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***Research Article***

# ANALYSIS OF AIR QUALITY USING BIOINDICATION METHODS (ON THE EXAMPLE OF THE TASHKENT REGION OF UZBEKISTAN)

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**ABSTRACT**
The article analyzes the possibilities of applying the bioindication method to assess the quality of atmospheric air in Uzbekistan. Based on field survey materials, digital maps of zoning of the Tashkent region of Uzbekistan on the degree of air pollution have been developed. The main sources of air pollution are industrial emissions and transport. Recommendations were developed for stabilizing the ecological situation in the region and improving the quality of life of the population.

***Keywords****: monitoring of environment, bioindicator methods, GIS technology. remote sensing*

## INTRODUCTION

The problem of air pollution occupies an important place among the environmental problems in our country. Sources of air pollution can be divided into two categories: natural and man-made. For Uzbekistan, the main natural sources are dust storms and weathering. In recent decades, the removal of salts and dust from the dried bottom of the Aral Sea has played an increasingly important role. Figure 1 presents a space photograph of the Aral Sea, on which plumes of dust storms are clearly visible. An example is the dust storm that passed through the region on June 14, 2019. Wind speed reached 23 m/s. Visibility dropped to zero (Fig. 2a). The streets of Nukus were covered with a layer of sand and salt (Fig. 2b).

**Figure 1: Dust storms on the Aral**


**Figure 2: Dust storm on Aral, Nukus**

The relevance of the study: it is possible to determine by the method of bioindication the Scots pine (Pinus silvestris) needles response to the complex environmental factors of the urban environment that is essential to determine the degree of suppression of certain trees. According to the degree of depression of Scots pine, it is possible to assess the degree of air pollution.

Objective: to conduct a bioindication of air pollution in the city of Tashkent on the life situation of the Scots pine.

Statistical analysis allowed to reliably establish the relationship between the level of air pollution and diseases such as lesions of the upper respiratory tract, heart failure, bronchitis, asthma, pneumonia, pulmonary emphysema, as well as eye disease (Smurov A.V.,2013). A sharp increase in the concentration of impurities that persists for several days increases the mortality of the elderly from respiratory and cardiovascular diseases.

In Uzbekistan, as in many other countries, motor transport is the main air pollutant. In almost all cities with a population of over 1 million people, environmental ill-being is estimated as “the highest” and “very high” (Alikhanov et al., 2008 a), Alikhanov et al., 2008 b). Although the amount of emissions of harmful substances into the atmosphere from motor transport has decreased per unit of motor transport in comparison with 1991, an increase in the production and operation of motor transport in the republic leads to a steady increase in air pollution. If we consider that the number of motor vehicles in Uzbekistan increases annually by 10%, the relevance of research on the analysis of the state of atmospheric air in the republic is beyond doubt.

## MATERIALS AND METHODS

When solving problems of environmental monitoring of the environment, it is advisable to involve modern information technologies and materials of space surveys (Kurbanov 2018). The most important qualities of the data used in the decision-making process are their relevance, completeness and objectivity. Remote sensing data has all these qualities. They contain all the information about the area within their resolution and coverage, a continuous field of information on the entire coverage and individual features of each object (Kurbanov 2005). Also, remote sensing allows you to get the most relevant information in time, which is especially important for conducting a situational analysis in order to develop an optimal solution (Kurbanov 2003).

High-resolution multispectral space images open up new and wider possibilities for analyzing atmospheric air by analyzing the state of vegetation cover and applying the bioindication method. One of the most popular software packages ArcGIS provides ample opportunities for the implementation of integrated GIS projects. ArcGIS contains a block of programs for the use and processing of Earth remote

sensing materials. One of these software systems is ERDAS IMAGINE. One of the ERDAS IMAGINE units is a sub-pixel classification unit.

Experimentally, we analyzed space images of QuickBird. In this case, four spectral ranges were used for the analysis: red, green, blue, and near infrared. Experiments have shown that the attraction of a layer with a near infrared spectrum significantly improves the interpretation procedure, increasing the gradation of the state of vegetation in the study area, including trees. Figures 3 and 4 show an example of the sub-pixel classification of the space images of QuickBird. In fig. Figure 3 shows a snapshot using four channels, including near infrared. In fig. 4 shows the result of automated decryption using four channels. Blue color indicates areas with a very good state of vegetation cover (trees). Blue color indicates areas with good tree condition. Yellow highlighted areas with a satisfactory condition of the trees. Orange color indicates areas with unsatisfactory condition of trees. Red color indicates areas with extremely unsatisfactory condition of trees. As the image analysis showed, the attraction of the near-infrared channel allowed us to conduct and obtain more detailed information about the state of vegetation.

In fig. 5 shows an example of processing a space image of a forestland by the sub-pixel classification method. The upper image shows a space image of the forest, and the lower one shows the result of subpixel classification. As can be seen from the analysis of the image, the results of the sub-pixel classification make it possible to assess not only the state of the forest as a whole, but also each tree individually. It is noteworthy that the unsatisfactory (orange colors in Fig. 5) and the extremely unsatisfactory (red colors) state of the trees are noted along the road. This was due to the negative impact of car exhaust on trees.

**Figure 3: The QuickBird space image. Pass Kamchik.**

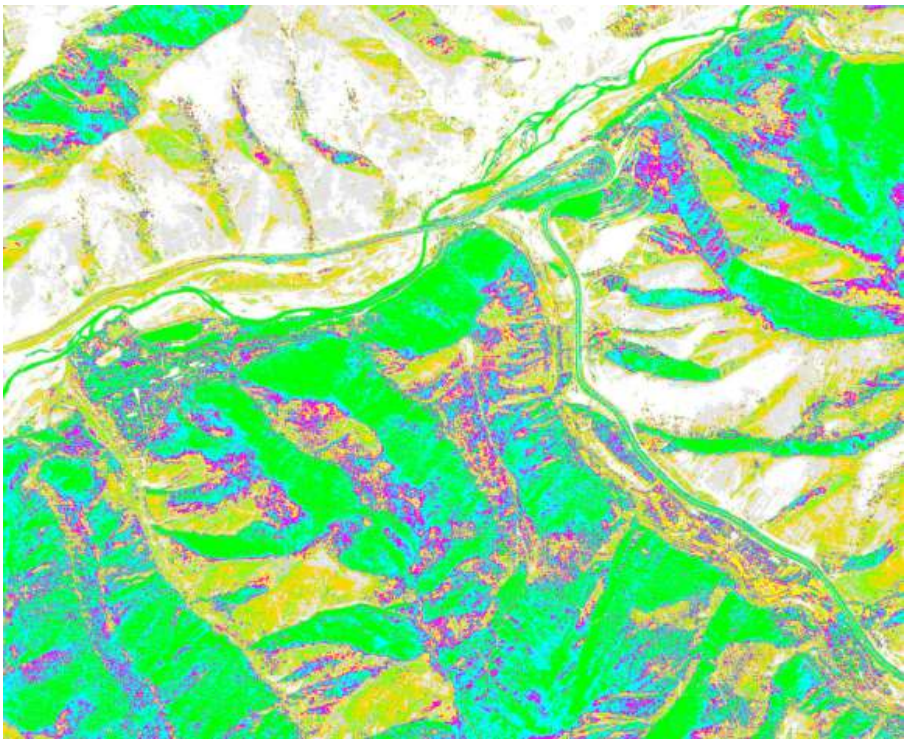

**Figure 4: Example of subpixel vegetation classification by high resolution multispectral satellite images. Kamchik pass.**

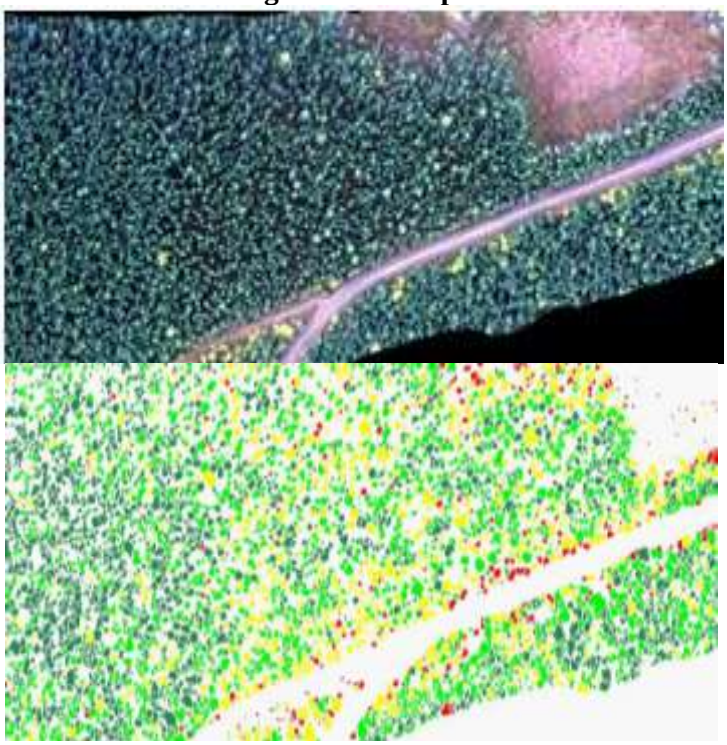

**Figure 5: An example of processing a satellite image of a forest area by the sub-pixel classification method**

Consequently, the processing of multispectral remote sensing materials by the sub-pixel classification method can serve as additional information and contribute to a more complete assessment of the degree of air pollution.

For a more detailed analysis of the degree of pollution of the atmosphere, a bioindication method was used.

The main objective of bioindication is the development of methods and criteria that would adequately reflect the level of anthropogenic impacts, taking into account a complex nature of pollution and diagnose early infringements in the most sensitive components of the biotic community. The bioindication, like the monitoring, is carried out at different levels of the biosphere organization: macromolecule, cell, organism, population, biocenosis (Rosenberg, 1994) that the use of bioindication method allows solving environmental monitoring problems in cases where it is difficult or inconvenient to measure directly the aggregate of factors of anthropogenic pressure on the biocenoses.

Thus the bioindication can be defined as a set of criteria and methods designed to search for informative ecosystem components which could:

• adequately reflect the level of exposure to the environment including integrated nature of pollution, taking into account synergies phenomena of the operating factors;

• diagnose early disturbances in the most sensitive components of the biotic communities and assess their importance for the entire ecosystem in the nearest and distant future.

To date, it is accumulated enough information about the indicator role of woody plants. First of all, it is linked with influence of contaminants on the leaf apparatus due to capacity of leaves to precipitate the largest quantity of impurities through the air.

The bioindication methods for environmental assessment allow realizing an integrated assessment of "environmental health" which in the most general sense refers to the state (quality) of the environment necessary to human health and other living creatures.

In the environment there is often not one but several toxic components. Whereby a synergism occurs quite frequently in their effect on living organisms, in which the total effect is greater than the action exerted by each component separately. In other words, the concentration of each individual component of the pollutants complex fixed by means of physico-chemical methods may seem harmless to living organisms, while their cumulative impact is threatening.

This synergism is not considered by physical and chemical methods of environment pollution studying, but it is determined by using bioindication.

Certainly, biomonitoring does not substitute and does not force out physical and chemical methods of environment conditions research. However its use allows to increase significantly the accuracy of forecasts for the shifts in the ecological situation caused by the human activity.

We conducted researches on the analysis of the atmospheric air pollution by the bioindication method according to results of the field inspections which are carried out in 2012-2015 in the 18 settlements of the Tashkent region of the Republic of Uzbekistan.

The scaling was carried out according to the technique proposed (Andreyeva *et al.*, 2002). Thus the extent of influence of atmospheric air in a varying degree of pollution was estimated under the WHO's recommendation. The assessment of level of pollution of the atmosphere was carried out by the bioindication method depending on a damage rate of pine needles.

Table 1 shows the scaling system used to assess the level of air pollution

**Table 1: Scaling levels of air pollution depending on changes in the morphology of the Scots pine needles (*Pinus silvestris*) and the human organism state in this situation**

| Air pollution levels | Morphological characters (by E.N. Andreeva) of pine needles | Status of the human body according to WHO's experts |
|---|---|---|
| I. Acceptable or not contaminated | I. Needles without apparent visual spots and some points that are only visible under the microscope, its damaged area does not exceed 5-15% | I. Relatively safe state |
| II. Weak or low pollution | II. Few spots of chlorosis or necrosis on the needle, damaged area of 15-25% | II. Functional changes that do not exceed the norm |
| III. Increased pollution | III. Large quantity of yellow or black spots of chlorosis or necrosis on the needle, including on the entire width of needles, damaged area of 25-40% | III. Functional changes that exceed the norm |
| IV. Heavy contamination | IV. Large chlorotic or necrotic spots. The needle tip damaged by necrosis (8-10mm) are brightly colored tones from gray-green to brown and red-brown, needles damaged area of 40-60% | IV. Increased morbidity |

One of the advantages of using GIS is the ability to analyze the cartographic information with the attributive information which allows conducting more in-depth and comprehensive analysis of the territory.

Based on the collected materials for field surveys it was created a database which was docked to the digital map of zoning. In this case, when you specify the location on the map it is loaded an attributive information on this item from the database.

It was found that the needles of Scots pine is most sensitive to air pollution, that is why this plant is included in the main list of vegetable bioindicators of air pollution level. The hypersensitivity of needles is related to a long needle life, an active gas absorption, as well as a decrease of needle mass, the conifers are convenient because they can serve as bio-indicators all year around. In addition, Scots pine (Pinus Silvestris) is a fairly common plant in Tashkent and other cities of Uzbekistan, unpretentious to the local climatic conditions and soil moisture. The total emissions of pollutants into the atmosphere from stationary and mobile sources in Tashkent characterize the overall anthropogenic load on the air. The trend of reduction of the pollutant emissions into the atmosphere observed in recent years is explained by some decline in production of certain sectors due to the reform and reconstruction of industrial enterprises.

We evaluated the impact of atmospheric pollutants on the Scots pine growing in different parts of the city of Tashkent.

As it has been observed, in the main cities of Tashkent region, pine needles should normally vegetate during 3-4 years in the contaminated ambient air having a "memory" of its needles reaction reflects the pollution over a long period on the needles, we have not once seen with atmospheric pollution appear dying sites (necrosis, chlorosis), by the degree of presence or absence of which we determined the level of air pollution.

In order to more thoroughly study the transport of air polluting components, a three-dimensional model of the territory of the Tashkent region was developed. Statistical materials and wind roses of the studied region were brought to the analysis. Figure 6 shows the three-dimensional mobility of the Tashkent region.

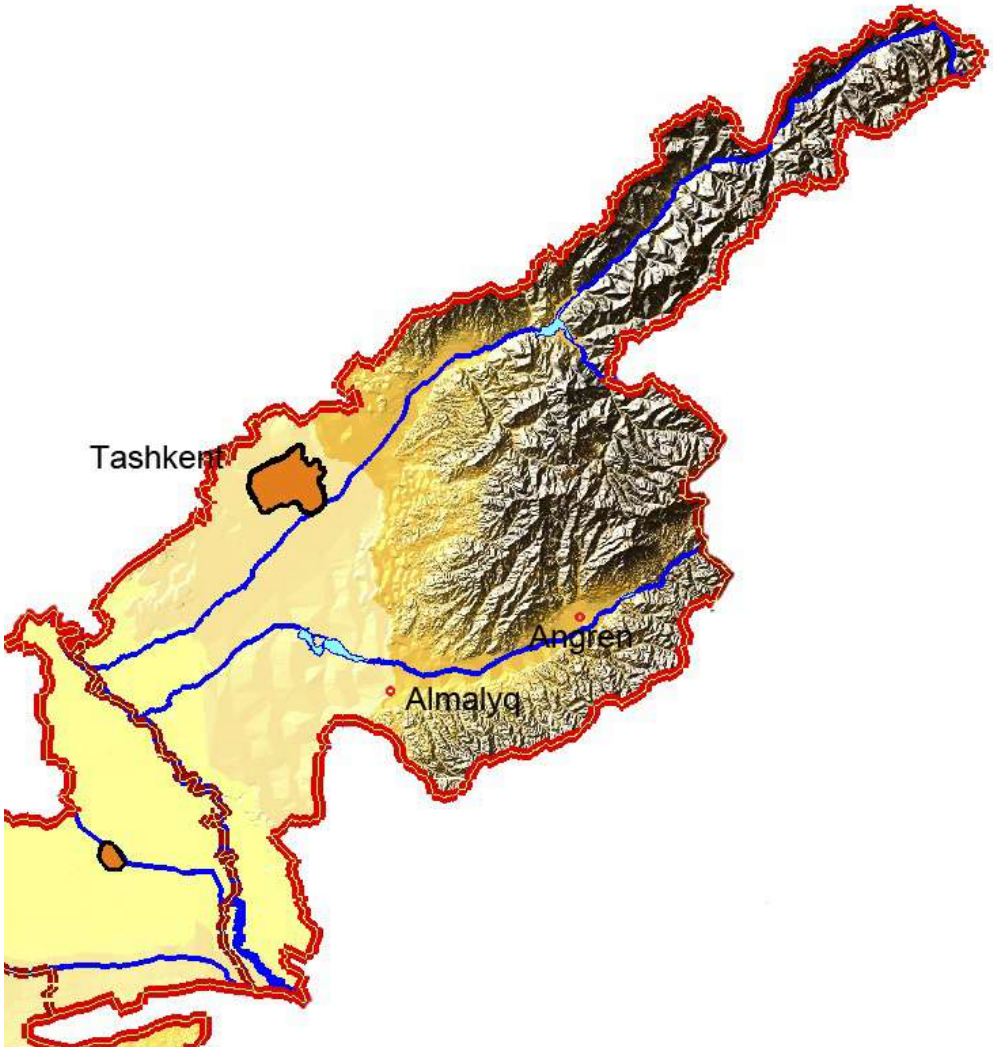


**Figure 6: Three-dimensional mobility of the Tashkent region.**

**RESULTS**

On the basis of the analysis of the field examinations results conducted on the studied region in the ArcGIS environment, it is elaborated a digital zoning map of the Tashkent region territory to define a degree of the atmospheric air pollution with help of the bioindication method (Figure 7).

Zoning was carried out on a scale assessing the level of air pollution (see Table 1).

On the surveyed settlements in the numerator it is specified a category in which this settlement is included, and in the denominator a percent of the damaged needles. To develop the digital card, it is necessary to consider a wind rose. The analysis of the wind rose showed that on the average in Almalyk west-east transfer prevails in a year, and in Angren the south-west and north-east transfer prevails. Thus

the components polluting the atmosphere from Almalyk can get Angren and vice versa. In other settlements the role of the wind rose is insignificant.

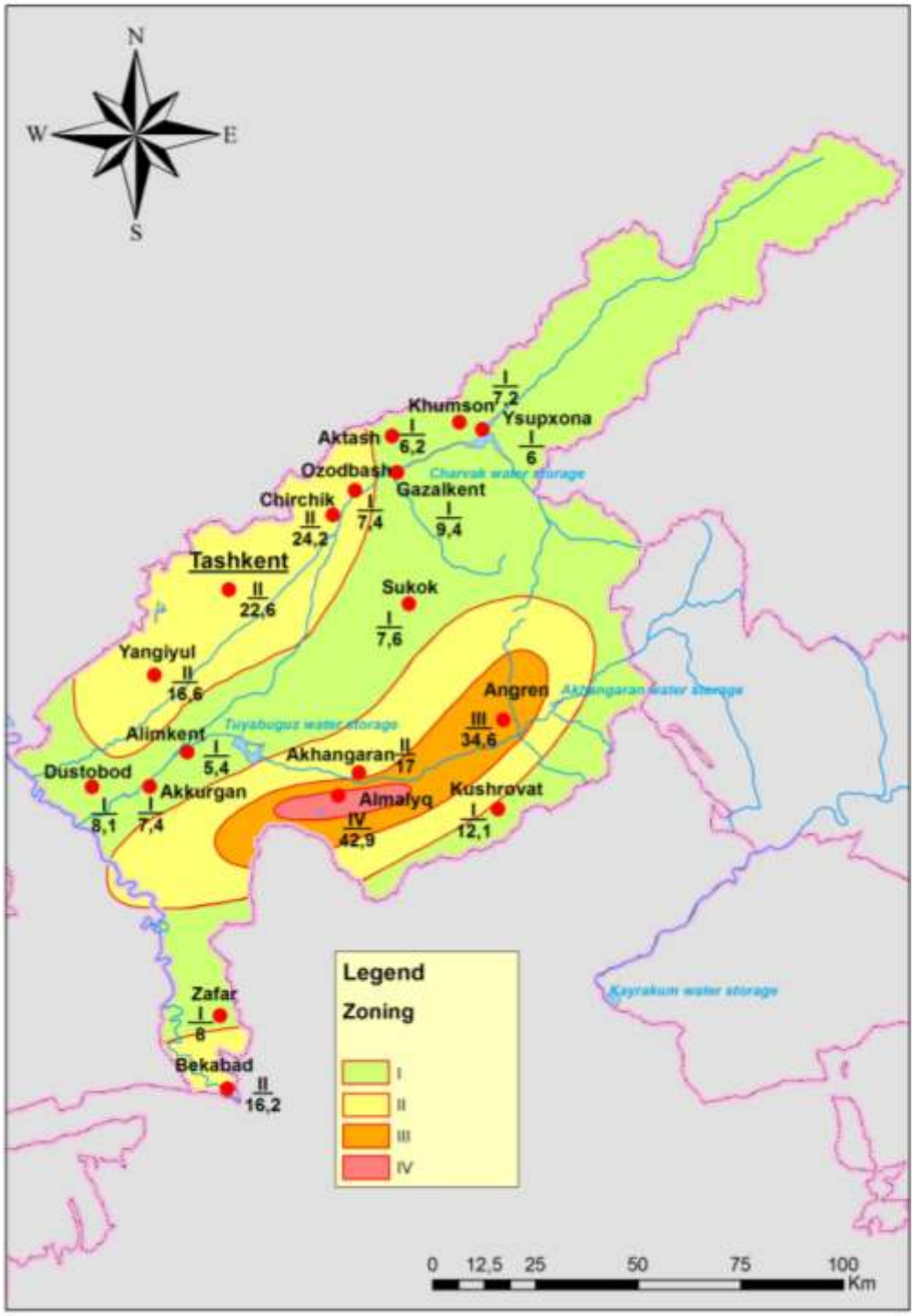


**Figure 7: Map of ecological zoning of the territory of the Tashkent region by the degree of air pollution**

Similar studies were conducted in 2015-2017 in 18 settlements of the Fergana region (Kurbanov, Askarhodzhaev, 2017).

## DISCUSSION

The use of multispectral high-resolution satellite images with the involvement of the near-infrared channel made it possible to obtain more detailed information on the state of vegetation, in particular trees.
An analysis of the ecological zoning map of the Tashkent region, taking into account the terrain relief, showed that the territories with the most polluted atmospheric air are located in the flat and foothill belt, where there are large industrial facilities. The cleanest air is found in mountainous areas. The cities with the most polluted air in the Tashkent region are Angren and Almalyk.
Summing up the research, it can be stated that the main sources of air pollution are industrial emissions and transport. In this regard, the following proposals are made:
1. The fight against atmospheric pollutants should be conducted primarily in the direction of greening production.
2. Measures taken in industry must be reduced to the improvement of technological processes, the introduction of new ones and the improvement of the effectiveness of existing dust removal and gas cleaning plants, the elimination of pollution sources.
3. The main measures to reduce air pollution from transport emissions are to improve the quality of fuel, search for alternative types of it, replace internal combustion engines with environmentally friendly ones, introduce analyzers, and renew a fleet of vehicles, especially trucks and buses.
The implementation of these proposals will contribute to the stabilization of the environmental situation in the regions and the improvement of the quality of life of the population.

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