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

ХАБАРЛАРЫ

ИЗВЕСТИЯ

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

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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»!

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STUDY OF THE METHOD FOR MONITORING THE CASPIAN SEA COASTLINE BASED ON THE DATA OF REMOTE SENSING OF THE EARTH

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Abstract. As the matter of fact, the Caspian Sea is an inland water structure that has no physical connection with the World Ocean, and has a high sensitive level for changes in various aspects. The live activity and mineral resources near the Caspian Sea was organized on the basis of the economic views of the states located on its coast since ancient times. Two-thirds of the earth's surface is covered by water ecosystem, and more than half of humanity is concentrated in a strip 50 miles wide along the coast. We are intimately connected to vast areas of water, and the health and quality of life in our oceans has a direct impact on the health of our lives. Systematic monitoring of water bodies should be an organizational and technological scheme for regular and continuous observations, assessment and forecasting of the state of water resources under the influence of natural and anthropogenic factors. The main purposes of monitoring are supplying water management and environmental complexities with reliable and latest updated information that allows scientists to assess the functional integrity of the state

of ecosystems, and additionally, identify the causes of changes and evaluate their consequences of determination of corrective measures. Supportive information of that artificial reservoirs research should contain a large amount of various options and data on the physical-geographical and socio-economic features of the regions adjacent to the reservoir. This paper describes a state of knowledge of the dynamic evaluation of the coastline of the Caspian Sea region today, as well as the consequences may affect to the future economical situation of that area. Analysis of this research is devoted to the study of the practical application of photogrammetric methods and coastline monitoring technologies, using system of satellite images with high spatial resolution. The results of that observation reveal the high technological efficiency and comparison of the proposed methods with indication of updated techniques productivity.

Keywords: water level, sea, cycle, settlements, level fluctuation, ecosystem, coastline, satellite image, period

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ЖЕРДІ ҚАШЫҚТАН ЗОНДАУ ДЕРЕКТЕРІ НЕГІЗІНДЕ КАСПИЙ ТЕҢІЗІ ЖАҒАЛАУ ЖОЛЫСЫН БАҚЫЛАУ ӘДІСІН ЗЕРТТЕУ

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Аннотация. Каспий теңізі Дүниежүзілік мұхитпен байланысы жоқ ішкі су айдыны болғандықтан, оның деңгейі әртүрлі элементтердің өзгеруіне сезімтал. Каспий теңізінің тірі және пайдалы қазбалары ежелгі дәуірден бері оның жағалауында орналасқан мемлекеттердің экономикалық көзқарастарының негізін ұйымдастырды. Жер бетінің үштен екі бөлігін су алып жатыр, ал адамзаттың

жартысынан көбі жағалау бойында ені 50 миль болатын белдеуде шоғырланған. Біз судың кең аумақтарымен тығыз байланыстымыз және мұхиттарымыздың денсаулығы мен өмір сүру сапасы біздің өміріміздің денсаулығына тікелей әсер етеді. Су объектілерінің жүйелі мониторингі табиғи және антропогендік факторлардың әсеріндегі су ресурстарының жай-күйін ұдайы және үздіксіз бақылау, бағалау және болжау үшін ұйымдық-технологиялық схема болуы керек. Мониторингтің негізгі міндеттері су шаруашылығы және қоршаған ортаны басқару кешендерін экожүйелердің жай-күйінің функционалдық тұтастығын бағалауға мүмкіндік беретін сенімді және ең өзекті ақпаратпен қамтамасыз ету; өзгерістердің себептерін анықтау және олардың салдарын бағалау, түзету шараларын анықтау. Жасанды су қоймаларын зерттеуді ақпараттық қамтамасыз ету су қоймасына іргелес аумақтардың физикалық-географиялық және әлеуметтік-экономикалық ерекшеліктері туралы әртүрлі ақпарат пен мәліметтердің үлкен көлемін қамтуы керек. Мақалада бүгінгі күні Каспий теңізінің жағалау сызығының динамикасын білу жағдайы, сондай-ақ Каспий маңы аймақтарының болашақ экономикасына әсер етуі мүмкін салдар қарастырылады. Мақала жоғары кеңістіктік рұқсаты бар спутниктік суреттерді пайдалана отырып, жағалау сызығын бақылаудың фотограмметриялық әдістері мен технологияларын тәжірибеде қолдануды зерттеуге арналған. Зерттеу нәтижелері ұсынылған әдістердің жоғары технологиялық тиімділігін көрсетеді.

Түйін сөздер: су деңгейі, теңіз, цикл, жағалау белдеуі, елді мекендер, деңгейдің ауытқуы, экожүйе, жағалау сызығы, спутниктік сурет, кезең

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ИССЛЕДОВАНИЕ МЕТОДИКИ МОНИТОРИНГА БЕРЕГОВОЙ ЛИНИИ КАСПИЙСКОГО МОРЯ ПО ДАННЫМ ДИСТАНЦИОННОГО ЗОНДИРОВАНИЯ ЗЕМЛИ

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Аннотация. Поскольку Каспийское море является внутренним водоемом, который не имеет связи с Мировым океаном, его уровень чутко реагирует на изменения. Живые и минеральные ресурсы Каспийского моря с давних времен организовывают основу экономических взглядов государств, расположенных на его побережье. Две трети части земной поверхности охвачены водой, и более половины человечества сосредоточено в полосе шириной 50 миль вдоль побережья. Мы тесно связаны с обширными акваториями, а качество жизнедеятельности в наших океанах напрямую оказывает влияние на здоровье нашей жизни. В связи с этим, систематический мониторинг водных объектов должен представлять собой организационно-технологическую схему регулярных и непрерывных наблюдений, оценки и прогнозирования состояния водных ресурсов под влиянием природных и антропогенных факторов. Основные задачи мониторинга — снабжение водохозяйственных и природоохранных комплексов управления достоверной и наиболее современной информацией, позволяющей оценить функциональную целостность состояния экосистем, обнаружить причины изменений и оценить их последствия, определить корректирующие меры. Информационное обеспечение исследований искусственных водоемов должно включать в себя большой объем разнообразных сведений и данных о физико-географических и социально-экономических особенностях территорий, прилегающих к водохранилищу. В статье рассмотрено состояние изученности динамики береговой линии Каспийского моря на сегодняшний день, а также последствия, которые могут повлиять на экономику прикаспийских регионов. Статья посвящена изучению практического применения фотограмметрических методов и технологий, для мониторинга береговой линии по космическим снимкам с высоким пространственным разрешением. Результаты исследований показывают высокую технологическую эффективность предлагаемых методов.

Ключевые слова: уровень воды, море, цикл, прибрежная зона, населенные пункты, колебание уровня, экосистема, береговая линия, космический снимок, период

Introduction

The accelerated pace of urbanization and technological development leads to changes of all components of the atmosphere and the Earth's surface, which occurred during the worldwide climatic changes in last recent decades. One of these components is the surface water bodies of the planet (rivers, groundwater, lakes etc.). Water is an important part for the existence of various ecosystems, including for the presence of mankind. Both the absence and excess of water lead to extraordinary transformations

in all sectors of the national economy. Therefore, the detection of water bodies and subsequent monitoring are important things in scientific and practical observations. In fact, on the present days there is no monitoring research of water bodies, which are able to demonstrate global deformations of water bodies, their area, coastline and type.

The development of remote sensing technologies allows managing multispectral measurements of the Earth's surface for regular basis. Moreover, mathematical methods of remote sensing data processing can make a possibility to obtain information concerning the spatial and temporal parameters of the Earth's surface, including water bodies. One of these features is a water mask that provides a precise determination of the pixels with indication of water objects locating on a satellite image.

The usage of remote sensing data may provide a plenty of solutions in determination of many characteristics of the environment, without physical contact with the object of study. The big advantage of these methods is the allowance of transferring of significant amount of time-consuming research to simple desktop conditions; increase the speed of work, and simultaneously, time improvement of reliability and results completeness of survey.

The purpose of this research paper is to develop a unique technique for decoding of multispectral images of Landsat satellites for determining water surfaces and water masks' creation. During the observation of the reshaping of the shores, the use of geographic information systems allows to perform and present information about the state of water resources, as well as adjacent territories in cartographic projection, including the formation of database for storing the spatial data about the object of study.

Research area

The examination of fluctuations in the Caspian Sea level is a pressing problem. The Kazakhstan's part of the territory of the Caspian region occupies a special place in terms of environmental disaster, which is formed under the influence of natural and anthropogenic factors, the most important of which is the change in the water sea level and the rapid progression of the oil and gas complexes.

In fact, Caspian Sea in Kazakhstan's area belongs to the northeastern coast of the Caspian Sea and captures the southeastern region of the Caspian lowland. This region is containing valuable biological and mineral resources, taking into account its geographical location. Additionally, it has a great strategic value in the economy and foreign policy of the Republic of Kazakhstan.

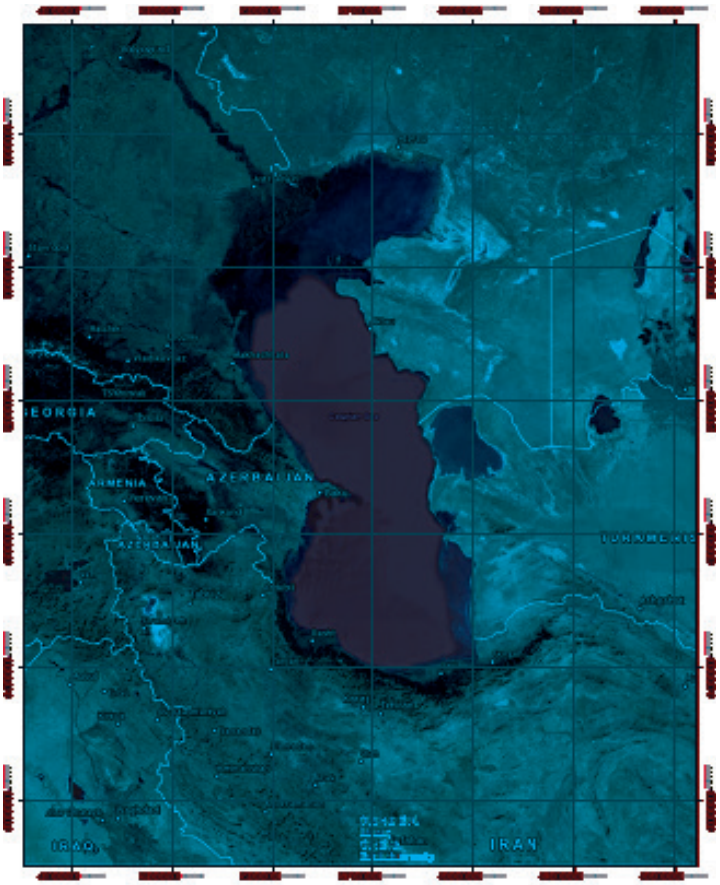


Fig.1. Location of the Caspian Sea

The variability of the surface level of the Caspian Sea is one of the high-value features of its hydrological regime. Massive fluctuations of various cycles are distinguished In the age-old course of the sea level itself. The modern economic capability of the sea basin was created during the regression of the sea levels in numbers of minus 27–28 m. At the same time, intensive settlement of the coastal zone took place with the creation of new infrastructure. However, during the period 1978–1991(Mustafa et al., 2017) the region was increased by about 10 % as a result of flooding of variety settlements and infrastructure facilities. Also, it should be emphasized that this period was the time of active industrial, agricultural and residential developments of the country, including the growth of the coastal zone sphere (Katayev et al., 2017).

In the twentieth century, two extreme phenomena of the Caspian Sea level were registered as a dramatically consequences for the population of coastal countries – an abnormally long drop in the level from 1930 to 1977 and, following this, an abnormally long rise from 1978 to 1995. In the table 1, the graph shows distinct level of water change (Kamza et al., 2018). Due to the abnormal lowering, and the same time the raising of the level, the evolution of the water body occurred as well.

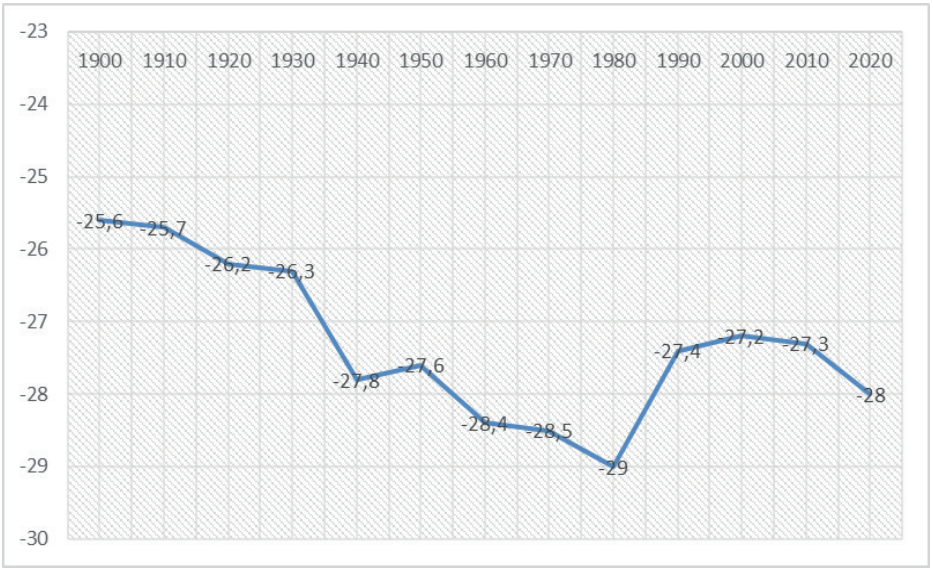


Table 2. The long-term progress of the average annual level of the Caspian Sea in the XX and early XXI centuries.

Initial data

The complex of the ArcGIS software product was used for processing of the received data to the study area. This product can provide photogrammetric processing of Earth remote sensing data, as well as performing further analysis using GIS analytical functions. Full integration with ArcGIS allows us to make quickly work with subsequent transformation of spatially coordinated raster data from one cartographic projection to another, perform image transformation and coordinate binding, convert from raster to vector format and vice versa.

The research of water bodies based on multispectral images using the method of determination the characteristics of the reflectivity on natural objects. Water bodies are categorized by the lowest coefficient value among other natural objects. At the same time, all other natural objects, even when in a state of moisture, have a higher reflection coefficient. This fact is used when detecting water objects in the measured image.

For the study, we used Landsat 4,5,8 TM images: a polyzonal (archived set of images in GeoTIFF format) and a synthesized image in natural colors in JPEG format with a coordinate reference, the resolution of the images is 30 m. The period was selected 1990 to 2021 (month: August), with a minimum cloud content (< 5 %) or cloudless.

Fig. 2. – Mosaic of Landsat satellite images on the study area for 2008

Paying attention to the interests of the high-resolution space-based systems of satellite images vendors try to use their products for updates of a range of maps and plans, it can be noted that the spatial resolution is one of the most important factors determining the extent of updated maps with the data of satellite systems, figure 2 (Levin et al., 2015).

For this research paper images were obtained through the USGS service of the US Geological Survey. The processing level of the original polyzonal satellite image- L1. This level of processing of Landsat images ensures their radiometric and geometric correction using digital terrain models ("earth correction"). Output cartographic projection UTM, where the coordinate reference system is a WGS-84 (Acharya et al., 2016).

Maxar satellite images were involved in assessment of the accuracy, which were provided by DigitalGlobe by request for research aims, using in this observation. DigitalGlobe is a world leader in production of satellite optical images and information. The resolution of the images is 50cm.

Method of separation of water bodies

This method includes several factors taking to account. Firstly, the range of measured electromagnetic waves varies from 1010 m (short-wave cosmic radiation) to 1010 meters (radio waves). At the second, the possibility of identifying and classifying objects is based on the fact that objects of different types — rocks, soils, water surfaces, vegetation, etc., reflect and absorb electromagnetic radiation in different ways in a particular wavelength range (Mustafa et al., 2017; Acharya et al., 2017; Elfatih et al., 2020). For the study, we used multi-channel images provided by the American Landsat satellite (Umirbaeva A. at el., 2021), which has 11 shooting channels with different wavelength ranges (Table 2). It is possible to obtain such data free of charge by going

through a simple registration procedure on the official website of the US Geological Survey (USGS) (European Commission et al., 2019).

The peculiarity of multi-channel images is that knowing the features of the wave characteristics of channels and their combinations, it is possible to obtain the information we are interested in about the properties of various geographical and ecological objects. However, channel combinations are not the same for different models of Landsat satellites (Umirbaeva et al., 2021), which is due to the improvement and refinement of each subsequent launched device. Since all the data received from the satellite are nothing more than multispectral images, in order to obtain the information contained in them, it was necessary to interpret the received data and reveal their physical meaning. The stage of remote sensing data analysis, the main task of which is the recognition and identification of objects detected in the image, is called image decryption. When processing a multispectral image (Caiya et al., 2021), transformations are often performed that build "index" images. A bitmap image was created based on mathematical data with matrices of brightness values in certain channels, where pixel values are assigned a "spectral index". Further research was carried out on the finished basis of the obtained image (European Commission et al., 2019).

The process of searching for water objects based on a set of measured multispectral images allows them to be detected by the reflectivity characteristics of natural objects (Morto et al., 2022; Klein et al., 2020; Elfatih et al., 2020). (see fig. 1). Water basin is characterized by the lowest values of reflection coefficients among other natural objects. Simultaneously, all other natural objects, even in a state of moisture, have a higher reflection coefficient. This fact was used when detecting water objects in the measured image.

The following indexes are widely used to detect water bodies from space data: DVI, NDMI, MNDWINDWI, WRI, NDVI refer to table 2.

#	INDEX	CALCULATION FORMULA	RANGE OF VALUES
1	Normalized Difference Water Index	NDWI= (GREEN-NIR)/(GREEN+NIR)	Water has a positive value
2	Normalized Difference Moisture Index	NDMI= (NIR-MIR)/(NIR+MIR)	Water has a positive value
3	Modified Normalized Difference Water Index	MNDWI= (GREEN-MIR)/(GREEN+MIR)	Water has a positive value
4	Water Ratio Index	WRI=(GREEN+RED)/ (NIR+MIR)	Water has a value more than 1
5	Normalized Difference Vegetation Index	NDVI= (NIR-RED)/(NIR+RED)	Water has a negative value

Table 2. Multispectral indices used to determine water bodies

NDVI (Normalized Difference Water Index) is used to identify objects of open water spaces and to highlight them on a satellite image against the background of soil and vegetation. The NDWI index was proposed by McPheeters in 1996. Today, it is used to detect and monitor the slightest changes in the content of water bodies. Using the advantages of the spectral ranges NIR (near infrared) and GREEN (visible

green), NDWI can enhance the presence of water bodies in the satellite image. The disadvantage of this index is the sensitivity to building structures, which can lead to a reassessment of water bodies (Acharya et al., 2017). Since the NDVI index effectively determines the moisture content, it is often confused with the NDMI index, also known as NDWI GAO. In fact, these are different indexes with unique calculation formulas and scope of application. HDMI uses a combination of NIR-SWIR (near infrared and shortwave) to enhance the presence of moisture in plant leaves. NDVI is calculated using a combination of GREEN-NIR (visible green and near infrared), which makes it possible to detect minor changes in the water content in reservoirs (Mustafa et al., 2017; Acharya et al., 2017).

The index NDWI was changed by replacing the mid-infrared band, such as the Landsat TM band 5, with the near-infrared band used in NDWI. Modified NDWI (MDI) can improve the characteristics of open water by effectively suppressing and even removing built-up ground noise, as well as vegetation and soil noise. Improved water information using NDWI is often mixed with ground-built noise, and therefore the area of extracted water is overestimated. Accordingly, MNDWI is more suitable for improving and extracting water information for a water region with a background dominated by built-up land, due to its advantage in reducing and even removing built-up land noise compared to NDWI.

Due to the dominant spectral characteristics of the green and red bands compared to the NIR and MIR bands, the water factor index (WRI) shows values above 1 for water. In addition to water indices, some other indices can be used to highlight water characteristics; an example of such indices is the normalized difference vegetation index (NDVI) (43), which shows a unique negative value (European Commission et al., 2019).

Result and discussion

The values for the NDWI, NDMI, MNDWI, WRI, NDVI indices are in the ranges [-1; 1]. Table 1 shows the ranges of values at which a pixel is most likely associated with a water object. Filters were built for each index based on taking into account the range of values of the indixes indicated above, which make it possible to distinguish water objects (binarization of images: 0 – non–water objects and 1 - water objects). The comparison of water masks for each filter with the reference mask of a water body was carried out. The reference water mask with a resolution of 50 cm was built from satellite images of Maxar Technologies.

The estimation of the accuracy of detection of water objects is obtained by dividing the sum of correctly classified pixels of a water object obtained using a water index by the total number of pixels of the reference mask:

$$O = 100 \times |Nw - Nwm|/Nwm, \%. \qquad (1)$$

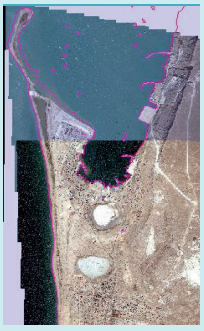
Here *Nw* is the number of water pixels of the analyzed image and *Nwm* is the number of water pixels of the reference mask. Accuracy of allocation of water bodies for water indexes interpreted in table 3.

Method	Range	Overall accuracy %
WRI	>1.0	86.5%
NDWI	>0.0	86.2%
	>0.18	87.2%
MNDWI	>0.0	86.2%
	>0.18	88.2%
NDVI	-0.45… - 0.25	87.2%
	<0.0	86.2%
NDMI	>0.0	85.2%
	>0.14	86.0%

Table 3. Accuracy results

Results

Interpretation of Table 3 describes the results of assessing the accuracy of the allocation of water bodies for the water indices WRI, NDWI, HDMI, DVI, NDVI. Therefore, it is necessary to be guided by methods and means that can be used to receive reliable and precise information on certain man-made objects during the accomplishment of environmental monitoring, in our case, water objects that directly affect the ecological system (Faiz et al., 2021). Also, it can be seen that the accuracy of detecting water bodies is high and as close as possible to the reference mask. Additional calculations were performed for some indexes, taking into account the various options of range values in pixels belonging to water surfaces. This made it possible to more accurately find the thresholds of values at which a pixel can be considered to belong to water objects.

	Index	**Image of the coastline**	**Enlarged fragment**
1	NDVI		

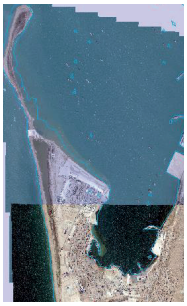
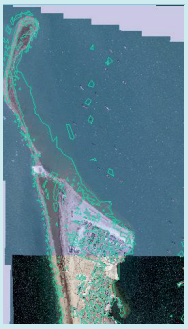
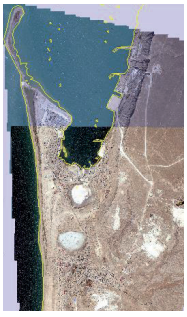
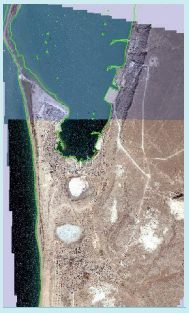
2	WRI		
3	NDMI		
4	MNDWI		
5	NDWI		

Table 4 - Visualization of the Mask of water objects calculated from 30 m images, in comparison with reference images with a resolution of 50 cm.

The mask visualizations of the Table 4 indicate the accuracy of detecting water bodies is high and as close as possible to the reference mask (Levin et al., 2020). Verification of the adequacy of decoding techniques showed that the best way to recognize water surfaces for the Caspian Sea is to calculate the MNDWI index, which has a minimum value of the standard error. In a further study of the dynamics of changes in the coastline was carried out using this index. To identify the temporal variability of the water mirror areas, 44 images were analyzed for each selected year (a total of 220 images). This index was used to calculate the coastline of the Caspian Sea for the period from 1990–2021, pointed out in figure 3.

Research paper reveals a calculation of the coastline of the Caspian Sea for each year of the study, using the mosaics structure of 44 images. In order to accelerate the processing of a large number of images, the geographic modeling process in the ArcGIS software was used. The whole process of modeling the calculation process interpreted in table 5.

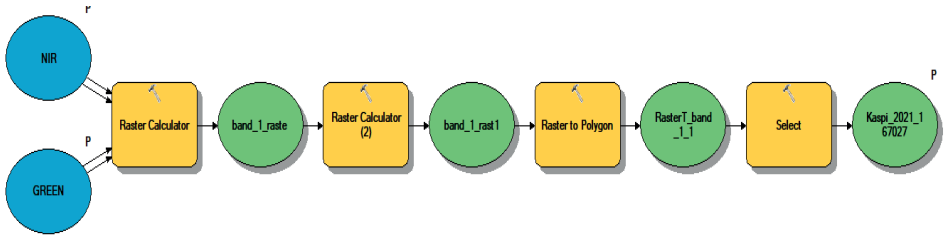
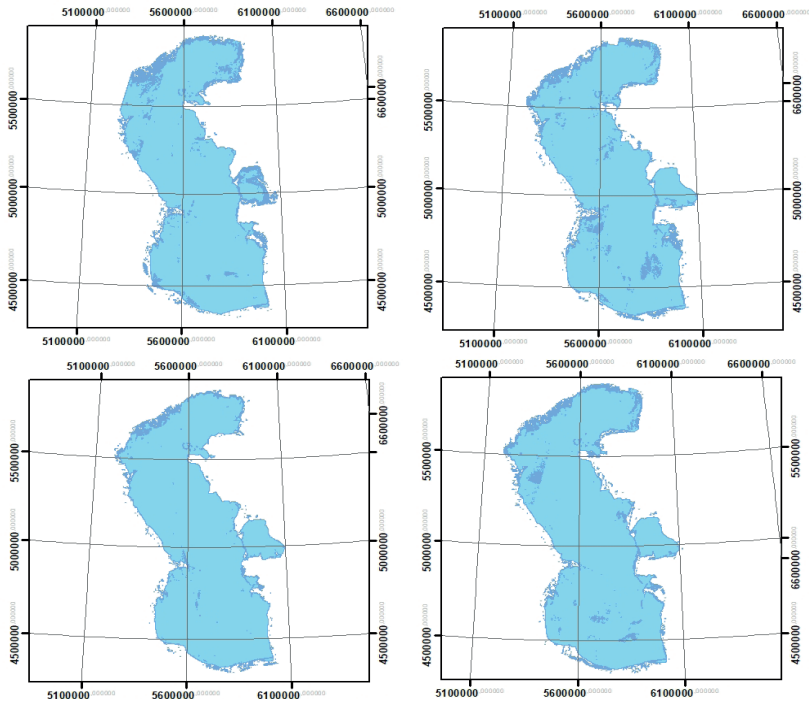


Table 5 – Geographic modeling of the calculation process



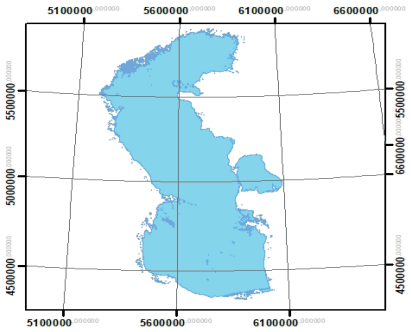


Fig. 3. The area of the water surface of the Caspian Sea from 1990 to 2021

In the process of the study, the indices were calculated from the Landsat 8 spacecraft, the resolution of the images was 30 meters.

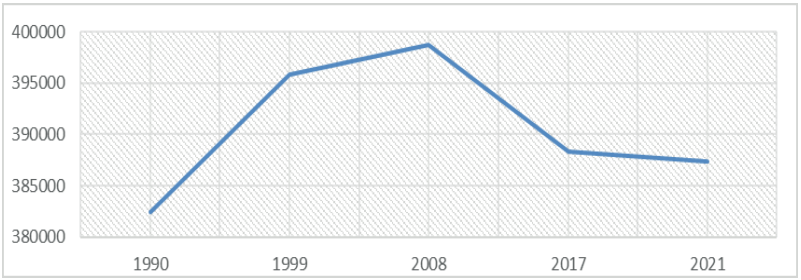


Table 6 – change in the volume of the Caspian Sea for the period from 1990 to 2021.

The time series of the area of the water object of the Caspian Sea allows us to distinguish periods of increasing and decreasing importance. In recent years, fluctuations in the level of the Caspian Sea have been caused by the ratio of the characteristics of the water balance, changing under the influence of anthropogenic climate change described in table 6.

According to the point of experts, the least amount of precipitation fell on the Caspian Sea was in the period from 2006 to 2020, and the evaporation processes were more intense. In addition, due to a series of low-water years in the Volga River basin, the average inflow of water was also the smallest. The main reason for this lack of water is the warming of the climate, which has engulfed the entire northern hemisphere. The coastline changes deeply interpreted in figure 4.

Thus, summarizing, it seen that the fluctuations of decreasing and increasing nature in the Caspian Sea level observed in the past, and possesses a long-term natural cyclical character. In recent years, global warming has also begun to affect the state of that water object. To determine the technique for studying the surface water researches, the analysis of published materials on modern methods of monitoring the natural water bodies based on data from the use of satellite imagery achievements (Tolepbayeva et al., 2020) were performed, including the possibilities of application the study sea level dynamics in the monitoring activity.

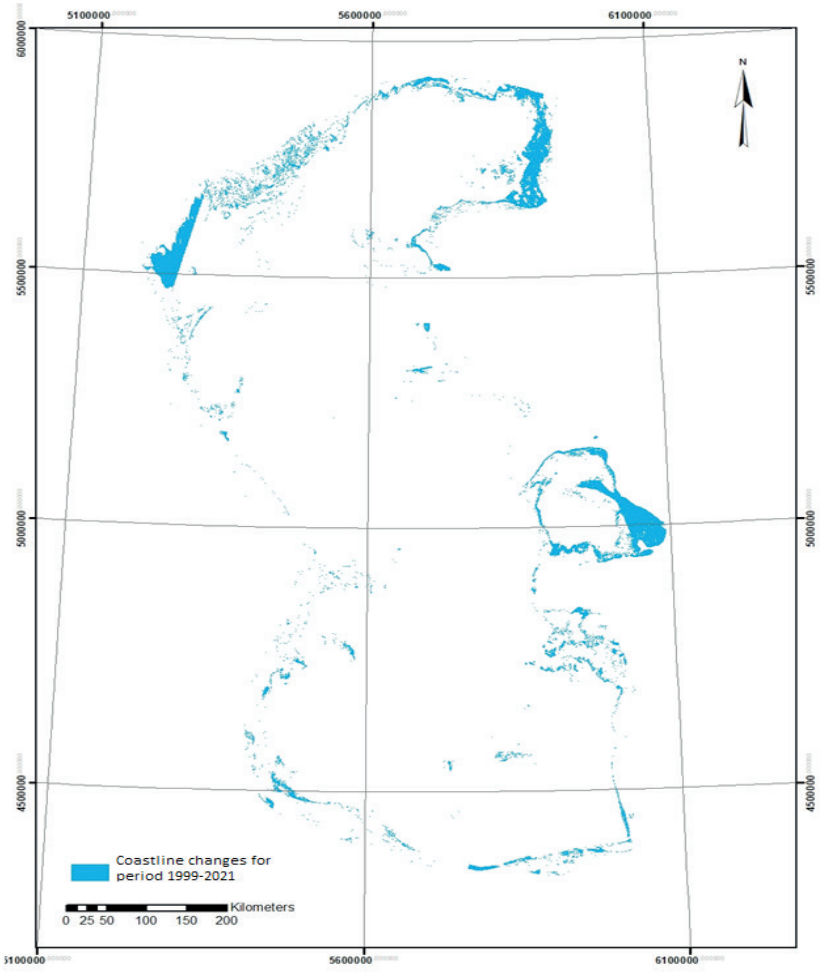


Fig. 4. – Changes in the boundaries of the Caspian Sea for the period from 1990 to 2021

Conclusion

To summarize the research paper, it is required to emphasize a performed comparative analysis of the composite indices. Based on that parameter, the filters create the opportunity to identify water surfaces (rivers, lakes, artificial reservoirs) on the earth's projection. Before indices calculations, radiometric and atmospheric corrections were accomplished with the conditions during shooting and adjusting the brightness interval of the resulting image.

As a result of data processing, the obtained conclusion showed that the best water index among WRI, HDMI, NDWI and DVI is MNDWI, which indicates the visual analysis of water masks and high accuracy assessment. In that case the comparison of water masks for each index are given as well.

Monitoring of the coastline, mentioned in this observation, given by photogrammetric method has the appropriate quality, since the data covers the entire necessary territory

and correctly transmits information about the water resource. Apart from that, digital photogrammetric technology is one of the most effective ways to provide precise data.

Additionally, the implementation of these methods can significantly reduce and simplify various types of traditional geodetic and cartographic measurements. On this basis, the usage of obtained data will increase the accuracy of the data, shorten the time for receiving the necessary materials, and reduce products costs.

This method is interpreted to user to get output materials both in graphic and digital forms. The use of GIS technologies for collecting and storing the information received in a single database allows for timely spatial analysis of the entire study area. Data exchange using global and local networks ensure efficient organization and management of work at facilities, as well as provides an opportunity to perform environmental forecasting and assessment of the surrounding area.

REFERENCES

Acharya T.D., Subedi A., Yang I., Dong-Ha Lee. (2017). Combining Water Indices for Water and Background Threshold in Landsat Image. // The 4th International Electronic Conference on Sensors and Applications. — Pp. 1–6. — *https://doi.org/10.3390/ecsa-4-04902*.

Acharya T.D., Lee D.H., Yang I.T., Lee J.K. (2016). Identification of Water Bodies in a Landsat 8 OLI Image using a J48 Decision Tree. // — Sensors 2016. — Vol. 16 (1075). — *https://doi.org/10.3390/s16071075*.

Caiya Y., Qiang Y., Kartbayeva K. (2021). Present-day movement trends of the major tectonic faults in the Sichuan-Yunnan region based on the constraint of GPS velocity fields.// Advances in Space Research (ASR). — Pp. 1719–1731. — ISSN: 0273–1177. — *https://doi.org/10.1016/j.asr.2021.04.014*.

European Commission (2019). NDWI: Normalized Difference Water Index. 2011.// DESERT Action — LMNH Unit. Link: *http://edo.jrc.ec.europa.eu/documents/factsheets/factsheet_ndwi.pdf*.

Elfatih M.A., Lalit K. (2020). Environmental sustainability with remote sensing in Africa Onisimo Mutanga. // ISPRS Journal of Photogrammetry and Remote Sensing. — Vol. 169. — Pp. 212–213. — *https://doi.org/10.1016/j.isprsjprs.2020.09.007*.

Faiz N.S., Satayev M.I., Satayeva J.I., Berdaliyeva A.A., Azimov A.M., Nikonov O.Ya. (2021). Visualization of Geodata of seasonal fluctuations of magnetic fields based on ESRI ArcGis. // News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technology sciences. — ISSN 2224–5278. — Vol. 1. — Pp. 66–72 — *https://doi.org/10.32014/2021.2518-170X.10*.

Katayev M.Yu., Bekerov A.A., (2017). Methodology for detecting water bodies by multispectral satellite measurement. // Reports of TUSUR. — Vol. 20(4). — Pp. 105–108. — Doi: 10.21293/1818-0442-2017-20-4-105-108.

Kamza A., Levin E., Kuznetcova I., Yerzhankyzy A., Orynbassarova E. (2018). Investigation of changes in dem, constructed from time to time data from the seabed. // International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, — 18. — Pp. 449–454. — *http://doi.org/10.5593/sgem2018/2.3/S11.057*.

Klein R.J.T.; Nicholls R.J., Gualbert H.P. (1998). Coastal Zones. // Handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies. — 1998. — P. 464. — https://wedocs.unep.org/handle/20.500.11822/32746.

Levin E., Banaszek A., McCarty J.L. and Zarnowski A, (2015) Attention driven approach for geospatial data update and fusion. // ASPRS 2015 Annual Conference Tampa, Florida Ann Arbor. — Vol. 1001. — P. 45

Levin E., Shults R., Habibi R., An Z., Roland W. (2020). Geospatial Virtual Reality for Cyberlearning in the Field of topographic surveying: Moving towards a Cost-Effective mobile solution.// ISPRS Int. J. Geo-Inf. — 2020. — Vol. 9(7). — P. 433. — DOI: *https://doi.org/10.3390/ijgi9070433*.

Mustafa T.M., Khalid I.H., Hussain M.H., Modher H. Abd. (2017). Using water indices (NDWI, MNDWI, NDMI, WRI) to detect physical and chemical parameters by apply remote sensing and GIS

techniques. // International Journal of Research Granthaalayal. — Vol. 5(10). — Pp. 117–128. — *https://doi.org/10.5281/zenodo.1040209*.

Morto B.F., Cristina P.L., Gil Penha-Lopes (2022). Using TanDEM-X Global DEM to Map Coastal Flooding Exposure under Sea-Level Rise: Application to Guinea-Bissau. // ISPRS Int. J. Geo-Inf. 2022. — Vol. 11(4). — Pp. 225. — *https://doi.org/10.3390/ijgi11040225* (in Eng.).

Nurpeisova M., Bekbassarov S., Kyrgizbaeva G., Rakhimbaeva D., Kapassova A., Zhaksylyk A. and Zhantyeva S. (2019). Integrated Monitoring of the Earth Surface Dynamics of the Caspian Zone. // Bioscience biotechnology research Communications Special Issue. — Vol.12 (5). — ISSN: 0974–6455. — Pp.79–8. — *http://dx.doi.org/10.21786*.

Tolepbayeva A.K., Tanbayeva A.A., Karagulova R.K., Iskaliyeva G.M., Zhakupova A.A., Urazbayeva G.M., Lentschke J., (2020). Estimation of the changes in water surface area based on the use of archives satellite images of Landsat satellites (on the example of the Ertis river). // News of the national academy of sciences of the republic of Kazakhstan series of geology and technical sciences. — ISSN 2224–5278. — Vol 3 (441). — Pp. 79–87. — *https://doi.org/10.32014/2020.2518-170X.57*.

Umirbaeva A., Nurpeisova M.B., Fedorov E., Miletenko N.A. (2021). Integrated monitoring-based assessment of deformation and radiation situation of territorial domains. // Eurasian mining. — Vol 1. — ISSN: 2072–0823. — Pp. 83–87.

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