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Advantages of determining the area of natural water bodies based on remote sensing and GIS technologies

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Abstract. Investigating natural water bodies and monitoring the expansion or contraction of their area is one of the urgent issues of today. Nowadays, the possibilities of doing this have become easier based on remote sensing and GIS technologies. Using Landsat 1-8 remote sensing data with ArcGIS software is considered effective. The Landsat satellite platform has yielded good results in conducting long-term repetitive monitoring, particularly in determining the area of the Aydarkul-Arnasay-Tuzkan lake system (AATLS), which is the subject of the study. Images from the Landsat 1-8 satellites from the years 1973, 1980, 1990, 2000, 2010, and 2022 were taken and classified based on unsupervised classification. As a result, analytical digital data on the area changes of the AATLS were generated.

1 Introduction

The Ramsar Convention, adopted in 1971 with the aim of conserving natural water resources globally, has identified more than 1,600 wetland areas covering over 145 million hectares as areas to be protected, with the goal of safeguarding natural water reservoirs.It's significant that the Aydarkul-Arnasoy-Tuzkon Lakes system was listed in the Ramsar Convention in 1999 as a wetland of international importance. This designation underscores the need to preserve and sustainably manage the Aydarkul-Arnasoy-Tuzkon Lakes system from an ecological perspective.Many foreign scholars have provided their own distinct definitions of natural water reservoirs. For example, Dong Ha Lee and other scholars state, Surface watersrefer to bodies of water on the earth's surface such as rivers, lakes, wetlands, and oceans. Surface water reservoirs are considered significant for human and ecological systems[1]. According to C. J. Vörösmarty and others, "..water helps preserve biodiversity

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in coastal or wetland ecosystems by providing habitats for a diverse range of flora and fauna[2]". According to A. Karpatne and others, Surface water objects have a dynamic nature because they are influenced by various natural and human factors, which can alter their appearance or flow direction"[3]. Chang Huang and others suggest, "Changes in water bodies affect not only other natural resources and the surrounding environment but also human activities. Changes in the volume of surface water often lead to significant consequences. Particularly, an increase in water levels leads to flooding, while their decrease can result in degradation, drying, and other adverse conditions. Therefore, it is crucial to accurately assess the presence of surface water bodies, monitor changes in their volume, and understand their dynamics"[4].Using remote sensing and GIS technologies is considered effective for detecting land cover changes. Digital data prepared based on remote sensing information covers areas inaccessible to human feet and provides access to information about the land. The study examines the advantages of the classification processes for identifying water-covered areas and distinguishing the types of land cover distributed around them. The objective is to compare the changes in the area of the Aydarkul-Arnasoy-Tuzkon lake system, which is considered a lake system of international importance, between 1990 and 2022, as well as to analyze the changes in land cover surrounding the lake system during the years 1973, 1980, 1990, 2000, 2010, and 2022.

2 Materials and methods

Through remote sensing methods, in the classification of long-term land use and land cover, especially in mapping agricultural lands[5]. Through repeated observations, it is possible to cover different seasonal cycles of plants and study geobotanical research remotely[6]. Additionally, by integrating remote sensing data with software, it is possible to create orthophotos that serve as a basis for organizing and managing the accurate distribution of areas[7].

Various satellites provide historical photographs over time, enabling the assessment and prediction of the impacts of natural and anthropogenic factors[8]. This enhances the quality and precision of forecasting, planning, and assessment tasks. Particularly, since the launch of the Landsat satellite in 1972, it has occupied a convenient place in orbit and has demonstrated a continuous record of satellite observations up to the present day[9].This satellite, operated under the program of the United States Geological Survey within NASA (National Aeronautics and Space Administration), continues to provide phase-specific information with increasing accuracy up to the present day.

Before classifying satellite imagery, images are required to undergo two types of corrections: atmospheric and radiometric corrections. Atmospheric corrections are carried out to enhance the clarity of the image based on the function they perform, while radiometric corrections involve removing additional elements present in the image (such as cloud cover, atmospheric gas scattering, and additional artifacts) to improve the clarity of the image for better interpretation, thereby increasing the level of detail and removing unwanted elements like shadows and unnecessary particles from the atmosphere[10]. After the corrections have been applied, satellite imagery data undergoes processing using various software programs such as ERDAS IMAGINE, ENVI, QGIS, SNAP, and ArcGIS. In the reprocessing stage, methods such as supervised classification and unsupervised classification are employed.

2.1 Study area

The Aydarkul-Arnasoy-Tuzkon lakes system is located between two regions, primarily in the Forish district of the Jizzakh region and the Nurata district of the Navoi region, as well as in the Tomdi district of the Navoi region (Figure.1).

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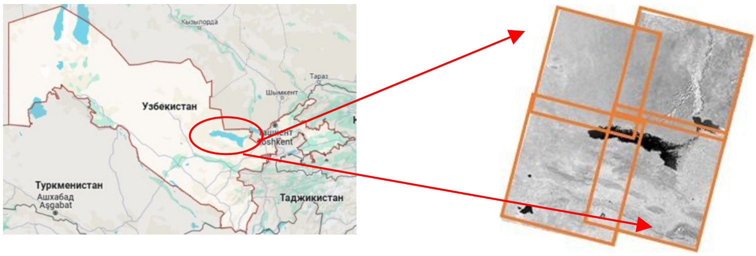

Fig. 1. Study area, with Landsat images Aydarkul-Arnasoy-Tuzkon lake system.

The research object, the Aydarkul-Arnasoy-Tuzkon lake system, had images obtained via remote sensing from Landsat 1, 2, 3, 4, 5, 7, and 8 satellites, capturing the highest water levels in May for the years 1973, 1980, 1990, 2000, 2010, and 2022 (Source: https://earthexplorer.usgs.gov).

3 Results and discussion

Classification involves identifying land cover types and land use designation, allocating them to categories. For example, it allows for the categorization of agricultural lands, residential areas, areas with water bodies, forests, and barren lands. Landsat 1-8 satellite data was utilized in ArcGIS 10.8 software to classify the area of the Aydarkul-Arnasoy-Tuzkon lakes system, with the objective of delineating different land types through unsupervised classification (Figure 2).

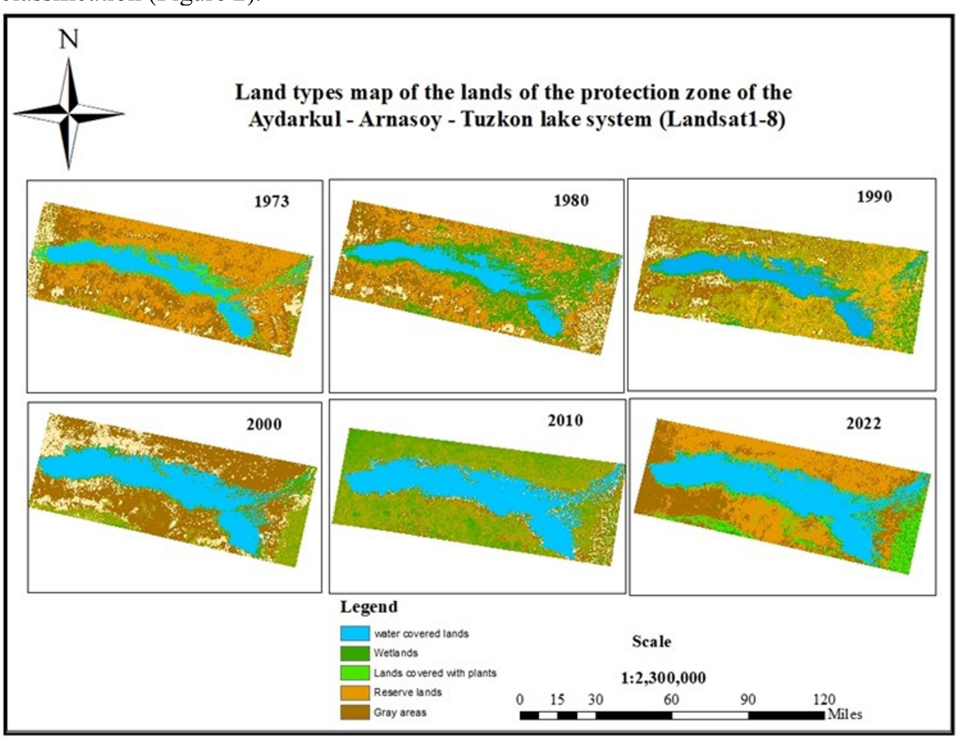

Fig.2.Land cover maps Aydarkul-Arnasoy-Tuzkon lake system.

Through unsupervised classification of satellite imagery, information was extracted from the obtained database to identify areas with water bodies and the types of land surrounding them. The ArcGIS 10.8 software was utilized for land classification, where in the number of classes was determined by specialists, and statistical clustering algorithms were employed to automatically group similar pixels into categories[11,12]. Land cover types were identified based on the statistical distribution of pixels within the area, considering the abundance of pixels within each pixel size (Diagram 1)

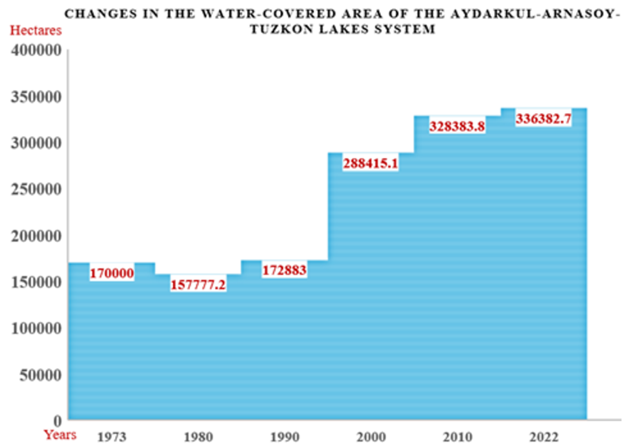

Fig.3. Changes area Aydarkul-Arnasoy-Tuzkon lakes system.

At the initial formation of the Aydarkul-Arnasoy-Tuzkon lakes system in 1973, it covered an area of 170 000 hectares. By 1980, the area covered by water in the lakes system was 157 777.2 hectares, increasing to 288 415.1 hectares by 2000, and reaching 328 383.8 hectares by 2010. By 2021, the area covered by water had grown to 336 382.7 hectares. Additionally, the vector layers of the Aydarkul-Arnasoy-Tuzkon lakes system for the years 1990 and 2022 were integrated and visualized in ArcGIS 10.8 software. (Figure 2).

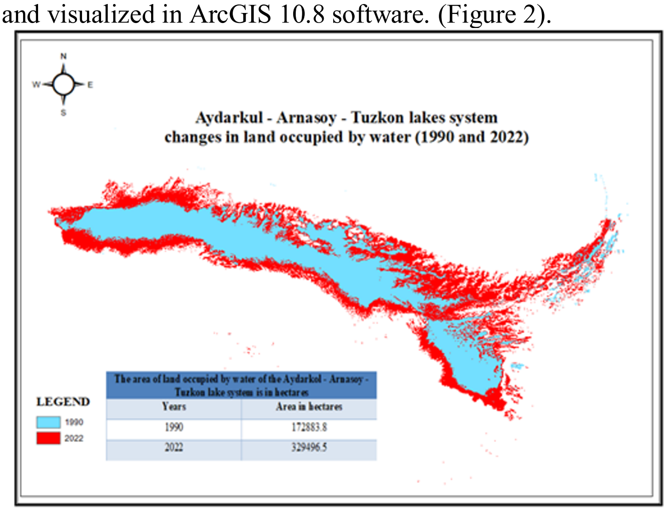

Fig.4. Water body changes of Aydarkul-Arnasoy-Tuzkon lakes system from 1990 to 2022.

4 Conclusion

1. Remote sensing allows for the rapid observation and analysis of large areas, reducing time and labor costs. Remote sensing and GIS technologies enable the

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collection of highly accurate data, helping to precisely monitor changes in natural water bodies.
2. Compared to traditional field research, remote sensing and GIS technologies can be more cost-effective.
3. Using satellite data and GIS technologies, it was determined that the Aydarkul-Arnasoy-Tuzkon lake system was 170,000 hectares in 1973, and expanded to 336,382.7 hectares by 2022.
4. Green and SWIR waves of satellite data have been found to have high sensitivity for water refraction in the range of 0.52-0.60µm and 1.56-1.66µm.

References

1. T. Acharya, D. Lee, I. Yang, and J. Lee, Sensors **16**, 1075 (2016)
2. C. J. Vörösmarty, P. B. McIntyre, M. O. Gessner, D. Dudgeon, A. Prusevich, P. Green, S. Glidden, S. E. Bunn, C. A. Sullivan, C. R. Liermann, and P. M. Davies, Nature **468**, 334 (2010)
3. A. Karpatne, A. Khandelwal, X. Chen, V. Mithal, J. Faghmous, and V. Kumar, in *Computational Sustainability*, edited by J. Lässig, K. Kersting, and K. Morik (Springer International Publishing, Cham, 2016), pp. 121–147
4. C. Huang, Y. Chen, S. Zhang, and J. Wu, Reviews of Geophysics **56**, 333 (2018)
5. A. Bégué, D. Arvor, B. Bellon, J. Betbeder, D. De Abelleyra, R. P. D. Ferraz, V. Lebourgeois, C. Lelong, M. Simões, and S. R. Verón, Remote Sensing **10**, 99 (2018)
6. J. Dong, X. Xiao, M. A. Menarguez, G. Zhang, Y. Qin, D. Thau, C. Biradar, and B. Moore, Remote Sensing of Environment **185**, 142 (2016)
7. X. Zhou and Y.-C. Wang, Landscape and Urban Planning **100**, 268 (2011)
8. R. Goldblatt, W. You, G. Hanson, and A. Khandelwal, Remote Sensing **8**, 634 (2016)
9. Z. Zhu, M. A. Wulder, D. P. Roy, C. E. Woodcock, M. C. Hansen, V. C. Radeloff, S. P. Healey, C. Schaaf, P. Hostert, P. Strobl, J.-F. Pekel, L. Lymburner, N. Pahlevan, and T. A. Scambos, Remote Sensing of Environment **224**, 382 (2019)
10. T. V. Ha, M. Tuohy, M. Irwin, and P. V. Tuan, The Egyptian Journal of Remote Sensing and Space Science **23**, 11 (2020)
11. B. Saipova, O. Ruzikulova, D. Djuraeva, and A. Altiev, IOP Conf. Ser.: Earth Environ. Sci. **1068**, 012046 (2022)
12. B. Saipova, Z. Mamatkulov, A. Altiev, M. Rajapbaev, and K. Bekzod, in (Chiangmai, Thailand, 2022), p. 040038