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MONITORING OF SURFACE OBJECTS AND PROCESSES DO IT IN ARCGIS SOFTWARE (IN THE EXAMPLE OF SAMARKAND REGION)

[1]Alimjonov Islom,
[2]Zayniddinov Abdulaziz
[3]Abdusamadov Abdushoir
[1]Student of TSTU, Aviation faculty,
[2]student of TSTU, Aviation faculty,
[3]student of TSTU, Aviation faculty

Abstract:
Monitoring of surface objects in the ArcGis program, analysis of surface processes using the classification method. And studying the effects on surface objects with the help of classification data. For this, using space images captured by Landsat satellites.

Key words: Classification tools, mosaic to new raster, supervised and unsupervised classification, composite bands.

Introduction

The Landsat program consists of a series of Earth-observing satellite missions jointly managed by NASA and the U.S. Geological Survey (USGS). To date, there have been nine missions, eight of which have been operational. The tenth mission, Landsat Next, is in its preliminary phases and is planned to launch in late 2030. Since the launch of Landsat 1 (formerly known as ERTS-1) in 1972, Landsat satellites have continuously and consistently captured images of the Earth's land surfaces. With over five decades of observations, the Landsat program has created a data archive of unmatched quality and coverage that has vastly improved our understanding of the Earth, its natural resources, and its dynamic processes. The sensors aboard each of the Landsat satellites were designed to acquire data in different ranges of frequencies along the electromagnetic spectrum (View Bandpass Wavelengths for all Landsat Sensors). The Multispectral Scanner (MSS) carried on Landsat 1,2,3,4 and 5 collected data in four ranges (bands); the Thematic Mapper (TM) sensor on Landsat 4 and Landsat 5 included those bands found on earlier satellites and also introduced a thermal and a shortwave infrared band. A

panchromatic band was added to Landsat 7's Enhanced Thematic Mapper Plus (ETM+) sensor.

While the earlier satellites carried just one sensor, Landsat 8 was designed to acquire data in a total of 11 bands from two separate sensors: the Operational Land Imager (OLI) and the Thermal Infrared Sensor (TIRS). Landsat 9 carries improved copies of the Landsat 8 sensors. With a planned launch of 2030, Landsat Next, a constellation of three satellites, will each carry sensors to acquire data in a total of 26 spectral bands. Specifics about each band will be added to this page in the future, but current information about Landsat Next spectral bands can be found on the Landsat Next web page.

Landsat 1-5 Multispectral Scanner (MSS) images consist of four spectral bands with 60-meter spatial resolution. Approximate scene size is 170 km north-south by 185 km east-west (106 mi by 115 mi). Specific band designations differ from Landsat 1-3 to Landsat 4-5.

Landsat 7 Enhanced Thematic Mapper Plus (ETM+) images consist of eight spectral bands with a spatial resolution of 30 meters for Bands 1 to 5 and Band 7. Spatial resolution for Band 6 (thermal infrared) is acquired at 60 meters but is resampled to 30-meter pixels during Level-1 product generation. The resolution for Band 8 (panchromatic) is 15 meters. All bands can collect one of two gain settings (high or low) for increased radiometric sensitivity and dynamic range, while Band 6 collects both high and low gain for all scenes. Approximate scene size is 170 km north-south by 183 km east-west (106 mi by 114 mi).

Landsat 8 Operational Land Imager (OLI) **and Thermal Infrared Sensor** (TIRS) images consist of nine spectral bands with a spatial resolution of 30 meters for Bands 1 to 7 and 9. New band 1 (ultra-blue) is useful for coastal and aerosol studies. New band 9 is useful for cirrus cloud detection. The resolution for Band 8 (panchromatic) is 15 meters. Thermal bands 10 and 11 are useful in providing more accurate surface temperatures and are collected at 100 meters but are resampled to 30 meters during Level-1 product generation. Approximate scene size is 170 km north-south by 183 km east-west (106 mi by 114 mi). The instruments on Landsat 9 are improved copies of those on Landsat 8.

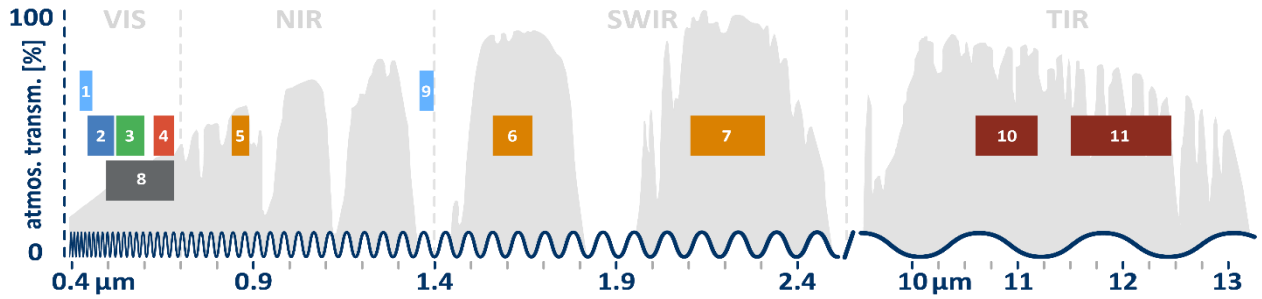

Fig1. Landsat spectral channels.

Fig2. Landsat satellites bands.

Landsat-7 ETM+ Bands (µm)			Landsat-8 OLI and *TIRS* Bands (µm)		
			30 m Coastal/Aerosol	0.435 - 0.451	Band 1
Band 1	30 m Blue	0.441 - 0.514	30 m Blue	0.452 - 0.512	Band 2
Band 2	30 m Green	0.519 - 0.601	30 m Green	0.533 - 0.590	Band 3
Band 3	30 m Red	0.631 - 0.692	30 m Red	0.636 - 0.673	Band 4
Band 4	30 m NIR	0.772 - 0.898	30 m NIR	0.851 - 0.879	Band 5
Band 5	30 m SWIR-1	1.547 - 1.749	30 m SWIR-1	1.566 - 1.651	Band 6
Band 6	60 m TIR	10.31 - 12.36	*100 m TIR-1*	*10.60 – 11.19*	Band 10
			100 m TIR-2	*11.50 – 12.51*	Band 11
Band 7	30 m SWIR-2	2.064 - 2.345	30 m SWIR-2	2.107 - 2.294	Band 7
Band 8	15 m Pan	0.515 - 0.896	15 m Pan	0.503 - 0.676	Band 8
			30 m Cirrus	1.363 - 1.384	Band 9

Image classification refers to the task of assigning classefined in a land cover and land use classification system, known as the schema to all the pixels in a remotely sensed image. The output raster from image classification can be used to create thematic maps. Depending on the interaction between the analyst and the computer during classification, there are two methods of classification: supervised and unsupervised. They both can be either object-based or pixel-based.

Image classification can be a lengthy workflow with many stages of processing. In ArcGIS Pro, the classification workflows have been streamlined into the **Classification Wizard** so a user with some knowledge in classification can jump

in and go through the workflow with some guidance from the wizard. There are also individual classification tools for more advanced users that may only want to perform part of the classification process.

Depending on the interaction between the analyst and the computer during classification, there are two methods of classification: supervised and unsupervised. Supervised classification is where you decide what class categories you want to assign pixels or segments to. These class categories are referred to as your classification schema. After the classification is complete, you will have to go through the resulting classified dataset and reassign any erroneous classes or class polygons to the proper class based on your schema.

Unsupervised classification is where you let the computer decide which classes are present in your image based on statistical differences in the spectral characteristics of pixels. After the unsupervised classification is complete, you need to assign the resulting classes into the class categories within your schema.

Methodology

It is not for nothing that we got acquainted with Landsat satellites and their sensors, bands and classification types above. This information is relevant in our monitoring of surface objects. First, we will download satellite images of the Republic of Uzbekistan, Samarkand region. These images were captured by the Landsat 8.9 satellites. Also, space photos taken in the summer months of 2014 and 2023 will be uploaded to the ArcGis program.

Each image uploaded to ArcGis consists of 7 bands. We can give the original colors to each image uploaded to the program through the **Composite bands** section of the ArcGis program. Then we mosaic the images using the **Mosaic to new raster** operation. After we have equalized the color of the general images, we can cut the Samarkand region we need by the border using the **Clip** section, as shown in **Fig3.**

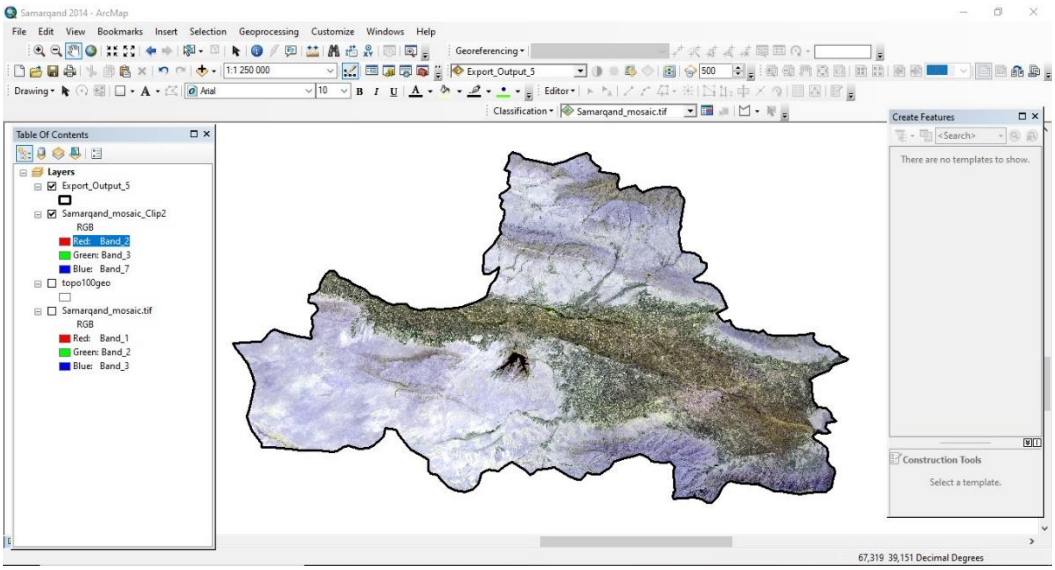

Fig3. A space image mosaiced in ArcGis and cropped along the border

After cutting the area we need, we start the classification process. First of all, we open the **Classification tools** section and select **samples** for water areas, mountains, green areas, crops, mountain snows, dry lands, residential areas, forests in the space image in the **Training center** section. This is called a common signature, and we take it separately for each section and divide it into groups.

This process is detailed in Fig4.

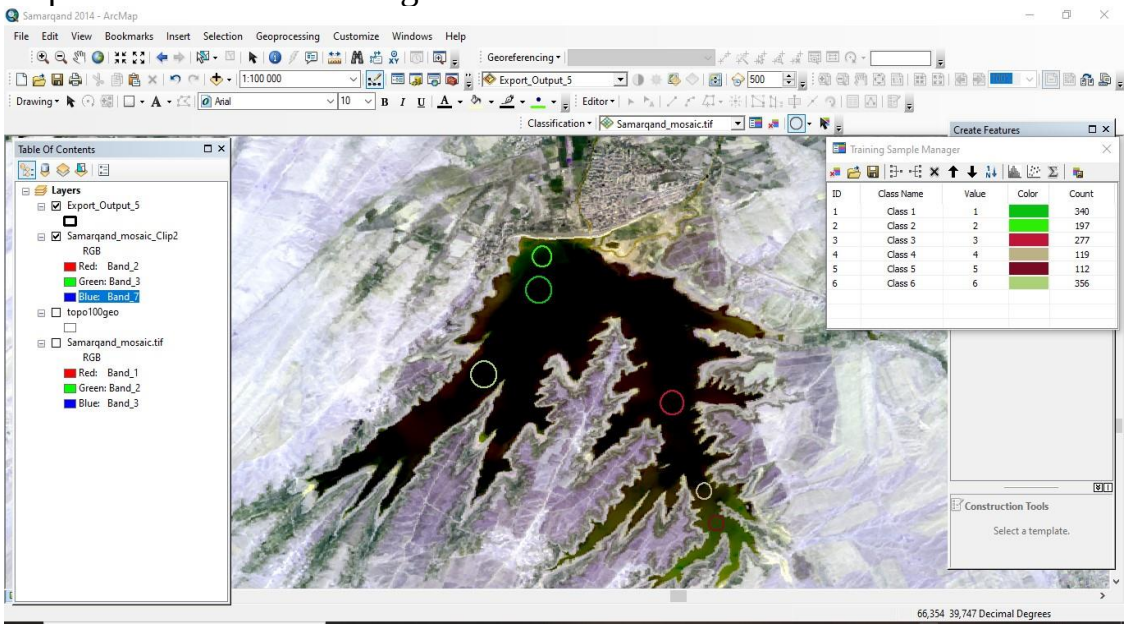

Fig4. The process of sampling

After completing this operation, permission for classification is given by clicking on the **maximum likelihood** section from the **Classification tools** section. Then the program provides us with classified images and colors them according to the groups separated above.

We classify the images from 2014 and 2023 through the same process and identify the changes that occurred between these years.

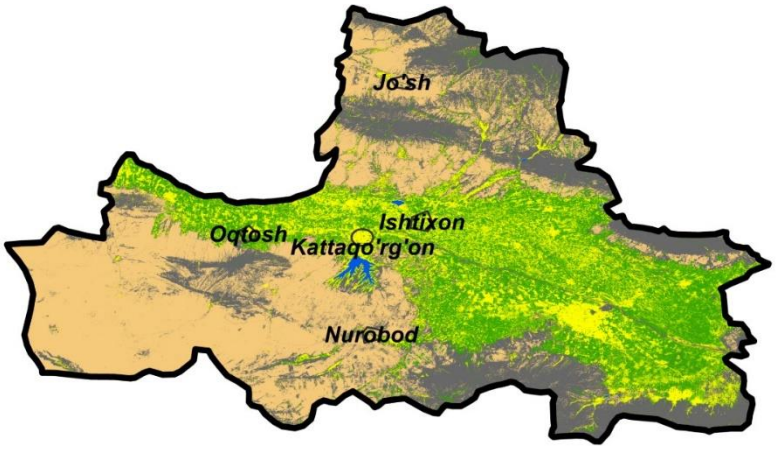

Fig5. Classified space image 2014

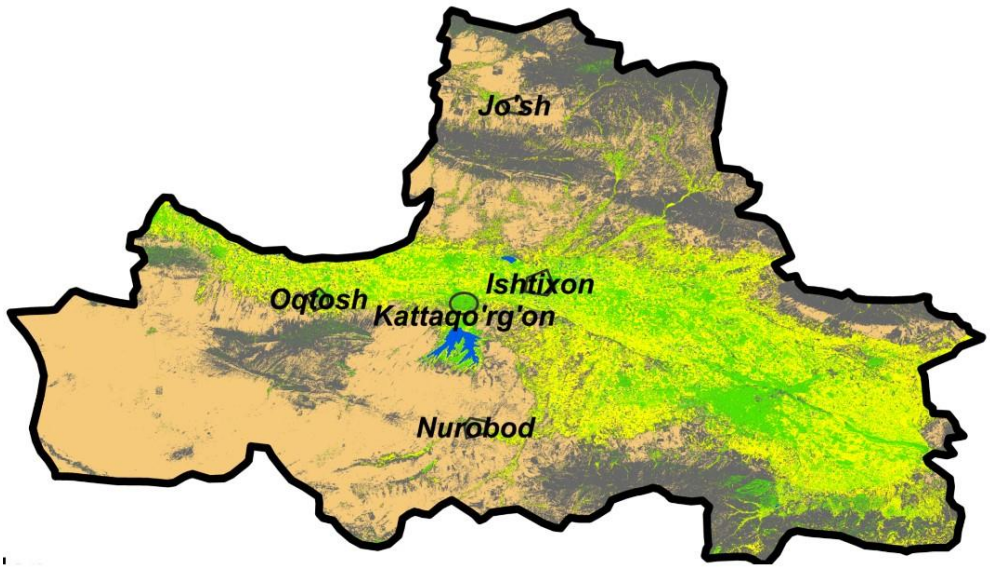

Fig6. Classified space image 2023

Summary

The green areas shown here are crop fields, the yellow areas are residential areas, the dark gray areas are mountainous areas, the light brown areas are dry land, and the blue areas are water bodies. From these classified images, it can be determined that between 2014 and 2023, the population of Samarkand region generally

increased, green areas decreased over the years, and some construction was observed in the lake in the center of the region. Dry lands, hills and mountainous areas in the South-Western and Northern parts of the province remained almost unchanged. In the period until 2023, residential areas have increased and green areas have decreased significantly throughout the regional center.

The results we obtained from this work were appropriate. As planned, the changes of surface objects of the region were monitored and the necessary results were obtained.

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