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ALGAE CHLOROPHYLL FLUOROMETRY AND OTHER METHODS IN MONITORING OF THE WATER RESOURCES OF A TECHNOGENICALLY TRANSFORMED REGION IN EASTERN UKRAINE

The system for monitoring water resources currently under development in the Donetsk region of eastern Ukraine is described.The use of algae chlorophyll fluorometry is discussed together with other test methods.

Keywords: chlorophyll, fluorometry, water monitoring.

Donetsk region of Eastern Ukraine contains several major industrial agglomerations with large metallurgical plants, coal mines, etc. which generate serious technogenical load on the environment. This situation raises critical issues on monitoring of all components of ecological hazard. Particularly, one considers the pollution of waters. The similar problem in Europe has resulted in a creation of special water monitoring systems intended for detecting the hazardous events and generating early warnings to minimize the damage. The information provided by such systems also makes it possible to develop the mathematical models of pollution propagation in river basins, which are useful for the forecasts of the situation. The solution of this problem is the establishment of a network of test points and stations distributed over a particular river basin or a whole region. The samples periodically taken at these points are analyzed by several techniques to get the information of the water quality and possible origins of pollutions. These tests may be performed automatically by means of special equipment installed at remote measuring stations, with subsequent transfer of the data to the central server. Such networked monitoring systems already exist in the states of the European Union and have proved their value and efficiency [3]. Indeed, the creation of such a system is very expensive, it should be carefully planned. First, it is reasonable to establish a network of test points for periodical water sampling with subsequent laboratory analysis to generate an optimized concept of a future automatic monitoring system.

Such project is currently in progress at Donetsk National University in the framework of the State Program for University Science of Ukraine (Contract NU/6-2011). The project has the following goals:

1) development of the network of test points;

2) implementation of several analytical methods including bioindication;

3) creation of the concept for optimal layout of the automatic monitoring system;

Development of application-specific measurement equipment and software is also carried out in the framework of this project. This report deals with the initial objective of the project, the development of test points network together with the choice of the set of analytical methods.

First, a typical water resource, which concentrates all pollutants and represents general trends of the ecosystem self-regeneration in a technogenically transformed conditions, should be chosen to determine an integral effect of pollutions [1, 2]. The Kalmiusriver, the main water stream of the city of Donetsk is chosen as such representative resource. The layout of the water monitoring system is based on the known principles already proven in existing monitoring systems of the European Union, operating in the framework of the EU Water Directive [3]. This is one of first monitoring systems of such kind in Ukraine.

The water monitoring system currently under development in the Donetsk region of Ukraine contains 82 test pointsgrouped into base and supplemental network. Some of these points are shown in Fig. 1. The tests at base network points are regularly performed every 10days, those at the

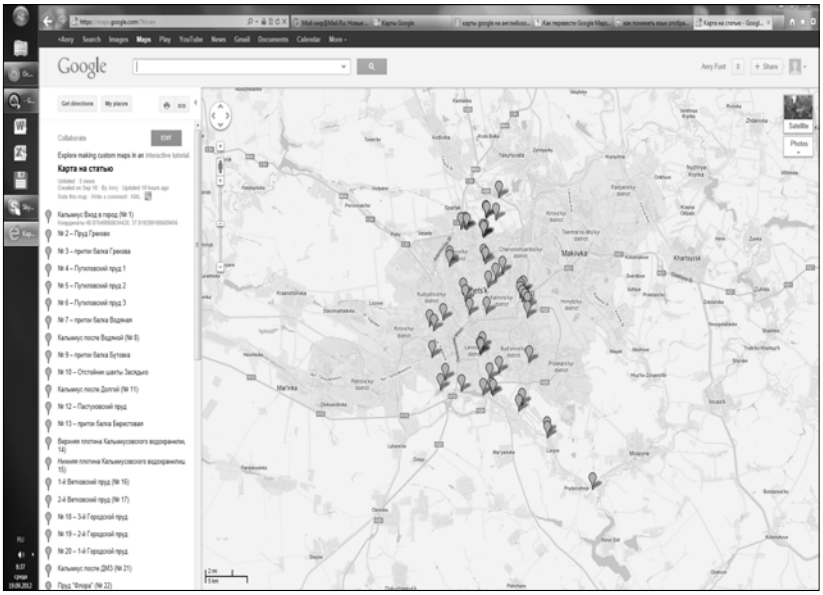


Fig. 1. Location of some test points within Donetsk city

supplemental points within the city of Donetskare done every month, and the supplemental points placed within the Donetsk region are examined once per season. The base points are positioned within the Donetsk City to monitor the water state near the major pollution source, the industrial objects and community wastewater outlets as well. The supplemental monitoring scheme also covers the pollution sources of different nature, together with water reservoirs and streams of various functions, from recreation ponds to wastewater storage of industrial objects. Finally, there are some reference points in the region, chosen in relatively clean environment. These points are needed to generate the basis for comparison of waters affected by environmental factors of different strength.

The tests performed on each water sample include the following:

1) hydrochemistry;
2) microscopy;
3) spectrophotometry;
4) chlorophyllfluorometry.

Let one discuss in detail the latter, the method of fluorometry, which reveals such information as chlorophyll content and state of the photosynthetic systems in phytoplankton [4]. The experience currently gained during the development of water monitoring systems in various states of the European Union,particularly to fulfill the goals of the EU Water Directive, reveals that the convenient physical and chemical tests alone are not sufficient for reliable detection of ecological hazards. Now the significant part of water quality monitoring consists of various bioindication and biotesting techniques.Single celled algae are recognized as very sensitive and fast responding bioindicators. There exist quite flexible and simple methods for obtaining the bioindicationinformations from them. Chlorophyll fluorometry is a method revealing the response of the photosynthetic system at the molecular level, it is the reason for its wide application in biomonitoring systems.

This method is currently implemented in our project using the Walz PHYTO-PAM algae fluorometer (compact version), which is intended for both the laboratory and field measurements. This instrument utilizes the method of pulse-modulated spectral fluorometry with four wavelengths of measuring light (470, 520, 645 and 665 nm) as well as saturation pulses at 655nm. Such excitation allows one to differentiate several algae classes and, hence the monitor of the phytoplankton variations under the influence of various environmental factors.

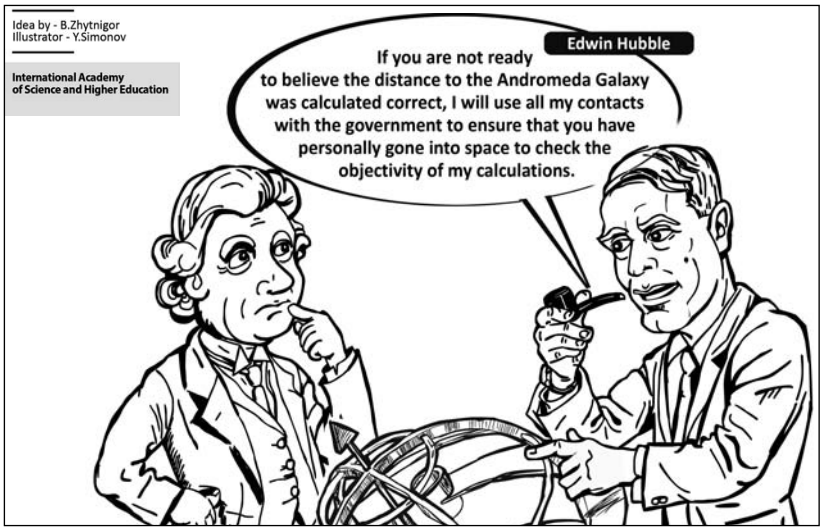
The fluorometryof native water samples is the fast and informative method of determination of the chlorophyll content, but it is indeed considered a semi-quantitative one and needs a calibration by several other techniques. Therefore the described monitoring system also incorporates the microscopic determination of algae cell counts for different classes and measurement of chlorophylls and other pigments contents by spectrophotometry of sample extracts. The photometric analysis of algaeextracts is performed according to the standardized techniques and provides the following content data:

1) chlorophyll*a*;
2) chlorophyll*b*;
3) chlorophyllc_1+c_2;
4) yellow substance;
5) pheophytin*a.*

Also the followinghydrochemical tests of water samples are carried out to take into account the effects of the environment on the fluorometry results:

1) pH;
2) various nitrogen forms (NH_3, nitrites, nitrates);
3) phosphates;
4) synthetic surface – active compounds;
5) phenolic acid.

The samples are taken observing the specific requirements for respective tests. The tests are carried out at the dedicated laboratory of the Donetsk National University. The further development of this monitoring system foresees the creation of the network of automated test stations and implementation of the methods of automated data acquisition and analysis.



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