PERIÓDICO TCHÊ QUÍMICA
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APLICAÇÃO DE TECNOLOGIAS DE GEOINFORMAÇÃO E SENSORIAMENTO REMOTO PARA DETECTAR O USO DA TERRA E MUDANÇAS NA COBERTURA DO SOLO CAUSADA PELA SECAGEM DO MAR DE ARAL

APPLICATION OF GEOINFORMATION TECHNOLOGIES AND REMOTE SENSING TO DETECT LAND USE AND CHANGES IN THE SOIL COVER CAUSED BY THE DRYING OF THE ARAL SEA

ПРИМЕНЕНИЕ ГЕОИНФОРМАЦИОННЫХ ТЕХНОЛОГИЙ И ДИСТАНЦИОННОГО ЗОНДИРОВАНИЯ, ДЛЯ ОБНАРУЖЕНИЯ ЗЕМЛЕПОЛЬЗОВАНИЯ И ИЗМЕНЕНИЙ В ЗЕМНОМ ПОКРОВЕ, ВЫЗВАННЫХ ВЫСЫХАНИЕМ АРАЛЬСКОГО МОРЯ

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RESUMO

Está estabelecido que o problema do Mar de Aral, devido ao impacto negativo da atividade humana ao longo do tempo, levou à degradação ambiental na região do Mar de Aral, bem como a mudanças na cobertura do solo. A extensão deste problema ambiental pode ser detectada usando tecnologias de geoinformação e métodos de sensoriamento remoto. Neste estudo, o algoritmo de classificação de máxima verossimilhança foi aplicado na apresentação das imagens do Landsat para detectar alterações na cobertura do solo com base em dados de satélite multiespectrais obtidos do Landsat 7 e Landsat 8 para 2008 e 2018, respectivamente. Os mapas de uso da terra resultantes indicam um aumento significativo de áreas salinas de 18% para 22% durante o período estudado. Essas transformações de terras representam uma séria ameaça aos recursos terrestres da área. Consequentemente, é necessária uma gestão adequada dos recursos da terra para preservá-los e garantir que eles continuem a desempenhar seu papel no desenvolvimento socioeconômico da região.

Palavras-chave: *Terra, Mudança no uso da terra, Classificação, Sensoriamento remoto, Sistema de informação geográfica*.

ABSTRACT

It is established that the Aral Sea problem, which is due to the negative impact of human activity over time, has led to environmental degradation in the Aral Sea region and changes in the soil cover. The extent of this ecological problem can be detected using geoinformation technologies and remote sensing methods. In this study, the maximum likelihood classification algorithm was applied in the presentation of Landsat images to detect changes in the soil cover based on multispectral satellite data obtained from Landsat 7 and Landsat 8 for 2008 and 2018, respectively. The resulting land-use maps indicate a significant increase in saline land from 18% to 22% during the period under study. These land transformations pose a severe threat to the land resources of the area. Consequently, proper management of the land resources is required to preserve them and to ensure that they continue to play their part in the socio-economic development of the region.

Keywords: *Land, Land use change, Classification, Remote sensing, Geographic information system.*

АННОТАЦИЯ

Как известно, проблема Аральского моря, вызванная негативным воздействием деятельности человека в течение прошедшего периода, привела к деградации окружающей среды в районе Аральского моря и изменениям в земном покрове, и выявить такую экологическую проблему можно обнаружение на основе геоинформационных технологий и методов дистанционного зондирования является эффективным решением. В исследовании был применен алгоритм классификации максимального правдоподобия в представлении снимков Landsat для обнаружения изменений почвенного покрова, по многоспектральным спутниковым данным, полученным с Landsat 7 и Landsat 8 за 2008 и 2018 годы соответственно. Результирующие карты землепользования, созданные в ArcGIS 10.1, указывают на значительный рост засоленных земель с 18% до 22% соответственно. Эти преобразования земель представляют серьезную угрозу для земельных ресурсов района. Следовательно, требуется надлежащее управление земельными ресурсами района, иначе эти ресурсы вскоре будут потеряны и больше не смогут играть свою роль в социально-экономическом развитии района.

Keywords: *Земельные угодья, изменение землепользования, классификация, дистанционное зондирование, геоинформационная система.*

1. INTRODUCTION:

The world is currently undergoing significant changes due to the negative impact of human activities. Climate change and its consequent various natural disasters are being felt globally, while changes in the human environment due to the strong anthropogenic implications for living and non-living components are causing environmental problems on the local, regional, and global scales. Among others, these issues have led to the emergence of the Aral Sea problem, which is one of the most dangerous environmental crises in the region (Golubov, 2018; Karakus, Cerit, and Kavak, 2015; Rafihov, Ergashev, and Khaidarov, 1997).

Over the past 40-45 years, the water level in the Aral Sea has decreased by 22 meters, the water area has decreased more than 4-fold, the volume of water has reduced 10-fold (from 1064 km3 to 70 km3), and the salt content in the water is 112 g / l, Because of the above, the Aral Sea is now practically a "dead" sea. The drying area of the sea encompasses 4.2 million hectares and has become a source of dust, sand, and salt aerosols, which have spread to the surrounding areas. It is estimated that between 80 and 100 million tons of dust have been produced. As a result, the environmental situation in the Aral Sea region is deteriorating, leading to significant environmental changes, whereby the environmental problems are primarily associated with land use and changes in land cover (Aidarov and Pankova, 2007; Degife, Zabel, and Mauser, 2018; Jazouli, Barakat, Khellouk, Rais, and Baghdadi, 2019; Micklin, 2014; Safari and Sohrabi, 2019; Tang, Zhang, Jing, and Gao, 2018; White, 2013).

In studying changes in earth's crust', global changes play a significant role. Data on land use and land cover change represent a crucial source of information for environmental monitoring, land-use planning, and the prediction of future land conditions. Determining land use potential, including soil capabilities and other characteristics, is key to conducting regional planning studies (Karakus *et al*., 2015; Reis, 2008; Srivastava, Singh, Gupta, Thakur, and Mukherjee, 2013).

Remote sensing and geographic information technologies (GIS) provide accurate, reliable data on current and emerging changes in land use and land cover (Alam, Bhat, and Maheen, 2019; Jovanovic *et al*., 2015; Lambin, Geist, and Lepers, 2003; Schaefer and Thinh, 2019). Meanwhile, research conducted by organizations and academic institutions worldwide is mainly focused on studying the changes in land use and land cover (Degife *et al*., 2018; Schaefer and Thinh, 2019). Over the past 15 years, remote sensing data have been widely used to determine land-use changes and land cover changes. The usefulness of remote sensing data is also recognized globally (Gadrani, Lominadze, and Tsitsagi, 2018; Xian *et al*., 2020).

High-resolution aerial photography, aerial photography, and drones are the best way to detect changes in any given region. However, due to the high cost of obtaining such data, Landsat satellite imagery can also be used to study large areas. The use of the Landsat data is almost free (Gadrani *et al*., 2018), and the Landsat archive contains information on land management from 1970 to the present (Gadrani *et al*., 2018).

The object of the study is the Chimbay district of the Republic of Karakalpakstan, about 150 km from the dry Aral Sea in the Republic of Uzbekistan. This area was chosen for the study as it has the most significant number of irrigated lands in the Aral Sea region (Bekchanov, Ringler, Bhaduri, and Jeuland, 2016; Breckle, Wucherer, Dimeyeva, and Ogar, 2012). Quantitative data show that in recent years there has been an increase in soil salinization, a decrease in productivity, an increase in the incidence of the population, and a significant increase in soil erosion, as well as a substantial reduction in agricultural production. It is observed that the local conditions in this area have deteriorated significantly (Abdullaev, 2018).

This study aimed to use GIS and remote sensing to identify land use and land cover changes in the Chimbay district of the Republic of Karakalpakstan.

2. MATERIALS AND METHODS:

2.1. Area of research

The Chimbay region of the Republic of Karakalpakstan was chosen as the object of study. Chimbay district was formed in 1927 and borders the districts of Kegeyli in the west and south, Muynak to the north, and Karauzyak to the east. The district area encompasses 217557.6 hectares and contains one city (Chimbay) and eleven makhallas, namely Tazadzhol, Koksu, Bakhtli, Kosterek, Tazgara, Kamsarik, Kyzyluzyak, Kenes, Mayap, Pashentov, Marked. The center is the city of Chimbay. The population of the district is 109,500 people (as of January 1, 2015). Of these, 53.8 thousand live in urban areas and 55.7 thousand comprise the rural population. The distance from Chimbay to Nukus is 56 km. Chimbay district is located in the north of the Republic of Karakalpakstan along the Kegaili canal. The climate is very variable, the groundwater is located close to the earth's surface, the summers are hot and dry, and the winters are short but cold (Aidarov and Pankova, 2007).

The total irrigated area in the district is 46910.0 ha, of which 41576.8 ha (88.6%) are saline soils, and 5333.2 (11.4%) are non-saline soils. Of the saline soils, 15 365.3 ha are weak saline (32.8%), 13390,4 ha (28.5%) moderately saline, 3871.5 ha (8.4%) are highly saline, and 8949.6 ha (19.1%) are very highly saline (Abdullaev, 2018). There are salt marshes with slightly saline soils, chloride-sulfate soils, and sulfate soils (Haque and Basak, 2017). The geographic location and satellite image of the object under study are shown in Figure 1.

2.2. Collection of the data

Pictures of Landsat 7 ETM dated 07/27/2008 and Landsat 8 OLI / TIRS dated 07/07/2018 were used to determine the land area changes in the Chimbay district. ArcGIS 10.1 software was used to detect land-use changes, and topographic maps and portable "field-type" GPS were used to determine the ground control points. The types of satellite image data used in the study are shown in Table 1.

2.3. Research methodology

The use of geographic information technologies and remote sensing methods in determining changes in land use and land cover are shown in Figure 2. The general function of the classification process is to classify all image pixels according to surface classes automatically. As a rule, multispectral data are used to classify images and as a digital basis for categorizing the spectrogram for each pixel in the database. Different forms are a combination of various numerical indicators based on their spectral reflective and dispersion properties (Spruce, Bolten, Mohammed, Srinivasan, and Lakshmi, 2020).

In the first stage, satellite images of Landsat 7 ETM 2008 and Landsat 8 OLI / TIRS 2018 from USGS (US Geological Survey) relevant to the research area were downloaded (Chen, 2014; Liu, Luo, and Zheng, 2018; Trisakti, Nugroho, and Zubaidah, 2016). Landsat 7 ETM satellite imagery consists of 7 groups (Pereira *et al*., 1999), and Landsat 8 OLI / TIRS satellite imagery consists of 11 groups (Hawbaker *et al*., 2017; Miranda, Alves, Pozza, and Santos Neto, 2020). Then, for the decryption, a combination of pictures by groups was selected. The main reason for choosing a combination of groups for decryption was to obtain a color image that was natural and close to the color of the image of the land.

Next, land type indicators were identified according to five classes (vegetation, disturbed land, water surface, saline land, and barren land). A topographic map of the studied lands was analyzed using high-resolution images obtained from GPS and Google Earth. Then, the method of land classification (maximum likelihood classification) was selected (Abino, Kim, Jang, Lee, and Chung, 2015; Cabral, Silva, Silva, Vanneschi, and Vasconcelos, 2018). A feature of image classification is the process of extracting classes of information from a multi-channel raster image. The raster obtained as a result of the image classification was then used to create various thematic maps. In the classification of maximum likelihood, the algorithm is based on probability and it assumes that the statistics of the studied data are distributed over each spectral range and class. The pixels were calculated based on the probability that each *m* class is defined, and then the pixel probability was assigned according to the highest class (Juliev, Pulatov, Fuchs, and Hübl, 2019).

In the next stage, the compliance of land types with indicators and classification methods was checked. If the obtained results of the decryption of the land types by years met the established requirements and allowed classification, the land types were determined, and the results were interpreted.

3. RESULTS AND DISCUSSION:

The cartographic map, satellite imagery, and statistical data presented in the study were analyzed by refining them by pixels and differentiating the area into five classes based on the value of the specific digital differences of the landscape elements. A description of the land-use classes in the area is given in Table 2. Samples were taken from each specific land-use type by delimiting polygons around representative sites. The spectral brightness of the signature for the corresponding types of land cover obtained from the satellite images was recorded using the pixels enclosed in these polygons. A satisfactory spectral signature ensures that there is "minimal confusion" between the land-use classes. After that, the maximum likelihood algorithm was used for the controlled classification of the images. This image classification is mainly controlled by the analyst, as the analyst selects pixels that represent the desired classes.

The maps of the land-use classes of Chimbay district in 2008 and 2018 are presented in Figure 3. The overall classification accuracy achieved was 95.32% and 95.13%, respectively, and the overall statistics were 0.9237 and 0.9070, respectively, for the classification of images in 2008 and 2018. According to Lea and Curtis (2010), accuracy assessment reports require an overall classification accuracy of over 90% and κ statistics above 0.9, which were successfully achieved in this study. The land classification results for 2008 and 2018 are shown in Table 3. The percentage of classes based on these results reflects compliance with land-use practices in the area during 2008 and 2018 (Figure 4). The resulting land-use maps and overlays created in ArcGIS 10.1 indicate a significant shift in land classes: vegetation from 28% to 22%, water surface from 15% to 14%, disturbed land from 22% to 24%, saline land from 18% to 22%, and barren land from 17% to 18%.

Based on the Strategy for the Further Development of Uzbekistan, approved by Decree of the President of the Republic of Uzbekistan dated February 7, 2017, No. UP-4947, approved by Decree of the President of the Republic of Uzbekistan dated January 18, 2017 No. PP-2731 "On the State Program for the Development of the Aral Sea Region for 2017–2021" "Effective use of land and water resources in agriculture", approved by Decree of the President of the Republic of Uzbekistan dated June 17, 2019 No. R-5742, this study will contribute to the implementation of the goals set forth in other rules.

One of the prerequisites for sustainable land use is the timely monitoring of irrigated arable land and the systematic management of land resources (Zhao, Lin, and Warner, 2004). As part of the topic, the work carried out by scientists on the study of land use in this area using geoinformation techniques and remote zoning methods was investigated. In particular, Scientists studied the province of Guangzhou, China, from 1998 to 2003 concerning changes in land use and land cover based on Landsat TM / ETM + images. They showed that changes in land use and its topography and global environmental changes, are important in the fastest growing countries in the world (Fan, Weng, and Wang, 2007), based on remote sensing methods.

The above-mentioned studies mainly used GIS and remote sensing methods to detect changes in land use and land cover due to urban expansion. In the current study, the differences in the land use and land cover as a result of the negative impact of the dry Aral Sea on the Republic of Uzbekistan as well as the impact of anthropogenic factors on the health of the population in this area and their arable land is explored using GIS and remote sensing methods (Shen, Abuduwaili, Ma, and Samat, 2018).

When mapping some natural areas in many developing countries, it was found that some of the study areas were weakly associated with changes in land use and land cover. Such situations require individual research in the field of environmental protection and environmental studies. Accordingly, remote sensing and GIS technology are practical tools for mapping the nature of changes (Haque and Basak, 2017; Schaefer and Thinh, 2019). The study of land use and land cover change has been one of the most popular and widely used methods in the last decade. Based on the data obtained using remote sensing methods, it has been shown that various analytical studies are useful and effective in monitoring land use and targeted land management (Tarawally, Wenbo, Weiming, Mushore, and Kursah, 2019). Using the methods used by previous scientists, we also examined the factors that led to the drying of the Aral Sea, which ultimately became a global problem, by studying land use and changes in the land cover in this region (Micklin, 2014; Reimov and Fayzieva, 2014; Umarov, 2011).

Besides, GIS technologies, including remote sensing, were used to map land-use programs in Chimbay district in the Republic of Karakalpakstan, and these were subjected to environmental analysis. They were also revised to collect data from existing data that are consistent with mapping, classification schemes, and mapping methods (Jazouli *et al*., 2019). This was followed by the use of Landsat satellite imagery using the geographic information from the US Geological Survey (USGS) of the Chimbay area associated with the object under study and a map of the Chimbay area based on ArcGIS. Landsat photos are free and easy to work with, and they have an extensive historical archive and extensive space-based coverage (10).

The map shows the geographical location of the study area. In contrast to previous work done on this topic, the work that we present is based on four parameters and characteristics of the data on the accuracy of satellite images. This study is aimed at determining the total amount of soil salinization and its degradation using the RGB model in a GIS environment (Kidane, Bezie, Kesete, and Tolessa, 2019). It is hereby intended to achieve a more accurate result of the studied object. In determining the variation of land types in Chimbay district, the network was divided into five classes. A description of each class is provided separately. Using the analysis results based on ArcGIS 10.1, the land-use map in the Chimbay region in western Uzbekistan was scaled to 1: 500 000. The map shows changes in the environmental situation in the region during 2008-2018.

Land and its field classes (Table 3) and annual indicators of land use and land use loss and percentage of land lost were used to provide more accurate GIS and remote sensing information. In short, the relationship between humans and the environment is based on certain rules and regulations. It is known that environmental conditions can deteriorate if a partial violation of these occurs (Prenov and Safarov, 2015). Given this, we hope that the use of the proposed methods will aid in the further investigation of the Aral Sea problem using geoinformatics and remote sensing methods as this is a global problem, not only in Uzbekistan but also in the CIS.

4. CONCLUSION:

The practice of land use in the research area has changed significantly over ten years. The land occupied by vegetation decreased from 60916.13 ha to 47862.67 ha, water surface declined from 32633.64 ha to 30458.06 ha, disturbed land increased from 47862.67 ha to 52213.82 ha, the area of saline land increased from 39160.37 ha to 47862.67 ha, and barren land increased from 36984.79 ha to 39160.37 ha. The expansion of barren land in the area was mainly due to the lack of proper land use management and planning and the lack of continuous satellite monitoring. It is recommended that (1) the use of water resources and the location of types of crops in the area should be properly regulated under consideration of the environmental situation; (2) it is necessary to create a land information system (LIS) for the district, based on remote sensing data; and (3) there should be an organization of the monitoring of optimal land use and its mapping based on GIS technologies.

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Table 1. *Data types and satellite image properties*

Data types	Data characteristics	
	2008	**2018**
Type of satellite	Landsat 7 ETM	Landsat 8 OLI/TIRS
Spatial resolution	30 m	15 m
Radiometric resolution properties	8 bit	16 bit
Coordinate system	WGS84	WGS84

Table 2. *Description of the land-use classes*

Class name	Class description
Vegetation	Fields, fallow lands, and mixed forest lands
Disturbed land	Pastures, industrial lands, and settlements
Water surface	Creeks, canals, lakes, reservoirs, and irrigated lands at the time of observation
Saline land	Land of high, medium, and low salinity
Barren land	Non-farm land and desert

Table 3. *Land classes and their area (in ha)*

Land use classes	2008		2018		Increase		Loss	
	Square (ha)	**(%)**	**Square (ha)**	**(%)**	**Square (ha)**	**(%)**	**Square (ha)**	**(%)**
Vegetation	60916.13	28	47862.67	22			13053.46	6
Disturbed land	47862.67	22	52213.82	24	4351.15	2		
Water surface	32633.64	15	30458.06	14			2175.58	1
Saline land	39160.37	18	47862.67	22	8702.30	4		
Barren land	36984.79	17	39160.37	18	2175.58	1		

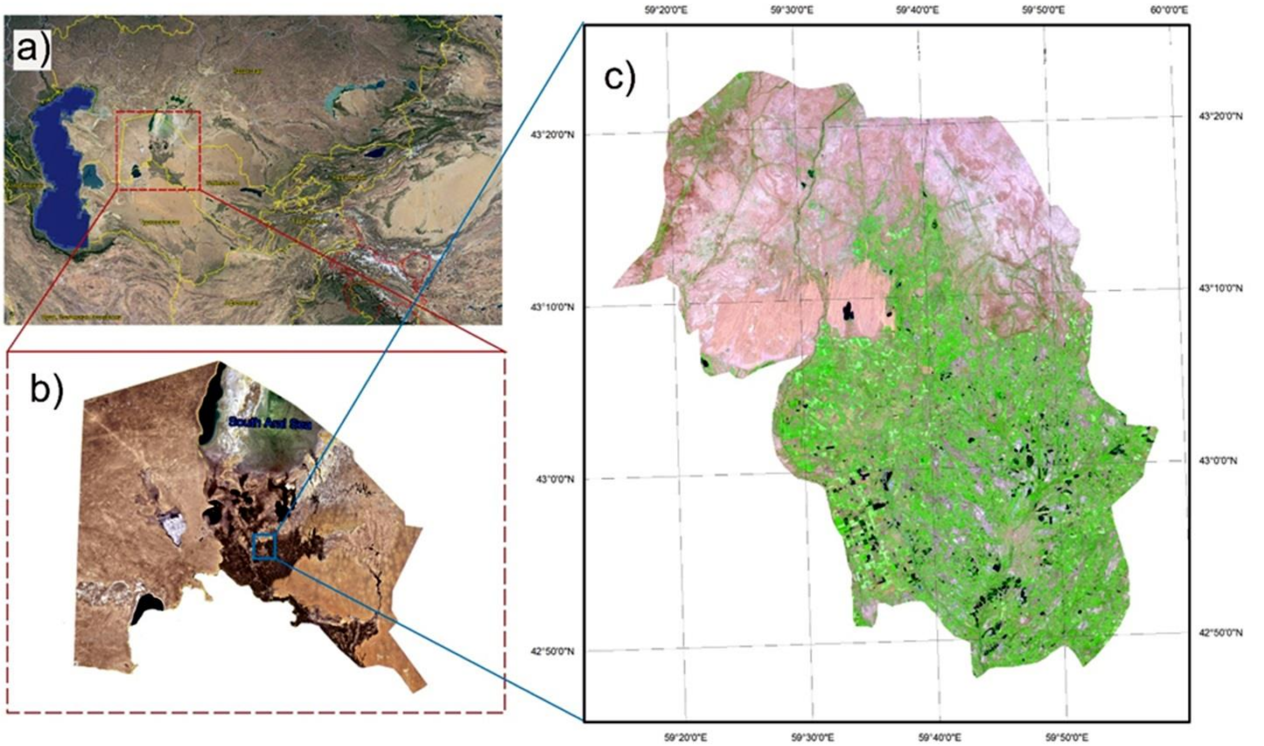

Figure 1. *Location of the object of study: a) the Republic of Uzbekistan; b) the Republic of Karakalpakstan as part of the Republic of Uzbekistan; c) the combination of satellite images from Landsat 8 of Chimbay district of the Republic of Karakalpakstan in groups 7: 5: 2 displayed as RGB*

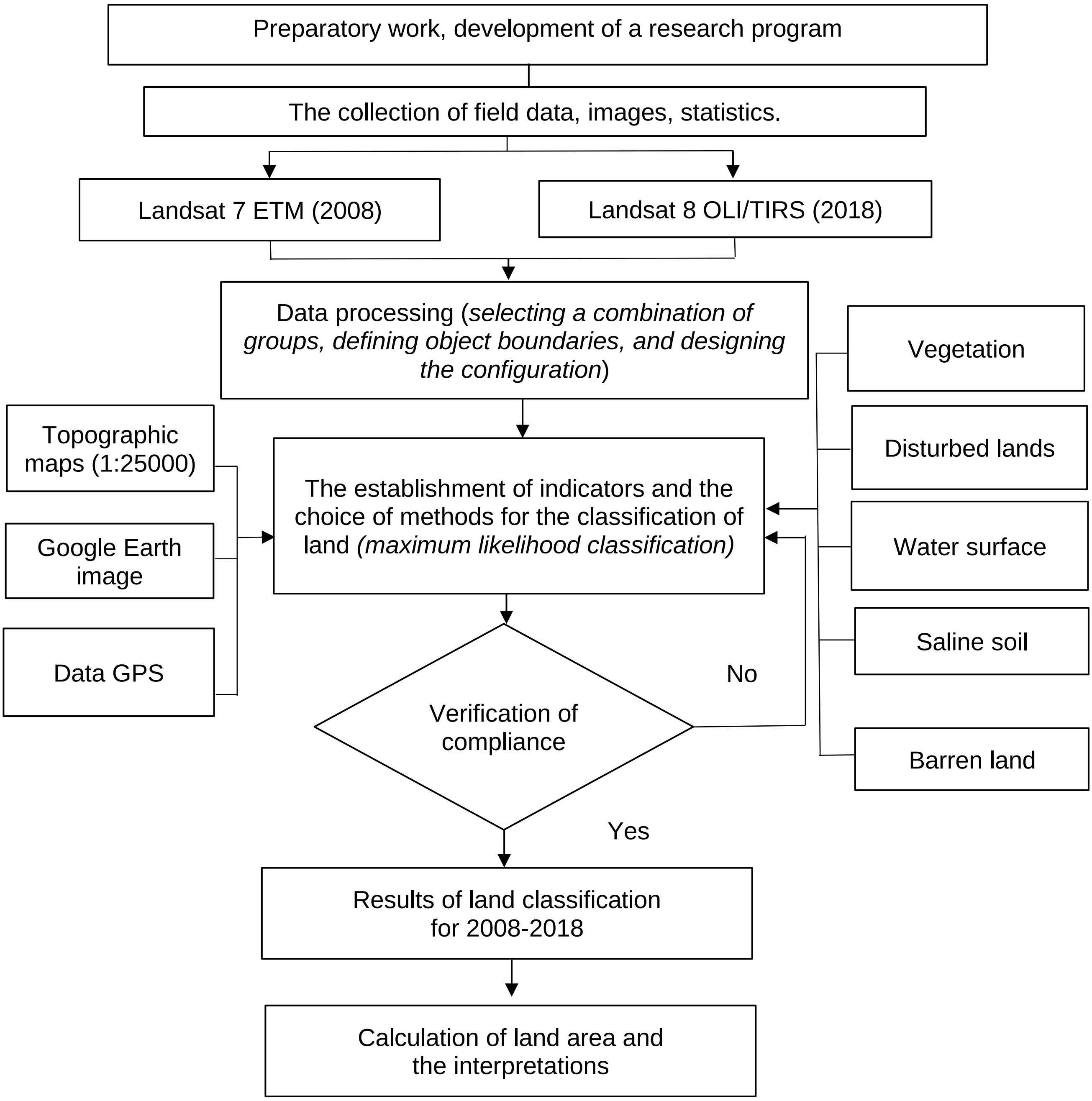

Figure 2. *Flowchart of the research methodology*

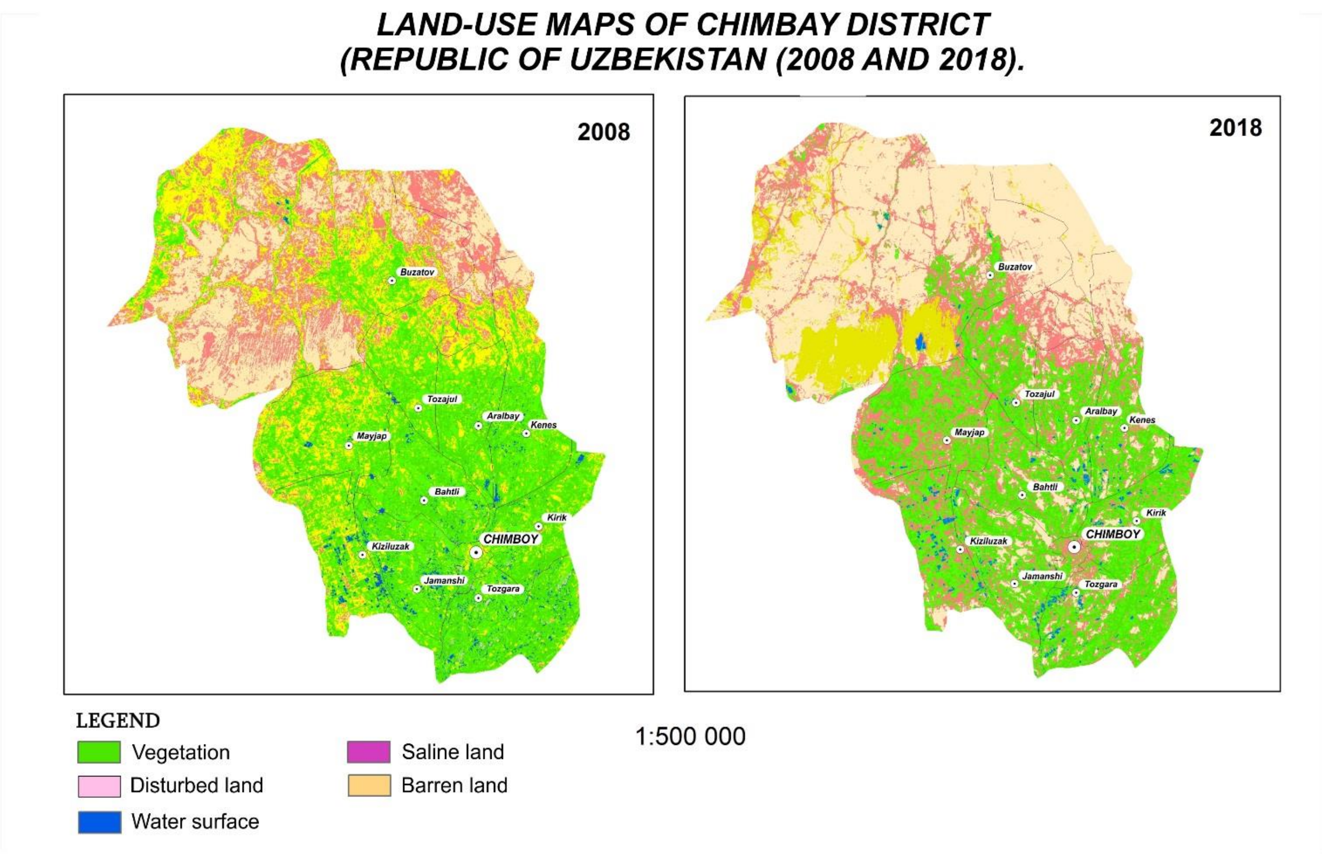

Figure 3. *Land-use maps of Chimbay district (Republic of Uzbekistan) (2008 and 2018)*

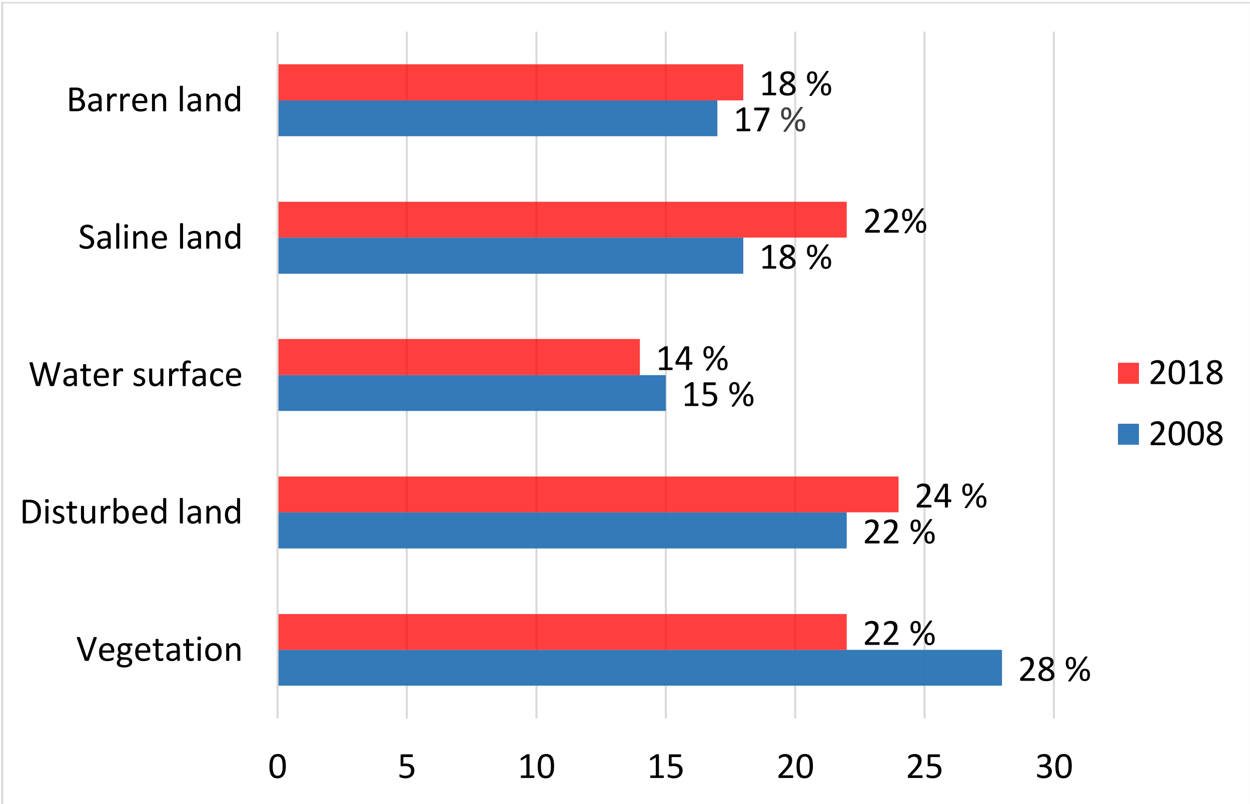

Figure 4. *Diagram of classes and areas of land use and land cover changes in Chimbay district (2008 and 2018)*

PERIÓDICO TCHÊ QUÍMICA
ARTIGO ORIGINAL

IMPLEMENTAÇÃO DE WEBINARS EM MODELOS DE APRENDIZAGEM COMBINADA PARA MELHORAR A MOTIVAÇÃO E RESULTADOS NA APRENDIZAGEM DO ESTUDO DO SISTEMA ESQUELETAL HUMANO

IMPLEMENTATION OF WEBINARS IN BLENDED LEARNING MODELS TO IMPROVE MOTIVATION AND LEARNING OUTCOMES OF THE STUDY OF HUMAN SKELETAL SYSTEM

PENGARUH MODEL BLENDED LEARNING MELALUI APLIKASI WEBINAR DAN MOTIVASI TEHADAP HASIL BELAJAR SISWA PADA MATERI SISTEM RANGKA MANUSIA

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RESUMO

A existência da pandemia de Covid-19 em 2020 teve um impacto devastador na educação. A interação entre professores e alunos normalmente não pode ser feita. Com base nisso, as inovações na educação devem continuar sendo realizadas para melhorar a qualidade da aprendizagem. Esse estudo objetivou descobrir modelos de aprendizagem combinada por meio de aplicativos de webinar e motivação sobre os resultados da aprendizagem do aluno no curso Sistema Esquelético Humano. O estudo foi realizado na Associação de Professores do Ensino Médio da República da Indonésia 2 Nganjuk Regency, Java Oriental, Indonésia, na classe 1 do ano acadêmico 2019/2020, em disciplinas de ciências com material no Sistema de Ordem Humana. O número de amostras foi de 83 alunos, divididos em 42 alunos da turma experimental e 41 da classe controle. A classe experimental usa o modelo de aprendizado combinado utilizando um aplicativo de webinar, enquanto a classe de controle usa a ajuda dos módulos eletrônicos. Os métodos de coleta de dados a serem utilizados são observação, questionários e testes. As técnicas de análise de dados utilizaram o Two Way Anova. Os resultados mostraram que (1) houve diferenças nos resultados da aprendizagem dos alunos no curso do Sistema Esquelético Humano com base no modelo de aprendizagem combinada por meio de aplicativos de webinar, (2) houve diferentes resultados na aprendizagem dos alunos no curso do Sistema Esquelético Humano com base na alta motivação para a aprendizagem e baixa motivação para o aprendizado, (3) há interação entre os modelos de aprendizagem combinada por meio de aplicativos de webinar e motivação nos resultados de aprendizagem dos alunos no curso Sistema Esquelético Humano. A novidade deste resultado é a aplicação de webinar no processo de aprendizagem e resultados na forma de produtos de mídia de aprendizagem holográficos desenvolvidos no sistema esquelético humano. Através da mídia holográfica, o material parece mais real e se assemelha à sua forma original. Os alunos podem aprender sistemas esqueléticos através de imagens holográficas de uma variedade de perspectivas diferentes. Os alunos são mais motivados por projetos apresentados pelos professores, porque os projetos fornecidos são interessantes e capazes de melhorar as habilidades. Os alunos podem estudar material tanto em termos de ciências físicas quanto biológicas.

Palavras-chave: *aprendizagem combinada, motivação, seminários on-line, resultados de aprendizagem, módulos eletrônicos, hologramas*

ABSTRACT

The existence of the Covid-19 pandemic in 2020 has had a devastating impact on education. Interaction between teachers and students typically cannot be done. Based on this, innovations in education must continue to be done to improve the quality of learning. This study aimed to find out blended learning models through webinar applications and motivation on student learning outcomes in the Human Skeletal System course. The study was conducted at the Vocational High School Teachers Association of the Republic of Indonesia 2 Nganjuk Regency, East Java, Indonesia, and held in class 1 of the academic year 2019/2020 on science subjects with material on