearance of human in Kura depression began with the Quaternary period – anthropogenic (1-4 million years). The most ancient human settlements of the Lower Paleolithic period (Agchagil age - 2.1-1.8 million years and Absheron age - 1.8-0.73 million years) were discovered as a result of archaeological excavations in the Guruchay basin and Azikh cave, located in the plain along Araz river. This ancient human culture is known as the Guruchay culture (Upper Absheron age - 1-1.5 million years). Since the Upper Khvalin age and in the New Caspian age the sea regression in the eastern part of Kura depression has created favorable conditions for the settlement of ancient people in these areas [19].

The emergence of a wise man (Homo Sapiens) in the Middle Paleolithic period (200-30 thousand BC - the Caspian-Khvalin ages), completion of formation of modern man in the Upper Paleoide period (from 30-40 thousand BC - Khvalin age to the 12th millennium BC - Holocene epoch), transition from mastering to production economy during the Mesolithic age (XII-VIII millennia - the last Khvalin age) and its formation in the Neolithic period (VII-VI millennia BC - Early New Caspian age), the development of agriculture and animal husbandry, the use of metal in the manufacture of tools of trade (Ilanlitepe, Chalagantepe, Leylatepe, Alikomaktepe ancient residences) in the Eneolith period (VI-IV millennium - Middle New Caspian age) are important milestones in the early evolution of anthropogenic impact on the environment. In the early Bronze Age (the end of the fourth millennium BC - the second millennium BC - the Middle Caspian age) the Kur-Araz culture (Mingachevir, Alikomaktepe, Aghtepe, Uchoglan, Misharchay ancient residences) was established and spread here. In the Middle Bronze Age (the first half of the second millennium BC - the last New Caspian age), early urban culture had already been established here (Goytapa, Chinartepe ancient residences, etc.) [19].

Anthropogenic factors affecting the ecogeomorphological conditions of the Eastern Kura depression in the modern era include man-caused activities (oil and gas extraction, building materials production, construction and exploitation of irrigation systems), artificial irrigation, pasture-cattle breeding, settlements and etc. (Figure 2). The Eastern Kura depression is an important agricultural region but also an area of international importance, where the Silk Road, the North-South transport corridors pass. In addition to it, the highways of national importance in the depression, local and rural, urban and interurban roads, with asphalt and ground cover, and railways of international importance have some influence on the environmental conditions of the studied area [20].

Fig. 2. Anthropogenic impact map in the Eastern Kura depression

The Eastern Kura depression is the second region in the country after the Absheron peninsula for oil and gas reserves on land. In the Yevlakh-Agjabedi and Lower Kura districts located in the Eastern Kura depression, oil and gas deposits were found in the Maykop, Eocene and Upper Chalk sediments except for the Productive layer. In the lower Kura basin, the area of Muradkhanli (1971), Jafarli (1981) and Zardab (1984) (Imishli district), Mollakend (Kurdamir district), Kurovdag (1955), Kursengi (1962), Garabaghli (1962) (Salyan region), Mishovdag (1956) and Kalamaddin (Shirvan city), Neftchala, Durovdag-Babazan (Neftchala district) are being exploited. 1451.7 sq. km in the blocks of oil fields Neftchala and Durovdag-Babazan, 446 sq.km in Mishovdag and Kalamaddin oil and gas blocks have been polluted with various types of crude oil and mining waters [21].

The wide spread of sediments also influences the availability of raw materials for the construction industry in these areas. In general, up to 13% of the construction materials produced in the country due to Kura depression. In Mingachevir and Shirvan cities, Bilasuvar, Sabirabad, Imishli, Neftchala regions and etc. construction materials production plants, sand and gravel quarries have led to the contamination of surrounding areas by spillage materials, deflation, erosion, and waste banks [21].

The Eastern Kura depression is specialized in agricultural cotton growing, viticulture, grain growing, feed supply, as well as dry subtropical fruits (pomegranate, quince, date), gardening, vegetable growing, fishing, winter pasture and cattle breeding. During the cold half of the year intensive overgrazing of large and small horned animals has led to the degradation of natural vegetation, surface and linear erosion, acceleration of aeolian processes. The intensive development of aeolian processes in the areas devoid of vegetation cover also cause significant damages to adjacent sown areas. The destruction of the Tugay forests on the banks of Kura River resulted in a disturbance of the ecological balance generally [22].

The arid climatic conditions (semi-desert and dry step climate) dominated in the Eastern Kura depression, where agriculture developed since ancient times, caused the cultivation here to be carried out only by artificial irrigation. Palaeo-geographical and archaeological research materials allow us to refer to the development of the irrigation system on the Kura-Araz plain in the first millennium BC. Traces of ancient irrigation canals can still be found on the Mil-Karabakh Plain (Gavurarkh, Yerchiarkh, Dashchayarkh aincent canals, etc.), and in the southeastern Shirvan (Khanarkh and Gumluvararkh aincent canals). Thick agro-irrigational layer, formed on the plains along Kura river, which has a history of irrigation for more than a thousand years, is 1-2 m [23]. The people who have historically settled along with the Kura and Araz rivers, besides these rivers use the water from the rivers of the Lesser Caucasus such as Tartarchay, Khachinchay, Gargarchay, Kondalanchay and etc., to irrigate Karabakh and Mil Plains, and irrigated the arable lands in the Shirvan plain, using water of Alijanchay, Turyanchay, Goychay, Girdimanchay and Aghsuchay of the Greater Caucasus Mountains [24].

During the flood period local residents with the use of pre-existing channels flowed water into the dumps and artificial turfs for the irrigation. These channels remained dehydrated during the drought time of the year. In the absence of heavy flooding in the rivers, these artificial turfs (for example, Karachala), which are rich in nutrients, have been used as a sowing area. The smoothness of the relief caused the creation of complex hydrotechnical facilities for the transportation of irrigation water to the arable areas in the plains [24].

In 1899-1902, the first engineering-hydrotechnical Sarıjalar canal (5,25 km) and Molday, Minbashili, Gur-Gur, Sabir channels, with a total length of 12,75 km, and in 1910-1917 four main channels with a total length of 297,2 km and watering 25,1 thousand hectares of arable land were built in Mugan plain. Irrigation works carried out in Mugan plain did not yield expected results. The intensive alluvial sedimentation in the Araz River caused the intake facilities to be filled with tea supplies and insufficient water transmission to the channels during the period of water abundance. Irrigation canals during this period were also destroyed due to floods in the Kura and Araz rivers. Lack of a collector-drainage system in the area has led to increased groundwater levels, development of salinization and swamping processes. In order to prevent the aforementioned harmful processes, Jafarkhan drainage system, consisting of 6 closed drainage canals with a total length of 5620 m, 6 open drainage canals with an average depth of 2.15 m and a length of 3077 m and a collector with an average depth of 4.0 m and a length of 7800 m was built in 1928-1931 [24].

In 1950-1970, the construction of new channels and collector-drainage systems, reservoirs and hydraulic structures, hydrotechnical facilities in order to develop agriculture, especially cotton-growing in Kur-Araz region was expanded with the help of new technical means compared to previous periods. In connection with the construction and commissioning of the Mugan-Salyan collector in 1950-1953, the drain waters was first drained into the Caspian Sea. The Mugan-Salyan collector with a service area of 172 thousand ha and water consumption of 21-36 m^3/sec, extends along the west coast of Lake Agchala, cuts the middle Agusha plain in Salyan plain towards the South-East and flows into the Caspian Sea in the territory of Neftchala district, near the village of Sarigamish. The 56 km-long part of the collector, which is close to the base of the collector, was built in half-digging, straightening the dump. The technical characteristics of the Mugan-Salyan collector are as follows: 4.5 m from the bottom in the beginning; 21.0 m in the end; slope 1.5; bottom inclination 0.0005; depth 3-5.4 m; the width of the dam from the roof is 5 m. According to the calculations and analysis, in 1975-1980, 930-2383 million m^3 of mineral water, which mineralization rate ranges from 18.2 to 20.5 g/l, were drained to the Caspian Sea annually. In 1950-1954, 13 intra-farm collectors with the total length of 316.7 km, serving area of more than 143 thousand ha were built in the Mugan plain [24].

The technical characteristics of the Mingachevir hydraulic unit with the capacity of 15,730 mln m^3 (commissioned in 1953) are: the water surface is 83 m above the ground, the water surface area is 605 km^2, the length of the reservoir is 70 km, the average width is 18 km, the maximum depth is 75 m, the average depth is 26 m. The height of the Mingachevir land dam is 80 m, the length from the top is 1559 m, and the width is 16 m. During the construction of the reservoir, 29.2 million tons of light ground was used, 4.5 mln. m^3 of rock was extracted, 17.7 mln. m^3 light ground was allocated for the body of the dam. The area under the Mingachevir reservoir, that is, out of the use of people, is 252 thousand ha, and the area under the influence of the reservoir in the Kur-Araz plain is 1.27 million hectares [24].

Exogenous processes in Mingachevir reservoir develop under the influence of anthropogenic and natural factors. In the lake environment, intensive abrasion processes were developed only on the shores of the Mingachevir Reservoir along the steep north slopes of the Bozdag-Ganja and Bozdag-Karaja ridges and the steep south slopes of the Khojashen range. According to M.Abbasov (1960, 1963), when the equilibrium profile was not formed, the total length of the shore that collapsed in the Mingachevir reservoir by abrasion and avalanche events reached 130 km, which is 50% of the entire coastline. As a result, 3.8-6.6 million m^3 of sedimentary material was deposited on the shores [25]. Sh.B. Khalilov (1965-1967) found out that the wave washing off the coast is more intense when the water level is 79 m [26]. Observations show that abrasion processes did not occur at all areas of the washed coast of the Mingachevir reservoir. In the early years of filling the reservoir with no balance profile, abrasion processes only developed along the washed northern slopes of the Bozdag-Ganja range. Here the abrasion processes were accompanied by intensive avalanches and the collection of soft materials transported to the coast as a result of these avalanches. The avalanche materials caused the deformation and depletion of the fluctuations (wave energy was spent on the processing of the avalanche materials), increased the beaches and created a balance profile, weakening and depleting the abrasion processes. In the areas where the abrasion process has been extinguished on the south coast, abrasion cliffs have been closed along the narrow accumulation beaches. Subsequently, abrasion processes developed in the eastern and partly western slopes of the Bozdag-Ganja Range, in the western part of the southern slope of the Khojashen range, and at the far north-west end of the Bozdag-Karaja Range. The balance profile of the Mingachevir reservoir is closely related to changes in water levels. For example, in 1959, with the rise of the reservoir level by 1 m, abrasion processes were intensified until a new equilibrium profile was created on the shores. The construction and commissioning of the Shamkir reservoir has led to significant changes in the Mingechevir reservoir level, and coastal flooding has been significantly reduced. The landslide on the right bank of the Mingachevir reservoir took place in 1999 as well.

CONCLUSİONS

As a result of direct impact of water reservoirs, canals and drainage collectors erected to increase soil fertility, thousands of hectares of land were withdrawn from economic turnover, and as a result of indirect impact exogenous processes such as irrigation erosion, salinization and swamping were accelerated. Although irrigation and land reclamation measures have been aimed at improving soil fertility, it has often led to increased irrigation erosion, development of salinization and waterlogging processes. Completion of operation of drainage-collector systems (Main Shirvan, 251.5 km; Mil-Karabakh, 168 km; Main Mil-Mugan, 143.7 km, etc.), designed to prevent the mentioned processes, and the spread of saltwater flowing from them to the surrounding areas further aggravated the ecogeomorphological conditions. According to the calculations, over 20 km^3 of irrigation water has been leaked into the soil over the period of operation of the Upper Karabakh canal for more than 50 years. This figure, which is generally considerably larger than the Mingachevir reservoir (16 km^3), provides a clear picture of the severe consequences of major defects in the construction of main irrigation canals. The main cause of the mentioned harmful exogenous processes is the gradual deformation of the open irrigation canals and drainage-collector systems as a result of natural and anthropogenic effects and loss of water carrying capacity. Natural impacts include different natural processes (natural pollution, landslides, weeding, soil, wind, rain, etc.), and anthropogenic impacts include insufficiency on existing design and construction of canals and drainage collectors, grazing of cattle, effects of machinery and etc.

Repair of irrigation and drainage systems (deepening the bottom of these canals, coverig with concrete, asphalt-concrete, bitumen, special clay, etc. on the surface), adherence to irrigation norms, and application of drip irrigation systems are essential to prevent harmful exogenous processes (swamping, saline and erosion) that adversely affect the environmental conditions of the study area.

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ЭВОЛЮЦИЯ АНТРОПОГЕННОГО ВОЗДЕЙСТВИЯ НА ЭКОГЕОМОРФОЛОГИЧЕСКИЕ УСЛОВИЯ (НА ПРИМЕРЕ ВОСТОЧНОЙ ЧАСТИ КУРИНСКОЙ ДЕПРЕССИИ)

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В статье подробно анализируются антропогенные факторы, влияющие на экогеоморфологические условия в восточной части Куринской депрессии (Кура-Аразская низменность и прилегающие территории). В соответствии с рецензируемой литературой были произведены анализы воздействия человека на геоморфологическую среду (в теоретическом плане), взаимное развитие природных и техногенных рельефообразующих процессов эволюции и современного состояния результатов человеческой деятельности в исследуемом районе. Проведен хронологический и геохронологический анализ антропогенного воздействия на экогеоморфологическую среду исследуемой территории. Установлено, что большинство экологических проблем, возникших в современный период, возникли и развивались именно в результате нерационального эксплуатации природных ресурсов и неправильного ведения сельскохозяйственных работ. В ходе научно-

исследовательской работы также были предложены мероприятия, направленные на решение экологических проблем и устранение их последствий.
Ключевые слова: антропогенный фактор, экогеоморфологическое состояние, орошение, канал, засоление.

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