Research of Regional Environmental Conditions in the East-West Transport Corridor on the Basis of Space Images on the Territory of Azerbaijan

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***Abstract*—A calculation method is provided for the use of satellite imagery in connection with environmental research in the "east-west transport corridor". The results of the calculations are related to the territory of Azerbaijan.**

Keywords—space images, east-west transport corridor, regional atmospheric correction, atmospheric transparency, spectral coefficient of the earth

I. INTRODACTION

Spectrophotometric observations made by Earth's satellites are based on measuring the energy characteristics of solar radiation coming into the "atmosphere-Earth's surface" system. These characteristics are informative carriers of the environment. Continuously through space data: receives optical data from satellites, space database is created, atmospheric correction of satellite data is carried out [1, 2]. In our country, as well as in the "east-west transport corridor", the study of the environment on the basis of regional space images remains a topical issue [3].

Satellite imagery consists of two-dimensional images obtained as a result of remote recording of special reflection radiation by technical means designed to detect objects, identify events and processes. Spatial images - spatial resolution - with the minimum size of objects, spectral resolution - with the number of spectral zones, their width and location according to the electromagnetic spectrum, time separation - with the periodicity of a field, radiometric resolution - with the number of gradations in each spectral zone and caliber are characterized [2, 4].

The processing of space images in determining the optical characteristics of the Earth's surface and atmosphere is a complex, multi-stage and multi-purpose process. A number of special software is used for this purpose. These programs can be used in conjunction with GIS programs. Our main goal is to conduct physical modeling of spectral characteristics of radiation returning to the system "atmosphere - surface ambient layer - background - surface" for the purpose of studying the environment on the basis of satellite images in the "east-west transport corridor" in Azerbaijan.

II. CALCULATION METHOD

Sunlight returning to space from the Earth's surface is subjected to multiple scatterings of light in the "atmosphere - Earth's surface" system (figure 1). The main

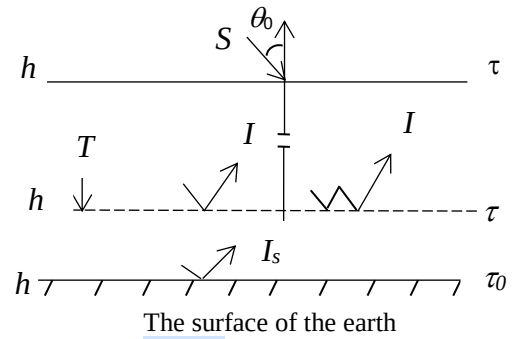

Figure 1. Reflection of light in the "Atmosphere - Earth's surface" system: S_0: Solar constant, I: "Sun radiation returning from the" atmosphere - earth's surface "system, I_{at}: from the atmosphere, I_s : from the Earth's surface, T - transparency of the atmosphere", h - height , τ: optical thickness of the atmosphere, θ_0 : angle of sunlight.

quantities that characterize this radiation are: the transparency and optical thickness of the atmosphere, the spectral brightness coefficient (SBC) of the earth's surface [2].

Since energy is an additive quantity, the intensity of the reflected radiation from the earth's surface h or the optical thickness of the atmosphere τ can be expressed as follows:

$$I(\tau_\lambda;\mu_0,\mu)=I_{at}(\tau_\lambda;\mu_0,\mu)+ I_s(\tau_\lambda;\mu_0,\mu) \quad (1)$$

Where $\mu_0=\cos(\theta_0)$, $\mu=\cos(\theta)$; θ is the angle of scattering of light.

If we determine the radiation reflected from the earth's surface at any height h, then at this height $I(\tau_\lambda, \mu_0, \mu)$ returning from the atmosphere remains intact. This quantity is calculated as the solution of the atmospheric correction problem [2, 4].

Radiation returning from the "Atmosphere - Earth System" can be determined as follows, depending on the values of t - optical thickness [2]:

$$I(\tau;\mu_0,\mu)=F\rho(\tau;\mu_0,\mu)\mu_0 . \quad (2)$$

Here $\rho(\tau_\lambda, \mu_0, \mu)$ is the SBC of the "Atmosphere - Earth's surface" system. As can be seen from (2), the reflected radiation depends on the directions of sunlight and the observation point, in addition to the values of optical thickness. Will be set by us for the following values of atmospheric transparency:
for incident radiation:

$$T^{\downarrow}(\mu_0)=exp(-\tau/\mu_0), \quad (3)$$

for returning radiation:

$$T^{\uparrow}(\mu)=exp(-\tau/\mu) . \quad (4)$$

The distribution of radiation characteristics of the "atmospheric-terrestrial" system on the basis of the processing of space images related to the "east-west transport corridor" in the territory of our country is determined below. In space images, the coordinates of the pixels of the cross section of the space images are determined in the form of a DNij matrix. DNij raster images are called primary (raw) data [1, 5]. For the processing of this data, we use the software package MATLAB (matrix laboratory), which is used to solve technical computational problems [6].

III. RESULTS OF CALCULATIONS

The distribution of radiation characteristics of the "atmospheric-terrestrial" system on the basis of the processing of space images related to the "east-west transport corridor" in the territory of our country is determined below. In space images, the coordinates of the pixels of the cross section of the space images are determined in the form of a *DNij* matrix. *DNij* raster images are called primary (raw) data [1, 5]. For the processing of this data, we use the software package MATLAB (matrix laboratory), which is used to solve technical computational problems [6].

To evaluate the transparency of atmospheric air was carried out using the following formula:

$$T_{ij}=\pi DN_{ij}/S_{i0}\mu_0 \quad (5)$$

In the visible region of the spectrum, based on the formula (5), the values of the Earth's surface area SBC at the approximation of the Lambert surface are determined as follows:

$$R_{ij} = 1-T_{ij} \quad (6)$$

In formulas (3) and (4), the optical thickness of the atmosphere is calculated according to the graph we constructed [2], given in figure 2.

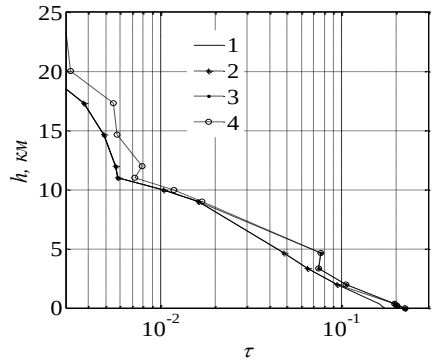

Figure 2. Vertical profiles of optical thickness of the atmosphere in the territory of Azerbaijan: 1 - average profile, 2, 3 and 4 -: daily (2), daily and seasonal (3), daily, seasonal and average annual (4) variations of optical thickness according to height.

Figure 3 shows a section of a spatial image of the “east-west transport corridor” in Azerbaijan.

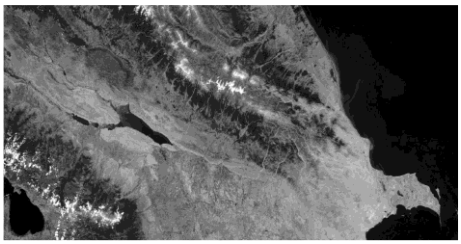

Figure 3. Section of space image to “east-west transport corridor” in the territory of Azerbaijan: A2005162.1010.250m _ Terra MODIS_ Bands 1-4-3 _true color [7].

Figure 4 calculates the brightness of the area given in figure 3. As can be seen from this picture, the territory of the Republic of Azerbaijan differs sharply in its diversity: the brightness of the mountainous areas is greater than that of the plains around the Absheron Peninsula and other Kura rivers.

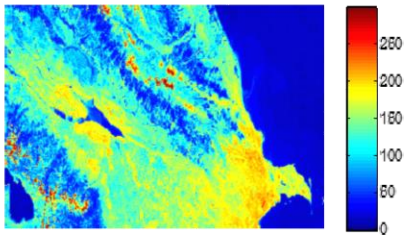

Figure 4. Brightness of the territory of the "east-west transport corridor" in Azerbaijan.

Figure 5 shows the transparency of the atmosphere and the distribution of the surface area SBC in the "east-west transport corridor" in the territory of our country. Figure 5a shows that the relief diversity of our country affects the background of the distribution of atmospheric transparency. This effect is more pronounced in the distribution of the Earth's surface area SBC. Thus, changes in the earth's surface can be accurately and quickly identified by satellite imagery in the "east-west transport corridor".

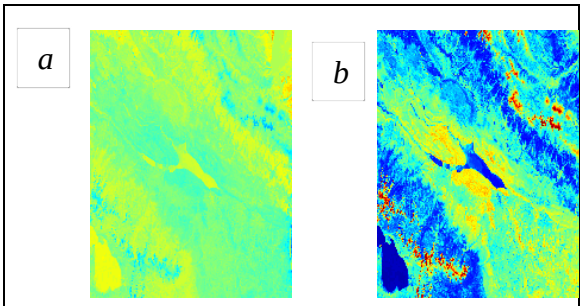

Figure 5. a - transparency of the atmosphere, b - surface area SBC.

IV. CONCLUSION

In Azerbaijan, on the basis of satellite imagery in the "east-west transport corridor", a calculation method has been provided for the study of the environment and the operative investigation of possible changes in this area. A regional optical model of the atmosphere was used to make the calculations. As a result of the calculations, the vertical profiles of atmospheric transparency and the SAA of the earth's surface cover are determined in the "east-west transport corridor".

REFERENCES

[1] GIS-Lab: Processing of data remote sensing (https://gis-lab.info/start.html) (in Russian).

[2] Ismailov F.I. Atmospheric aerosol. LAP LAMBERT Academic Publishing,, 2019. – 288 c. ISBN: 978-613-9-45431-0.

[3] East-West Transport Corridor - ADY Express. https://wvvw.adyexpress.az/en/transport-corridors/east-west (in Azerbaijani).

[4] A.M. Chandra, S.K. Gosh. Remote sensing and geographic information systems. Moscow, Technosphere, 2008, p. 82-84.

[5] Geographic information systems and remote sensing Electronic resource]. - Access mode: http: //gislab.info/qa/ndvi.html.

[6] Дьяконов В. Р. A guide to using the PC MATLAB system. - М .: «Физматлит», 1993. - 112 с. - ISBN 5-02-015101-7.

[7] NASA Visible Earth: Caspian Sea. MODIS Atmosphere: Images (http://modis- atmos.gsfc.nasa.gov/IMAGES/index.html).