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«ҒЫЛЫМ ЖӘНЕ БІЛІМ - 2018»
XIII Халықаралық ғылыми конференциясы

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студентов и молодых ученых
«НАУКА И ОБРАЗОВАНИЕ - 2018»

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ASSESSMENT OF WATER SURFACE INDEX USING NDWI, MNDWI AND SUPERVISED CLASSIFICATION ON THE PLATFORMS OF QGIS AND ARCGIS

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This study aims to quantify the impact of urbanization on the surface water bodies of Balkhash. This paper also assesses the performance of MNDWI, NDWI, WRI and supervised classification technique in detection of water bodies along with selection of suitable thresholds. These methods make use of reflectance values in various bands of electromagnetic spectrum namely: Blue, Green, Red, NIR, MIR and SWIR which are available in Landsat-7 ETM+ imagery with the additional benefits of high spatial, temporal and multispectral resolution. Table 1 lists the band characteristics of the ETM+sensor [1-3]:

Table 1. Landsat 7 ETM+ band characteristics

Band No.	Description	Wavelength (nm)	Band No.	Description	Wavelength (nm)
1	Blue	450-515	5	Medium IR	1550-1750
2	Green	525-605	6	Thermal IR	1040-1250
3	Red	630-690	7	Shortwave IR	2090-2350
4	Near infrared	750-900	8	Panchromatic	520-900

In the present scenario, various band indices of water extraction for multispectral data are available. These methods make use of the spectral reflectance of water and other features in different spectral bands. Each method offers its advantages and disadvantages. Following are some of the proposed methods to extract water bodies which are considered in this study:

$$WRI = \frac{Green + Red}{NIR + MIR}$$

a) Water Ratio Index (WRI): Due to dominating spectral reflectance of water in green (Band 2) and red (Band 3) bands as compared to Near Infra-red (Band 4) and Medium Infra-red(Band 5). WRI shows values, in general, greater than 1 for water [3-4], where WRI is definedas*Figure 1(a):*

$$NDWI = \frac{Green - NIR}{Green + NIR}$$

b) Normalised Difference Water Index (NDWI): Based on the fact that water has strongest absorption while vegetation has strongest reflectivity at near infra-red,[2-3] proposed the method of NDWI to highlight waterbody.NDWI proved to work well in separating water body and vegetation but has limitations when it comes to soil and built up area. *Figure 1(b):*

$$MNDWI = \frac{Green - MIR}{Green + MIR}$$

c) Modified Normalised Difference Water Index (MNDWI): Due to the limitations of NDWI, [5], MNDWI which was found to be efficient in distinguishing water and urbanareas. *Figure 1(c):*

d) Wetness component of K-T transformation:Kauth and Thomas (1976) first proposed this method to distinguish between three special features termed as Brightness, Greenness and Yellowness for the MSS data. Subsequently, Crist and Cicone (1984)adapted the tasseled cap transformation to the six channels of Thematic Mapper data. The weights are different and the third component is taken to represent soil wetness rather than yellowness as in Kauth and Thomas' original formulation.The wetness component of K-T transform can beutilized to extract water information wherein a weighted sum of bands of ETM+ is taken according to the following formula[2-3]: *Figure 1(d):*

$$Wetness = 0.1509 \times Blue + 0.1793 \times Green + 0.3279 \times Red + 0.3406 \times NIR - 0.7112 \times MIR - 0.4572 \times SWIR$$

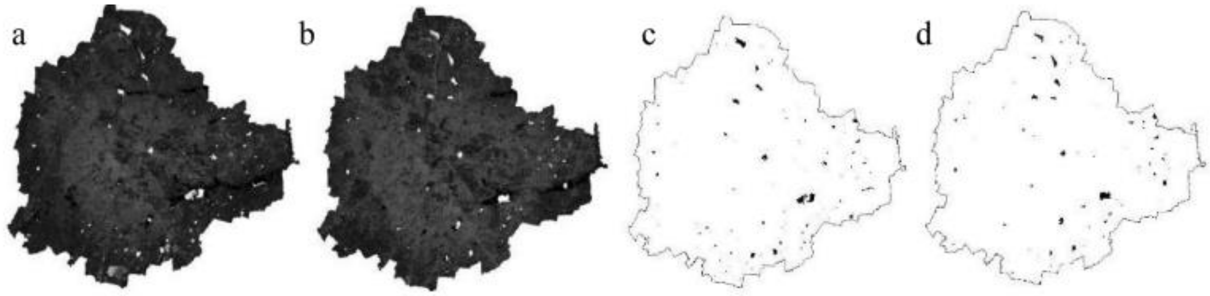
Lake Balkhash is one of the largest lakes in Asia and 15th largest in the world. It is located in Central Asia in southeastern Kazakhstan and belongs to an endorheic (closed) basin shared by Kazakhstan and China, with a small portion in Kyrgyzstan. The basin drains into the lake via seven rivers, the primary of which is the Ili River, bringing the majority of the riparian inflow; others, such as the Karatal, provide both surface and subsurface flow. The Ili is fed by precipitation, largely vernal snowmelt, from the mountains of China's Xinjiang region[4-6].

The lake currently covers an area of about 16,400 km^2 (6,300 sq mi). However, like the Aral Sea, it is shrinking as a result of the diversion of water from rivers that feed it. The lake is divided by a strait into two distinct parts. The western part is fresh water, while the eastern half is saline. The eastern part is on average 1.7 times deeper than the western section. The largest city near the lake is also named Balkhashand has about 66,000 inhabitants. Major industrial activities in the area include mining, ore processing and fishing[7].

While the size of the lake is temporarily growing, there is concern about the lake's swallowing due to desertification and industrial activity.

Several water body extraction methods were applied over the images of Balkhash for the years 2002 and 2014. Based on the observation of Xu (2005), MNDWI was considered the most suitable method for urban area as it discriminates water and other features appropriately. Thus, in order to evaluate the performance of other water detection algorithms, MNDWI served as a reference. Several iterations were performed to select optimal threshold. The most appropriate threshold was selected by correlating the water body locations of the ground survey data with the MNDWI image of 2014. Once the surface water map as per MNDWI was finalized, thresholds for other extraction methods were carefully selected based on:

a) Performance as close as possible to the MNDWI referenceimage
b) Non-inclusion of features like cloud shadows, roads and vegetation in the surface watermap.

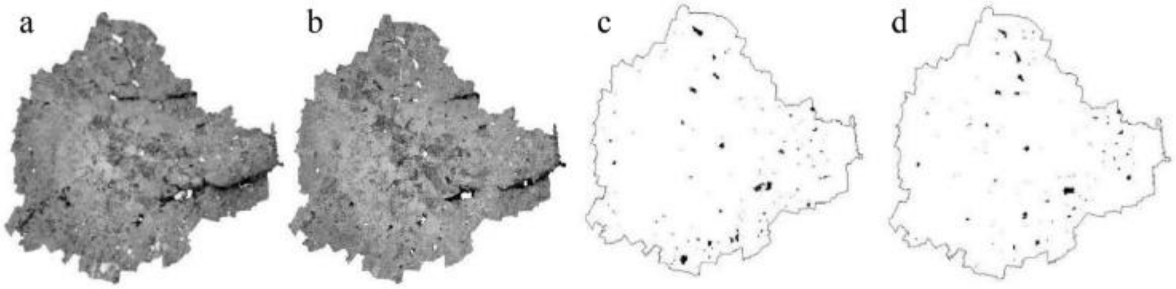


WR

I

Figure 1 (a) WRI images for the year 2002; (b) 2014; (c) Water bodies identified using WRI for the year 2002 and (d) 2014

This method showed convincing results for values greater than 1.9 as it enhanced water while the cloud shadows, roads and vegetation remained suppressed. Fig. 7. (a) & (b) display computed WRI images while 7. (c) & (d) shows the threshold images for the year 2002 and 2014 respectively.



NDWI

Figure 2 (a)NDWI images for the year 2002; (b) 2014; (c) Water bodies identified using NDWI for the year 2002 and (d) 2014

The NDWI for the Balkhash images was evaluated for both 2002 and 2014. Based on the reasons mentioned in section 3,the NDWI values greater than 0.3 performed closest to the MNDWI for trustworthy water body extraction. However, this method encountered limitations as it highlighted cloud shadows as a part of water body. By increasing the threshold, it was possible to eliminate the shadow areas but that also lead to further elimination of actual waterbodies. *SupervisedClassification*

The training samples were provided over the Balkhash image for known and unambiguous representatives for each class namely Water body, Vegetation over wet areas, Vegetation, Urban/Rock/Soil. Maximum likelihood supervised classification was implementedover the image. Fig. 10 indicates water body (in dark blue) and vegetation over wet areas (light blue).

Result and discussion.

The study shows a considerable decrease in surface water in a span of 12 years. The MNDWI algorithm, used as reference, demonstrates a reduction of about 1000000 m^2 which is equivalent to a total decrease of 13.7 %.The water surface area and number of pixels extracted from data of 2002 and 2014 using different methods (*Table 2):*

Table 2 – The water surface area and number of pixels (2002, 2017)

Surface water Detection Algorithm (threshold)	2002 km^2(pixels)	2014 km^2(pixels)	Temporal Change (%)
MNDWI(0.3)	7.2477(8053)	6.255(6950)	13.69
NDWI (0.3)	7.6239(8471)	6.021(6690)	*21.02
WRI (1.9)	6.3009(7001)	5.5116(6124)	12.52
K-T(20)	8.5122(9458)	7.7868(8652)	8.51
Supervised Classification	6.5646(7294)	5.1561(5729)	21.45

*The high percentage of change in surface water area for NDWI is due to the fact that the 2002 image includes clouds and their shadows which are misclassified as water while the 2014 image is completely free of clouds.

This study can be significantly utilized in disciplined urban planning with timely and accurate assessment to optimize the limited water resources for fast growing urbanpopulation.

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УДК528

АКТУАЛЬНЫЕ ЗАДАЧИ РАЗВИТИЯ ДИСТАНЦИОННОГО ЗОНДИРОВАНИЯ ЗЕМЛИ (ДЗЗ) В КАЗАХСТАНЕ

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Космические средства дистанционного зондирования Земли (далее - ДЗЗ) и наземная инфраструктура, предназначенная для приема, обработки, хранения и распространения космической информации ДЗЗ, должны создаваться и совершенствоваться в максимальном соответствии с потребностями хозяйственных и научных организаций страны.

В этот обобщенный состав входят многочисленные задачи следующих направлений: гидрометеорологии, экологии, мониторинга чрезвычайных ситуаций (ЧС), обширный спектр народно-хозяйственных задач (сельское и лесное хозяйство, промысел морепродуктов, геология, включая поиск и разведку полезных ископаемых, землеустройство, строительство, прокладка транспортных магистралей, картография, создание и обновление геоинформационных систем, гидротехника и мелиорация и другие), а также океанографические и океанологические задачи и научные задачи фундаментального изучения состояния и эволюции Земли, как целостной и развивающейся экологической системы. [6]