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MODERN SITUATION AND DYNAMICS OF ANTHROPOGENIC IMPACT ON ECOGEOMORPHOLOGICAL CONDITIONS (CASE STUDY OF THE EASTERN KURA DEPRESSION)

Abstract. The article analyzes in detail the anthropogenic factors affecting the ecogeomorphological 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 and modern situation of human activity were analyzed in the studied area. On the base of supervised and unsupervised classification of the Landsat images (1976-2017) land use-land cover (LULC) map of the territory was compiled with application of GIS technologies. Six land cover types were distinguished with a geomorphological interpretation executing the classification for the year 1976 and 2017: water, green, bare land, salinity, parcel and urban (settle areas). It was estimated the area, decrease and increase of each land cover type. The dynamic and transformation of land covers were determined with the change detection function. For example, it was defined that the most increasing land cover in the area of transformation since 1976 to 2017 is the sown area. Due to the anthropogenic development of the studied territory, the largest reduction in the area of bare (33.85%) and salinization (25.43%) land covers occurred during this period.

Key words: Anthropogenic factor, Ecogeomorphological condition, GIS, land use, land cover.

Introduction. 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 research 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 [1,2,3,4,5,6,7,8,9,10,11]. Thus, most studies conducted in the field of anthropogenic effects on ecogeomorphological conditions express their theoretical provisions and are focused on individual components. However, studies on the anthropogenic impacts on ecogeomorphological conditions on the base of land use-land cover classification have not been conducted. From this point of view, the presented research work is of significant scientific and practical importance.

The object of the study, methods and data. The study area 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 (figure 1). Supervised (Maximum-likelihood algorithm) and unsupervised (ISODATA clustering) classification methods have been applied using corrected Landsat 2 MSS (1976) and Landsat 8 OLI & TIRS (2017) images with a band combination (RGB) of near-infrared (0.7-0.8 mkm), red (0.6-0.7 mkm) and green (0,5-0,6 mkm) wavelengths and multitemporal LULC maps were composed. Change detection of 1976 and 2017 LULC maps was conducted in SagaGIS and ArcGIS software (figure 3).

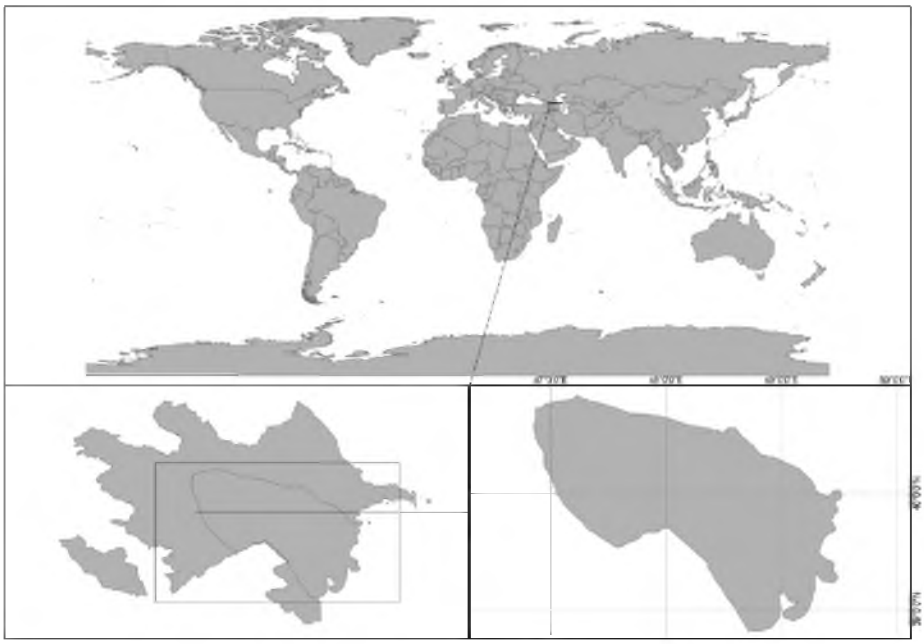

Figure 1 – The location map of the Eastern Kura depression

Results and discussion. 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 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 [12].

Figure 2 – Anthropogenic impact map in the Eastern Kura depression

The hydrological regime and environmental conditions of the Eastern Kura depression have been significantly altered through irrigation systems such as Mingachevir Reservoir, Upper Shirvan (123 km) and Upper Karabakh (172.4 km) canals, Bahramtapa hydropower station (6-7 m height of dump) and the Rasularkh (51 km, irrigating 18.3 thousand ha), the main Mugan (34 km, irrigating 65 thousand ha), Azizbeyov (46 km, irrigating 37 thousand ha) canals, the Mil-Mugan hydropower station (40 m height of concrete dump, with length of 1026 m) and the main Mil canal (37.1 km), etc. Along the main canals there are large settlement and planting areas, orchards, intra-farm and inter-farm distribution channels, a dense network of drainage and collectors, and other anthropogenic complexes. Perennial irrigation and melioration measures caused generating of anthropogenic relief forms here [13].

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. 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. 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 [14].

On the base of LULC analyze it was determined that the sown areas were less transformed land cover (11,25%) during the years 1976-2017 and most transformed land covers were erosion-accumulation (bare land and salinity) areas (47,62%). The largest quantitative transformation was between the areas of erosion-accumulation and sown areas (figure 3). 1828,487 sq. km (33,85%) of erosion-accumulative areas have changed into sown areas (table).

Transformation of land cover in the Eastern Kura depression

Land cover, sq. km (%)	2017	Water 1657,29	Green-847,84	Bare land - 3552,63	Salinity-3475,2	Settled areas-2520,19	Sown areas-15287,09
1976							
Water–1854,95 (100)	1259,1 (68)		156,7 (8,4)	39,18 (2,1)	74,84 (4)	41,67 (2,2)	283,79 (15,3)
Green–891,45 (100)	99,8 (11,2)		549,42 (61,63)	36,38 (4)	100,02 (11,22)	3,06 (0,34)	102,76 (11,52)
Bare land -1976 – 5401,544 (100)	211,01 (3,9)		88,04 (1,6)	2829,16 (52,38)	377,73 (6,99)	67,1 (1,24)	1828,49 (33,85)
Salinity-1976-4222,289 (100)	30,28 (0,72)		20,42 (0,48)	302,91 (7,17)	2766,13 (65,51)	32,43 (0,77)	1070,11 (25,34)
Settled areas-2196,23 (100)	6,70 (0,3)		2,92 (0,13)	14,31 (0,65%)	11,22 (0,5 %)	1654,36 (75,33%)	506,72 (23,07%)
Sown areas - 12830,3712 (100)	75,77 (0,59%)		34,83 (0,27%)	330,70 (2,58%)	151,19 (1,18%)	722,65 (5,63%)	11515,22 (89,75%)

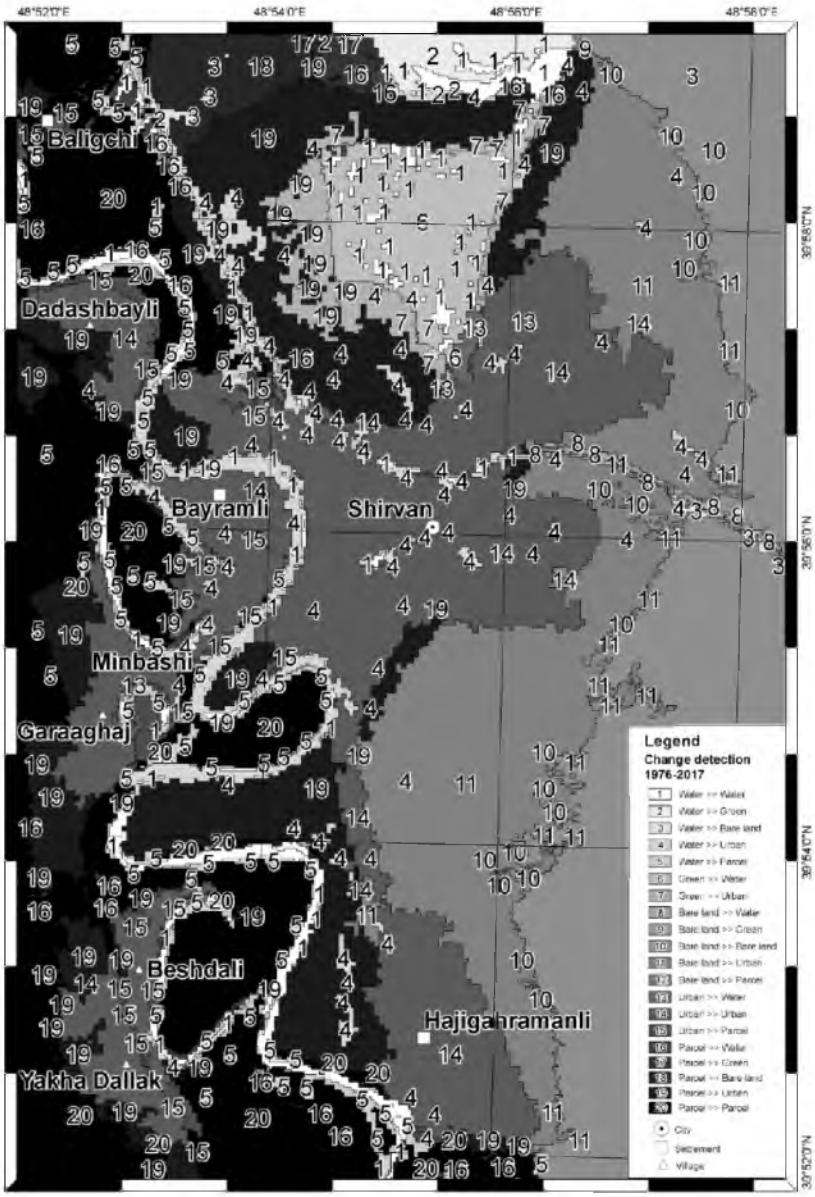

Figure 3 – Change detection map of LULC in Shirvan city and surrounding areas (1976-2017)

Conclusions and proposals. During the 41-year period (1976-2017) as a result of the anthropogenic transformation of the territory, sown areas with irrigation erosion and accumulation increased by 2456,72 sq. km (245672,28 ha) and settlement areas increased by 323,96 sq. km (32396,13 ha). The average annual increase in sown areas and settle areas during the mentioned period amounted to 59,92 sq. km (5992 ha) and 7,9 sq. km (790 ha) respectively. In general, 15,3% of the water bodies (283,786 sq. km), 11,52% of vegetation cover (102,76 sq. km), 33,85% (1828,487 sq. km) of erosion-accumulation areas, 25,34% (1070,115 sq. km) of salines, 23,07% (506,719 sq. km) of settlement areas have turned into sown (cultivated) area (table) and it is estimated as the most increasing land cover in the area of transformation since 1976 to 2017 (11515,216 sq. km).

In order to prevent the development of swamping, saline and erosion processes along the trunk and intra-farm canals in the Eastern Kura depression, first of all, it is important deepening the bottom of these canals, and cover with concrete, asphalt-concrete, bitumen, special clay, etc. on the surface. It is important improvement of the taking irrigation water from the canals and to adhere to the irrigation norm. Also, the maximum and minimum levels of water in the canals and collectors should be strictly controlled not to exceed the intended scope of the project, and repairs should be carried out in a timely manner. It is necessary to pass from the classic method of irrigation to the modern drip irrigation method.

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ЭКОГЕОМОРФОЛОГИЯЛЫҚ ЖАҒДАЙЛАРҒА АНТРОПОГЕНДІК ӘСЕР ЕТУДІҢ ҚАЗІРГІ ЖАҒДАЙЫ МЕН ДИНАМИКАСЫ (КУРИН ДЕПРЕССИЯСЫНЫҢ ШЫГЫС БӨЛІГІН МЫСАЛГА АЛУ НЕГІЗІНДЕ)

Аннотация. Мақалада курин депрессиясының шығыс бөлігіндегі экогеоморфологиялық жағдайларға әсер ететін антропогендік факторлар (Құра-Араз ойпаты және іргелес аумақтар) жан-жақты талданады. Зерттелетін ауданда адамның геоморфологиялық ортаға әсерін және адам қызметінің қазіргі жай-күйін талдау жүргізілді. Антропогендік факторлардың арасында (Мұнай және газ өндіру, құрылыс материалдарын өндіру, жайылымдық мал шаруашылыгы, қоныстар және т.б.) олардың тікелей және жанама әсерлері, кең ауқымды және елеулі әсерлері (ирригациялық жүйелерді салу және пайдалану, жасанды суару) егжей-тегжейлі сипатталган. Су қоймаларын, арналарды, коллекторлық-дренаждық жүйелерді салу кезінде шаруашылық айналымнан мың гектар жер шыгарылды, ал оларды пайдалану кезінде ирригациялық эрозия, тұздану және батпақтану сияқты зиянды экзогенді процестер дамыды. Көрсетілген процестерді болдырмау үшін салынган коллекторлық-дренаждық жүйелерді пайдалану мерзімінің аяқталуы, сондай-ақ тұздалган судың қоршаган ортага ағып кетуі экогеоморфологиялық жағдайларды одан әрі нашарлатты. Табиги (лайлану, сыргымалар, шаю және т.б.) және антропогендік (арналар мен дренаждық коллекторлардың қолданыстағы құрылымдары мен құрылыстарын жобалаудагы қателіктер, мал жаю және т.б.) факторлар, сондай-ақ ашық ирригациялық және коллекторлық-дренаждық жүйелердің істен шығуына ықпал етті.

ГАЖ-технологияларды қолдана отырып орындалган Ландсат (1976-2017 ж.) көп арналы суреттерінің бақыланатын және бақыланбайтын дешифрлеу негізінде зерттелетін аумақтың жер пайдалану және жер жамылгысы (LULC) картасы жасалды. Жер жамылгысының алты түрі: су, өсімдік, жалаңаш жерлер, тұздану, егістік алқаптары және селитебті аумақтар геоморфологиялық интерпретация кезінде дешифрлеу негізінде бөлінген. Жер бетінің әр түрінің азаюы мен ұлгаюы анықталды. Жер жамылғысының динамикасы мен трансформациясы өзгерістерді анықтау функциясының көмегімен анықталды. Мысалы, 1976 жылдан бастап 2017 жылга дейін трансформация аймагындагы ең ұлгайтылган жер жамылгысы – егіс алаңы екені анықталды. Зерттелетін аумақты антропогендік игеру есебінен, аталган кезең ішінде жалаңаштанган (33,85 %) және тұздалган (25,43 %) жер жамылгыларының ауданы барынша азайган.

Мақалада, сондай-ақ зерттеу аумагының экогеоморфологиялық жағдайына кері әсер ететін экзогенді процестердің (эрозия, тұздану, батпақтану) дамуын болдырмау үшін қоргау шаралары ұсынылды. Қолда бар суару каналдарының түбін тереңдету, бетін бетонмен, асфальтбетонмен, битуммен және т.б. жабу, суару және мелиоративтік жүйелерде жөндеу жұмыстарын жүргізу, дәстүрлі ирригациялық жүйеден тамшылатып суару жүйесіне көшу – тұтастай алганда аумақтың экологиялық жағдайын жақсарту жөніндегі маңызды шара.

Түйін сөздер: антропогендік фактор, экогеоморфологиялық жағдай, ГАЖ, жер жамылгысы, жер пайдалану.

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СОВРЕМЕННОЕ СОСТОЯНИЕ И ДИНАМИКА АНТРОПОГЕННОГО ВОЗДЕЙСТВИЯ НА ЭКОГЕОМОРФОЛОГИЧЕСКИЕ УСЛОВИЯ (НА ПРИМЕРЕ ВОСТОЧНОЙ ЧАСТИ КУРИНСКОЙ ДЕПРЕССИИ)

Аннотация. В статье подробно анализируются антропогенные факторы, влияющие на экогеоморфологические условия в восточной части Куринской депрессии (Кура-Аразская низменность и прилегающие территории). Был проведен анализ воздействия человека на геоморфологическую среду и современного состояния результатов человеческой деятельности в исследуемом районе. Среди антропогенных факторов (добыча нефти и газа, производство стройматериалов, пастбищное скотоводство, поселения и др.) описаны подробно те из них (строительство и эксплуатация ирригационных систем и искусственное орошение), которые имеют прямые и косвенные эффекты, более широкий диапазон и значительное влияние. При строительстве водохранилищ, каналов, коллекторно-дренажных систем было выведено из хозяйственного оборота тысячи гектаров земли, а во время их эксплуатации развивались такие вредные экзогенные процессы, как ирригационная эрозия, засоление и заболачивание. Окончание срока эксплуатации коллекторно-дренажных систем, построенных для предотвращения указанных процессов, а также утечка

засоленной воды в окружающую среду еще больше ухудшили экогеоморфологические условия. Природные (заиление, оползни, промывание и др.) и антропогенные (ошибки в проектирование существующих конструкций и сооружений каналов и дренажных коллекторов, выпас скота и др.) факторы также способствовали выходу из строя открытых ирригационных и коллекторно-дренажных систем.

На основе контролируемого и неконтролируемого дешифрирования многозональных снимков Ландсат (1976-2017 гг.), выполненных с применением ГИС-технологий была составлена карта землепользования и земельного покрова (LULC) исследуемой территории. Шесть типов земельного покрова: вода, растительность, обнаженные земли, засоленность, посевные площади и селитебные территории были выделены при геоморфологической интерпретации, на основе дешифрирования. Была вычислена площадь и выявлено уменьшение и увеличение каждого типа земного покрова. Динамика и трансформация земного покрова определялись при помощи функции обнаружения изменений. Например, было выявлено, что наиболее увеличенной земельным покровом в зоне трансформации с 1976 по 2017 год является посевная площадь. За счет антропогенного освоения исследуемой территории произошло наибольшее уменьшение площади обнаженных (33,85%) и засоленных (25,43%) земельных покровов в течение указанного периода.

В статье также были предложены защитные меры для предотвращения развития экзогенных процессов (эрозии, засоления, заболачивания), негативно влияющих на экогеоморфологические условия территории исследования. Углубление дна существующих оросительных каналов, покрытие поверхности бетоном, асфальтобетоном, битумом и т.д., проведение ремонтных работ в оросительных и мелиоративных системах, переход от традиционной ирригационной системы к капельной оросительной системе в целом являются важными мерами по улучшению экологического состояния территории.

Ключевые слова: антропогенный фактор, экогеоморфологическое состояние, ГИС, земельный покров, землепользование.

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