

MONITORING OF CHANGES IN THE WATER BOUNDARIES OF DAMSA RESERVOIR

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Rational water use is a set of measures to reduce water consumption and improve the efficiency of wastewater treatment in order to conserve resources, protect nature and increase economic efficiency in industry, housing and communal services and agriculture [1].

For the work carried out, Landsat 8 images were used, which are one of the few images that are freely available.

To calculate the index, it is necessary to have two images with channels b5 and b6 that are georeferenced to the Earth's surface from a satellite or an aircraft. It is possible to get such a picture from the USGS. United States Geological Survey, or USGS - American Geological Survey, a research government organization specializing in the geological survey of the United States and the study of Earth sciences [2].

In the "Search Criteria" tab, you need to determine the territory that the satellite image will cover and specify the desired time period. Next, in the "Datasets" tab, you need to select a satel-lite. In this work, images of the Landsat 8 satellite were used. It is not necessary to specify any-thing in the "Additional Criteria" tab. In the "Result" tab, those satellite images that fit the speci-fied requests appear. Next, you need to select the desired snapshot and download the channels you need or the entire data folder.

The normalized difference water index is used to detect and monitor the slightest changes in the content of water bodies. Using the advantages of the NIR (near infrared) and GREEN (visible green) spectral ranges, NDWI can enhance the presence of water bodies in a satellite image. The disadvantage of this index is the sensitivity to building structures, which can lead to a reassessment of water bodies. The index is calculated using the near infrared and green channel (Fig. 1) [3].

$$NDWI = (NIR - SWIR) / (NIR + SWIR)$$

$$\text{For Landsat 7 data, } NDWI = (Band 4 - Band 5) / (Band 4 + Band 5)$$

$$\text{For Landsat 8 data, } NDWI = (Band 5 - Band 6) / (Band 5 + Band 6)$$

But result appear form above formula is poor in quality. The pure water neither reflects NIR nor SWIR. The formula of NDWI then modified by Xu (2005). It uses Green and SWIR band.

Fig. 1 Index calculation formula

Next, you need to upload the channels to ArcGIS and use the Raster Calculator tool to calculate the desired index. In the "Layers and Variables" list, a selection of the data set and variables to be used in the expression is indicated. You can also add numeric values and mathematical operators in the tool dialog box. The expression field specifies the formula for calculating the composite index. After starting the tool, the result will be automatically displayed in the "Table of Contents".

For a more visual display of the values of the composite index on the satellite image, color gradation is used, which allows you to visually determine the location of objects with a particular index value. For example, the highest value is displayed in a blue shade, which characterizes water bodies or clouds (Fig. 2).

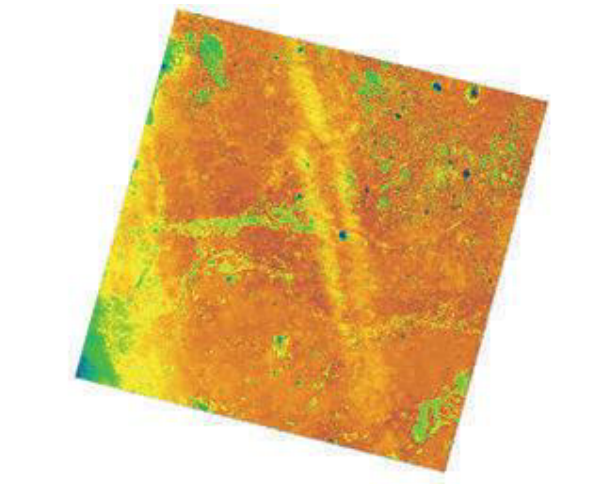


Fig. 2 NDWI for April 23, 2021

Next, you need to group the pixel values in the image into certain classes. To do this, the tool "Uncontrolled classification of the isocluster" is used. This tool performs uncontrolled classification on a number of input raster channels using Iso Cluster and Maximum Similarity Classification tools. In the input raster of this tool, select the calculated water index and specify the required amount in the number of classes field. The resulting result will also be displayed in the table of contents, while the raster will be divided into 7 classes and displayed in different colors.

All pixels with a similar value are combined into one group, which will denote water objects.

The following tool "Extract by attributes" is used to extract the necessary channels by specifying a specific channel in the tool. In the input, we specify the already classified raster, in response to the "Where" condition, we need to specify the value of our class in order for the tool to export only the desired value. In this case, the condition "Value=7" is set in the "Where clause" field. Which means that exactly class 7 will be extracted into a separate raster. The resulting result will be displayed in the table of contents, while the raster will consist of only one class and have only one color.

After getting a raster of only water objects, we need to convert the raster into a

polygon. To do this, use the "Raster to Polygon" tool. In the input raster field, select the raster that will be converted into a polygon in the future. After converting the raster into a polygon, we get an object with uneven borders, since it was formed from a raster that consists of many pixels.

For further work with the polygon, you need to export the object to a separate shapefile. After exporting the polygon, to smooth the boundaries of the object, you need to use the "Smooth Polygon" tool.

In the input raster field, select the exported polygon. In the "Pre-start smoothing" parameter, you need to specify the distance by which the borders will change. In the polygon attribute table, we create the "Shape Area" field and calculate the reservoir area for a certain period of time by calculating the geometry.

Analysis of the received data.

Figure 3 shows all the Dams reservoir polygons for the month of July in the period from 2013 to 2021. Due to the overlapping of polygons, it is possible to see the similarity or, conversely, the differences between the reservoir area for a given period.



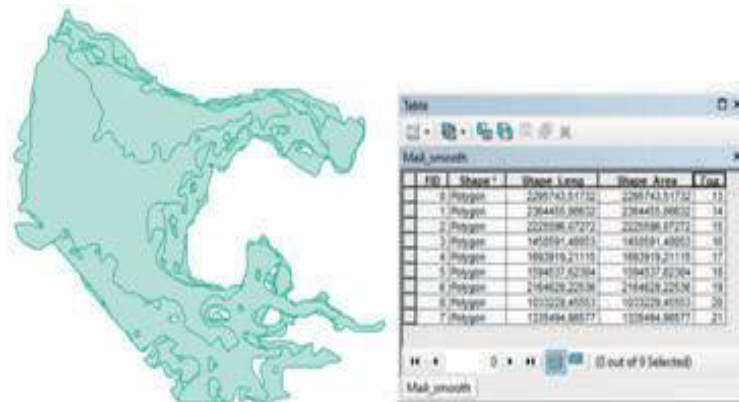
Fig. 3 Reservoir polygons for July 2013-2021

Figure 4 shows all the Dams reservoir polygons for the month of August in the period from 2014 to 2019. There are no data for 2013, 2020 and 2021, as the cloud cover in the images for this period of time was too large, which did not allow them to be used in this work.



Fig. 4 Reservoir polygons for August 2014-2019

In Fig. 5 shows all the Dams reservoir polygons for the month of May in the period from 2013 to 2021. The area of the reservoir varies greatly depending on the year. The reason for this is the spring floods. Waters often come out of their borders flooding nearby lands. Therefore, for a more accurate analysis, it is necessary to use



satellite images for July and August.

Fig. 5 Reservoir polygons for May 2013-2021

In Fig. 6, you can clearly see all the changes related to the reservoir area over the past 8 years. Analyzing this graph and Figures 24 and 25, it can be concluded that the water boundaries of Dams reservoir have not changed much since 2013-2014. However, it is possible to observe a slight decrease in the area in July 2016 and 2018.



Fig. 6 Graph of Dams reservoir area change

At the same time, comparing the polygons for July 2013 and July 2021, there is not a huge difference, but it is worth noting that in 2021 the area is smaller than in 2013. In Fig.7, the red border indicates the area for July 2013 and the blue color for July 2021.

When studying the issue of changes in the water boundaries of Dams reservoir, there is no critical change in the area, which would contribute to the emergence of ecological and economic problems in the Shortandinsky district. However, in the course of the work, another important problem was identified, floods.

In Fig. 6, it can be seen that the values of the area of the water body for May are

much higher than for July and August. In 2014, 2015 and 2019, the area of the reservoir is twice as large as the area in July of the same years, which tells us about a major spill of water beyond the boundaries of the reservoir. When comparing the area for May and July 2021, the area for May exceeds the area for July by 55%.

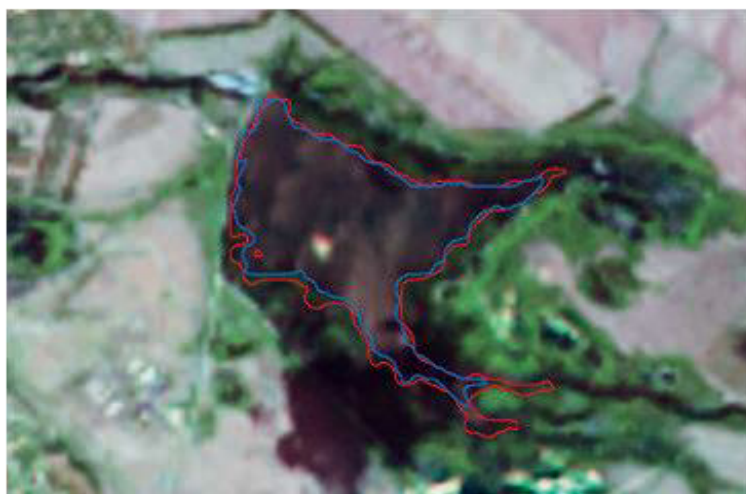


Fig. 7 Illustrative changes in the Dams reservoir area

The aim was to analyze water boundaries by studying the principles of processing the re-ceived data from the Landsat 8 system, using the ArcGIS software. To achieve this goal, the following tasks were solved: the processing of satellite images, the designation of water boundaries, as well as the evaluation and analysis of the data obtained. This work is relevant, as it allows us to obtain up-to-date information about the state of the reservoir, for timely identification of prob-blems, as well as prevention of negative impact on the economy, since water used for irrigation and fish caught by fishermen is an important part of the life of local residents. As a result, it was revealed that the area of the reservoir varies greatly depending on the year in the month of May. The reason for this is the spring floods. Waters often come out of their borders flooding nearby lands. Residents of the Damsa reservoir faced the problem of floods during the spring warming.

Therefore, for a more accurate analysis, it is necessary to use satellite images for July and August. As a result of the analysis, the water boundaries of the Dams reservoir have not changed much, which was confirmed by satellite images.

List of used literature

- 1 Гидросфера, ее значение и структура. Современное состояние, охрана и рациональное использование водных ресурсов. – URL: <https://cyberpedia.su/14x772d.html>
- 2 Electronic resource. – URL: <https://earthexplorer.usgs.gov/>
- 3 Расчет NDVI, NDBI и NDWI с использованием Landsat 7, 8. / Электронный ре- сурс. – URL: <https://www.linkedin.com/pulse/ndvi-ndbi-ndwi-calculation-using-landsat-7-8- tek-bahadur-kshetri>
- 4 Islam, Md Shajedul, Mostafa, M.G. Development of an integrated irrigation

water quality index (IIWQ(Index)) model. / Water supply. Iwa Publishingalliance House, 12 Caxton St, London SW1H0QS, England, 2020. – URL: <https://www.webofscience.com/wos/woscc/full-record/WOS:000714695900001>

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