

## **IDENTIFICATION OF WATER BODIES AND PREPARATION OF MAPS FOR ASSESSING THEIR CONDITION BASED ON REMOTE SENSING DATA**

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<b>ABSTRACT</b>	<b>KEYWORDS</b>
<p>This article describes the effective use of modern geoinformation and remote sensing technologies to develop a scientific and methodological approach based on satellite data and to test it in practice in order to determine the water availability of agricultural land, as well as to produce thematic water maps based on the MNDWI (Modified Normalized Difference Water Index).</p>	<p>Agriculture, Water Index, Sentinel-2, MNDWI, satellite, water resources, map, ArcGIS, aerial photography, Waterinformation.uz, OpenStreetMap, Esri.</p>

### **Introduction**

#### **Annotatsiya**

Mazkur maqolada qishloq xo'jaligi yerlarining suv bilan ta'minlanganlik darajasini aniqlash maqsadida sun'iy yo'ldosh ma'lumotlari asosida ilmiy-metodik yondashuv ishlab chiqilishi va amaliyotda sinovdan o'tkazilishi hamda MNDWI (Modified Normalized Difference Water Index) asosida tematik suv xaritalarini tuzish zamonaviy geoinformatsion va masofadan zondlash texnologiyalarining samarali qo'llanganligi bayon etilgan.

**Kalit so'zlar:** Qishloq xo'jaligi, suv indeksi, Sentinel-2, MNDWI, sun'iy yo'ldosh, suv resurslari, Xarita, ArcGIS, aerofotosurat, “Waterinformation.uz”, OpenStreetMap, Esri.

#### **Аннотация**

В данной статье описано эффективное применение современных геоинформационных технологий и технологий дистанционного зондирования для разработки научно-методического подхода на основе спутниковых данных и его практической проверки с целью определения уровня водообеспеченности сельскохозяйственных угодий, а также для составления тематических водных карт на основе MNDWI (Modified Normalized Difference Water Index).

**Ключевые слова:** Сельское хозяйство, водный индекс, Sentinel-2, MNDWI, спутник, водные ресурсы, Карта, ArcGIS, аэрофотосъемка, «Waterinformation.uz», OpenStreetMap, Esri.

Due to the limited availability of water resources, the seasonal variability of river flow, and soil salinization, the need to scientifically plan land management and water management projects has been increasing. It is also essential to establish a transparent system for water resource management and water accounting through the widespread use of digital technologies [1]. There is a high demand for the conservation of water resources, the processing of remote sensing data, and its application in agriculture. Based on this, it is possible to calculate and analyze the level of water availability using satellite data.

## Relevance of the Topic

In recent years, the decline in water supply, cases of illegal irrigation, unauthorized use of water, inefficient land use, and the impacts of climate change have become increasingly noticeable in our country. Therefore, rapid and accurate monitoring of surface water is of great importance for hydrological processes and water resource management. Unlike traditional field measurements, remote sensing imagery is macroscopic, dynamic, and cost-effective, allowing the acquisition of surface data in real time. From this perspective, the use of remote sensing data and indices such as MNDWI (Modified Normalized Difference Water Index) is particularly relevant for Uzbekistan.

## Research Results and Discussion.

The creation of thematic water maps based on the MNDWI index represents the effective application of modern geoinformation and remote sensing technologies. This index provides high accuracy in detecting water bodies and has significant scientific and practical importance in the fields of land management, land reclamation, and water resource management. MNDWI maps developed using Sentinel-2 data enable the monitoring of water supply in irrigated areas, the calculation of water balance, and the scientific justification of project decision-making processes. During the research, the water difference index is calculated using the following formula:

$$\text{MNDWI} = (\text{Green} - \text{SWIR}) / (\text{Green} + \text{SWIR})$$

where: Green – green spectral band, SWIR – short-wave infrared spectral band.

For the Sentinel-2 satellite, the index is calculated using the spectral bands: Green: B3, SWIR: B11. Thus, the formula becomes:  $\text{MNDWI} = (B3 - B11) / (B3 + B11)$  [4].

Step 1. To calculate MNDWI, Sentinel-2 L2A satellite images (with up to 10 m spatial resolution) are obtained from the Copernicus data platform (<https://copernicus.eu/>) [5]. After clicking the search button in the panel, the system automatically displays the available images based on the selected area, date, and specified cloud cover (see Figure 1).

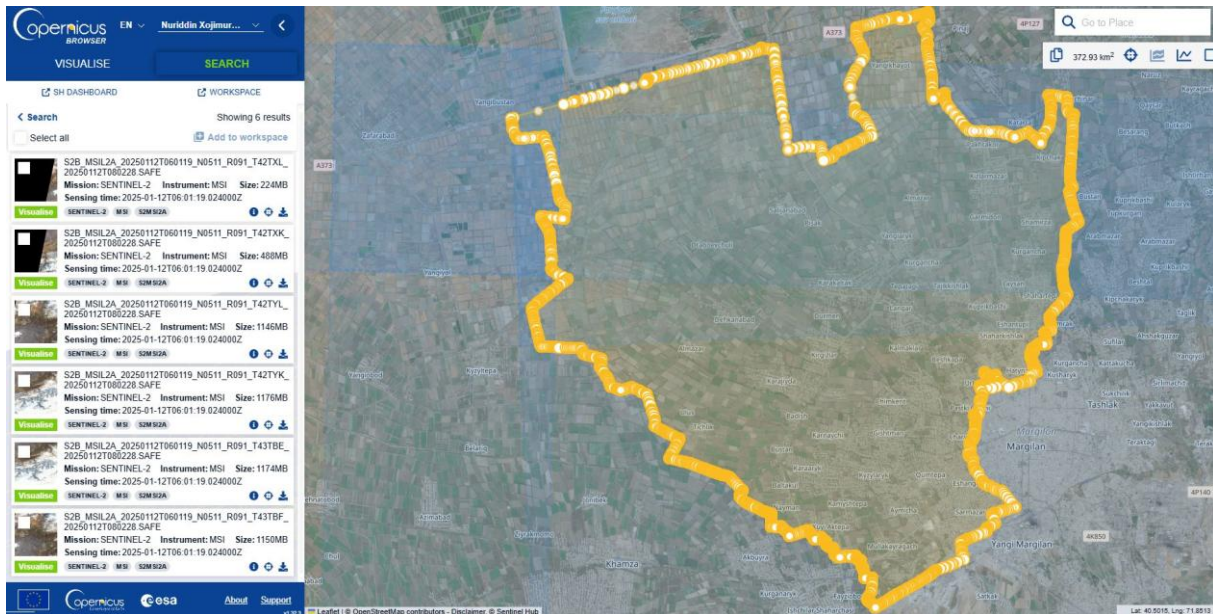


Figure 1. Representation of the generated dataset.

During the downloading process, the orthophoto data provided is carefully examined, where cloud cover and the acquisition time of the imagery play an important role in calculating the water index. By downloading the required satellite data from the available dataset, the water index of the study area is calculated (see Figure 2).

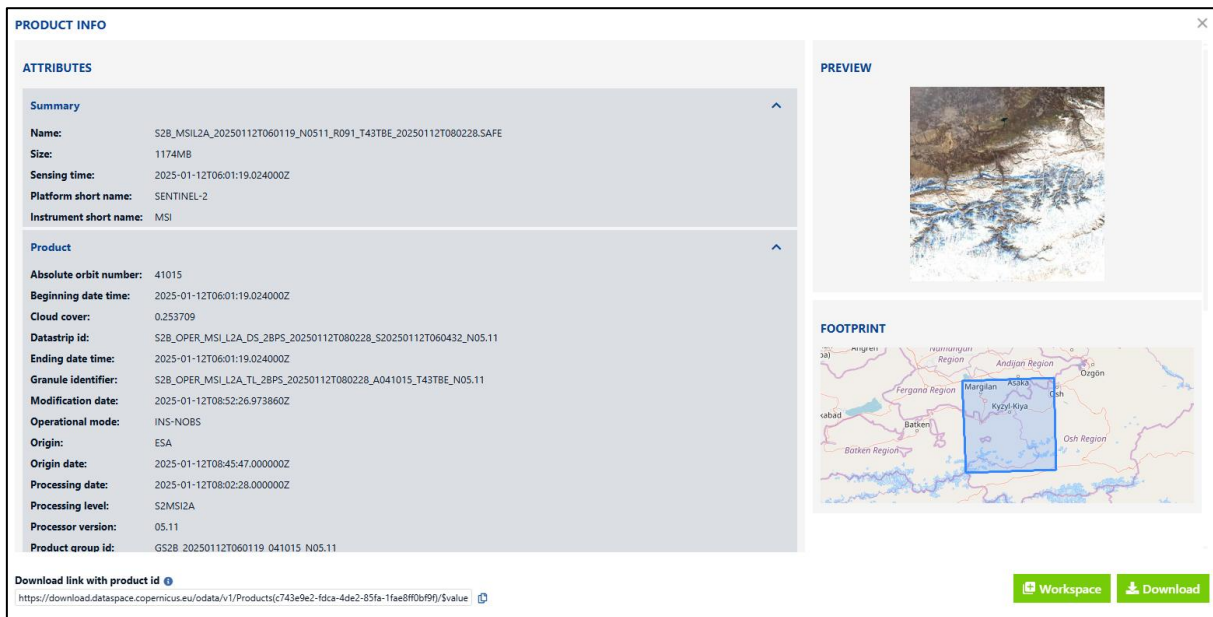


Figure 2. Visualization of image data.

Step 2. After downloading the Sentinel-2 raster data, the required B3 and B11 raster bands are selected and imported into the ArcGIS software for further processing.

To perform calculations on the downloaded imagery, the Raster Calculator function (ArcToolbox → Spatial Analyst Tools → Map Algebra → Raster Calculator) is used, as shown in Figure 3.

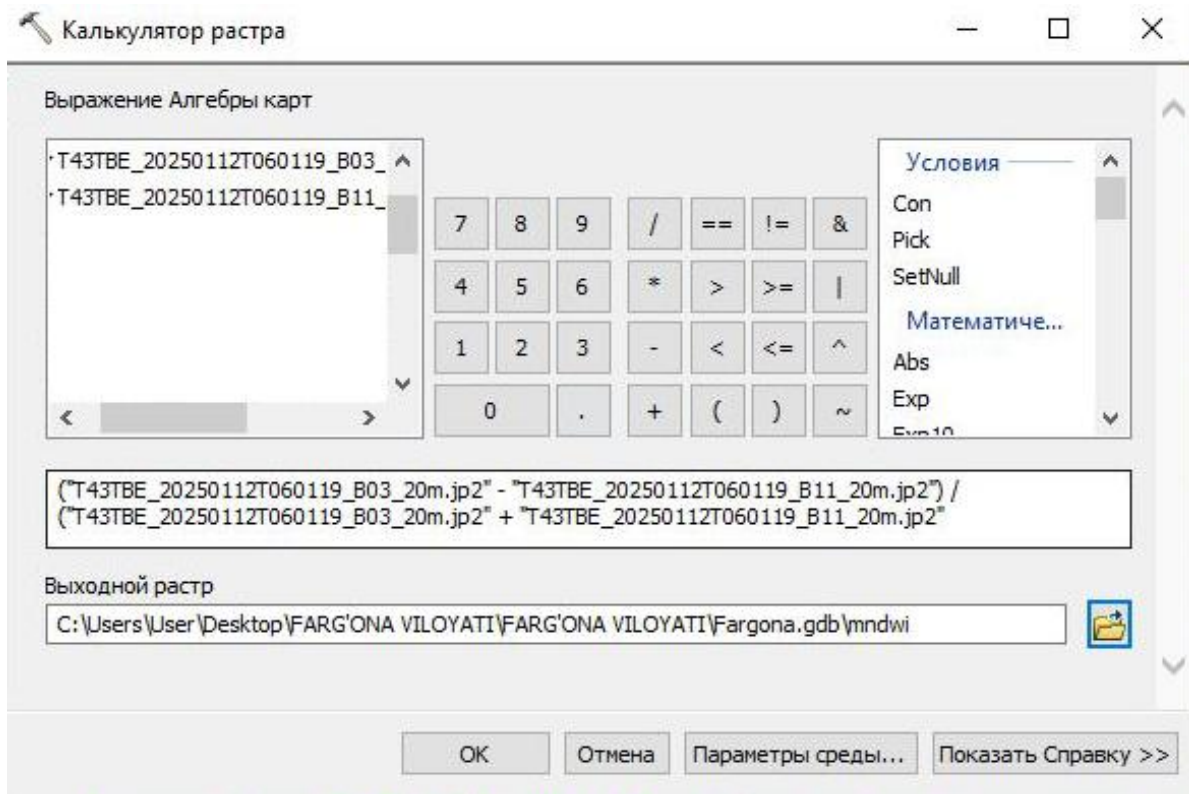


Figure 3. Water index calculation formula.

After performing the calculations in the third step, we obtain a raster with values of -1, 0, and 1, where MNDWI > 0 represents water and MNDWI < 0 represents land. The generated raster can be clipped to the designated study area using the “Raster Processing” function (ArcToolbox > Raster > Raster Processing > Clip) (see Figure 4).

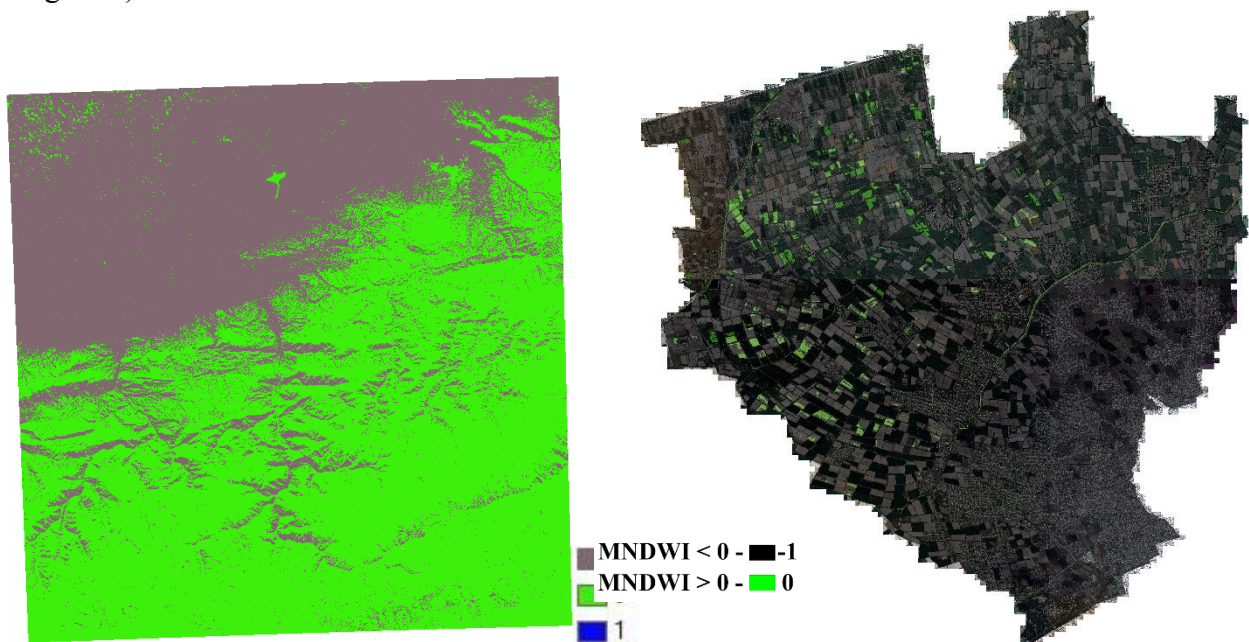


Figure 4. Processed aerial image of the study area.

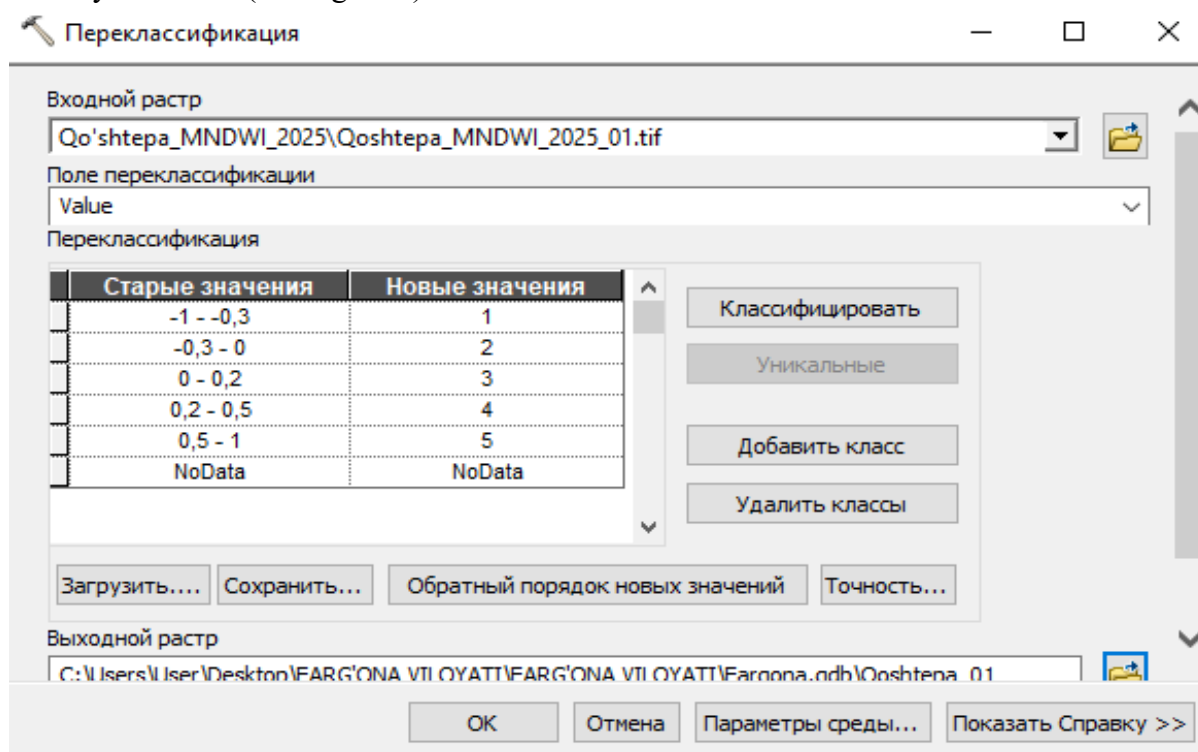
In the fourth step, after clipping the study area, the raster derived from the water index takes values ranging from -1 to +1. To more accurately distinguish water bodies, the index values are divided into specific classes (categories). During the research, to precisely calculate water areas, the map was classified into 5 classes (categories) as an optimal approach. The “Reclassify” function (ArcToolbox > Spatial Analyst Tools > Reclass) was used for the study area, and the recommended 5 classes (categories) are presented in Table 1.

**Table 1 Classification of water resources based on value**

No.	MNDWI Values	Raster color	Description	Role in Calculation
1	-1 – (-0,3)	Yellow	Land	Not water
2	-0,3 – 0	Light Green	Semi-dry soil	Not water
3	0 – 0,2	Green	Moist soil	Conditional water
4	0,2 – 0,5	Light Blue	Shallow water	Shallow water
5	0,5 – 1	Dark Blue	Open water	Water

**\*Note:** Values above 0 are considered as water-covered areas, and the combined shallow and water classes represent the total water area.

In the fifth step, using the classes above, the MNDWI water index map is created, and water-covered areas are classified into 5 categories. The map is reclassified according to Table 1 using the “Reclassify” function (see Figure 5).



**Figure 5. Reclassify window.**

After performing the reclassification, the resulting raster data were used to distribute areas into land, semi-dry soil, moist soil, shallow water, and open water, and statistical information for the entire selected area was generated in terms of hectares and percentages.

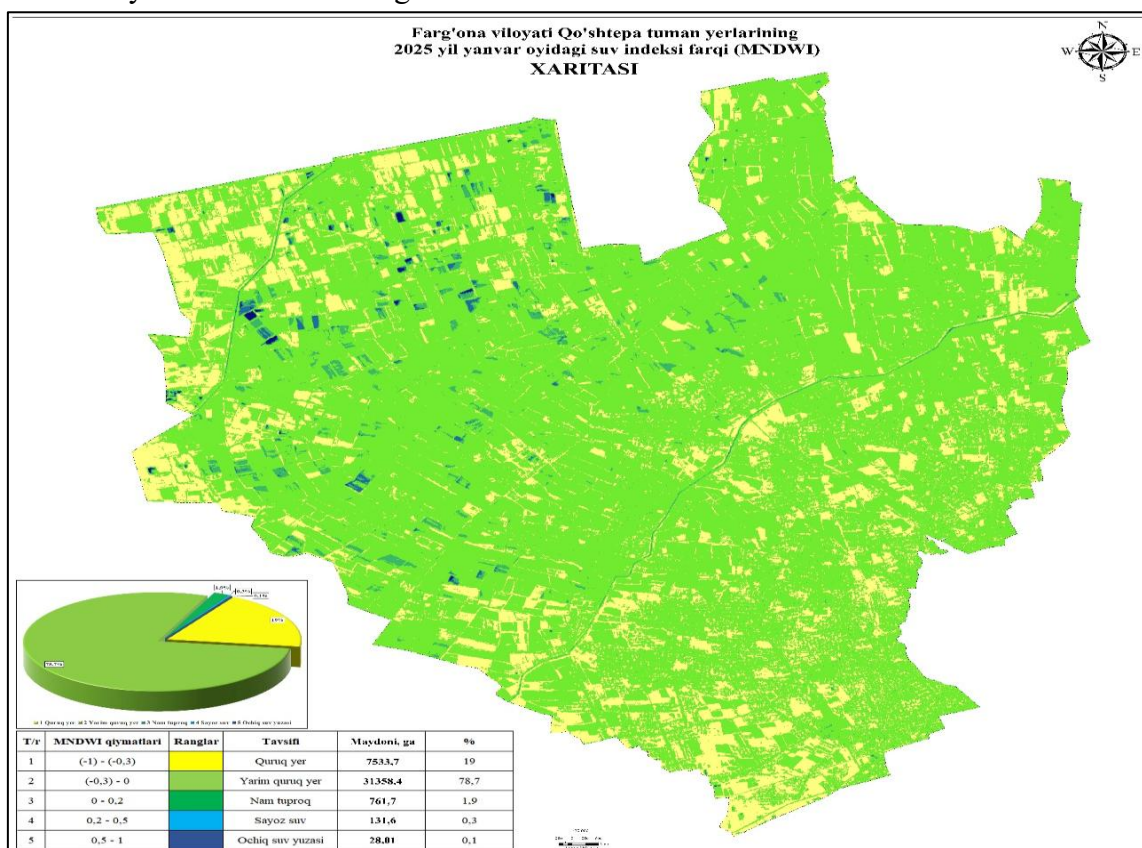
It was concluded that using a 5-class water index to identify water bodies and perform statistical analysis is an effective method. Values of MNDWI > 0 were considered as water-covered areas, which allowed the spatial distribution, area, and percentage of water to be determined. The results are presented in Table 2.

**Table 2** Analysis of Qo'shtepa district, Fergana region, for January 2025.

No.	Raster color	Description	Role in calculation	Analysis Data	
				Area	%
1	Yellow	Land	Not water	7533,7	18,9
2	Light Green	Semi-dry soil	Not water	31358,4	78,8
3	Dark Green	Moist soil	Conditional water	761,1	1,9
4	Light Blue	Shallow water	Shallow water	131,6	0,3
5	Dark Blue	Open water	Water	28,01	0,1
<b>Total</b>				<b>39 813</b>	<b>100</b>

**\*Note:** The data analyzed by the author using reclassification.

Analysis of the Qo'shtepa district using reclassification showed that in January 2025, the area covered by water was 920.71 hectares, which accounted for 2.2% of the total area. After completing the above steps, the visually generated map of the study area is shown in Figure 6



**Figure 6. Final map of the calculated water index.**

In this study, a scientific-methodological approach was developed and tested in practice to determine the water coverage of agricultural lands based on remote sensing data. Sentinel-2 Level 2A (atmospherically corrected) images provided by the European Space Agency were used during the study. The results showed that applying the MNDWI index based on Sentinel-2 data allows for rapid and accurate assessment of water availability in agricultural areas. The 5-class classification model enables a comprehensive evaluation of the spatial distribution of water resources.

## **Conclusion, Suggestions, and Recommendations**

Using Sentinel-2 satellite data to apply the MNDWI index provides a fast, accurate, and cost-effective method for assessing water availability in agricultural areas. This methodology is especially relevant in water-scarce regions of Uzbekistan. The developed method serves as an effective tool for scientific-based decision-making in land management and water resources administration and provides a methodological basis for establishing long-term monitoring systems. Furthermore, applying the MNDWI index has been proven to be a valuable tool for rapid identification and monitoring of water bodies, as well as for scientifically substantiating land reclamation and irrigation projects.

## **References**

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