

Analysis of the anthropogenic influence on the territories of metropolitan areas with the use of remote spectrophotometry

Detailed study of the dynamics of landscape structures of metropolitan areas allows to solve the problems of optimal management of the city, reduce the impact of anthropogenic factors on the ecological condition associated with pollution of the Earth's surface, water and air.

The study of terrestrial landscapes with the use of remote sensing in the infrared range enables thematic thermal mapping of the territories and can determine the natural and anthropogenic factors that contribute to the formation of the contrast of the soil's surface temperatures. Remote determination of the heterogeneity of the temperature of landscape structures requires finding the contrasts of the brightness of aerospace images of territories in the infrared spectrum range. The temperature fluctuations of the structural components of the landscapes depend on the season, time of day, physical and chemical properties of soils and the radiating capacity of structures of natural and anthropogenic origin. Creation of thematic thermal maps of urban territories requires a detailed study of the contrast of images obtained by remote sensing at different wavelengths in the thermal range of the electromagnetic spectrum.

We can find the contrast of temperature with the help of the measured change in the brightness of cosmic images of the earth's surface.

$$\left(\frac{\Delta T}{T}\right) \approx \frac{\lambda T}{c_2} * \left(\frac{\Delta b}{b}\right) \quad (1)$$

Thus, by measuring the variation of brightness in the aerospace images, we find an approximate contrast of the temperature of different structures in the territory of anthropogenic landscapes. The level (magnitude) of temperature contrasts can have a natural and anthropogenic character and characterize the change in the natural properties of landscapes. The ambient temperature at the time of space photography is determined from ground observations. Application of formula (1) to space images of large cities of Ukraine:

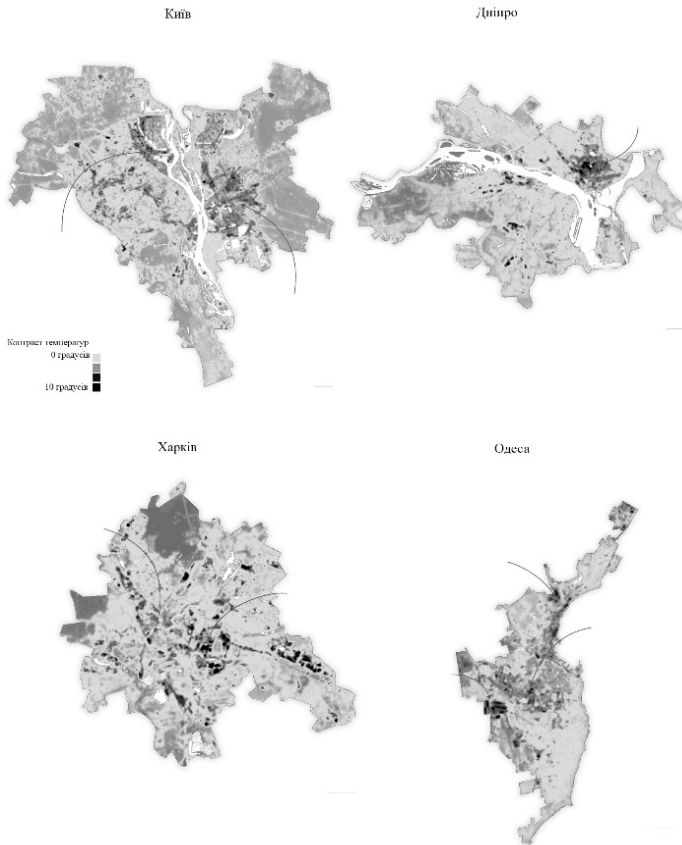


Fig. 1 Temperature contrasts of the large cities of Ukraine

From the analysis of the given images of territories of these cities it follows that the greatest anthropogenic influence is carried out by constructions of thermal power plants, residential areas, built in the 60-80s of the XX century, thermal power plants, seasons, and spatial features of how those cities were constructed. According to formula (1), the temperature contrasts of metropolitan areas that are based on the processing of infrared space images are calculated, and the main results are presented in table 1.

City	Date	Temperature contrast $\left(\frac{\Delta T}{T}\right)$	Accuracy
Kyiv	June 23, 2019	91% (Darnytsia CHP)	$\pm 2\%$

Kharkiv	August 18, 2019	87% (KHTZ plant)	±2%
Dnipro	August 5, 2019	94% (Interpipe plant)	±2%
Odesa	August 3, 2019	96 % (Railway yards)	±2%

Table 1. Measured temperature contrasts of the landscape structures of the large cities of Ukraine

Using the data of space spectrophotometry, a quantitative analysis of the influence of anthropogenic factors on the properties of the landscape structures of metropolitan areas has been carried out. The function of transformation of landscapes is introduced, which is determined using the correlation of the coefficients of the brightness of the landscape structures. The value of the function $q(\lambda, t)$ lies in the range from -1 to 1 and characterizes the change in the albedo of the territories of metropolitan areas. It is shown that remote sensing in the thermal (infrared) range of electromagnetic waves has its own characteristics, because they characterize the proper radiating ability of landscape structures. The criterion for the influence of anthropogenic factors in this range is the contrast of temperatures. Using the images of the territories of large cities of Ukraine in the thermal part of the spectrum that were taken by Landsat satellites, the value of temperature contrasts with respect to the ambient temperature has been found. The value of contrasts depends on the ratio of the areas of the landscape structures of metropolitan areas.

References

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