ISSN NO: 2770-2936
Date of Publication:14-10-2023

Assessment of Surface Water and Estuarie Quality and Soil Condition Monitoring

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Summary: Assessing the quality of surface waters and estuaries and monitoring soil health are critical to monitoring and maintaining the health of aquatic ecosystems and ensuring sustainable land management practices. This involves the assessment of various parameters, such as chemical composition, physical characteristics and biological indicators, to determine the overall condition and potential impact on human health and the environment.

Key words: Surface water quality assessment, estuary monitoring, soil monitoring, water pollution, ecosystem health, land use practices

The ecological characteristics of the quality of surface waters of land and estuaries (widened fan-shaped river mouths) of Ukraine are presented in in accordance with the ecosystem principle. Its objectivity is ensured by a wide range of indicators that characterize the abiotic and biotic components of aquatic ecosystems.

A set of indicators for assessing the quality of surface waters is formed by general and special indicators. General indicators include indicators of salt composition and trophosaprobic water (ecological and sanitary indicators). They characterize common ingredients characteristic of aquatic ecosystems, the concentrations of which can change under the influence of economic activities. Special indicators characterize the content of toxic and radiation pollutants in water.

Thus, the system for assessing the quality of surface waters of land and estuaries of Ukraine covers three blocks of indicators:

- block of salt composition indicators;
- block of tropho-saprobiological (ecological and sanitary) indicators;
- block of special indicators of toxic and radiation effects.

Block 1. Assessment of salt composition . This block provides:

1. determination of the degree of water mineralization (fresh, brackish, salt);
2. determination of the class, group, type of water in accordance with the ionic composition (ratio of main ions) according to the Alekin classification .

As is known, the class of water is determined by the predominant anions, the group by the predominant cations, and the type of water (I÷IV) by the ratio between the ions (in equivalents).

Type $HCO_3^- > Ca^{2+} + Mg^{2+}$ I ;

II type $HCO_3^- > Ca^{2+} + Mg^{2+} < HCO_3^- + SO_4^{2-}$;

III type $HCO_3^- + SO_4^{2-} < Ca^{2+} + Mg^{2+}, или Cl^- > Na^+$;

IV type $HCO_3^- = O$

The classification of waters by ionic composition is given in Table 1.

Table 1 – Classification of water by ionic composition

Class	Hydrocarbonate e(C)									Sulfate(S)									Chloride e(Cl)								
Group	Ca			Mg			Na			Ca			Mg			Na			Ca			Mg			Na		
Type	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III

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An assessment of the given waters by the content of salt composition components, which reflects the degree of their anthropogenic pollution with chlorides, sulfates and other ions , is given in Table 2.

Table 2 – Assessment of fresh water quality based on the content of salt composition components

Indicator mg/dm ^{3}	Water category and quality							
	I	II	III	IV	V	VI	VII	VIII
Sum of ions	>300	300-500	501-750	751-400	501-1250	1251-1750	1751-2000	>2000
Chlorides	<25	25-50	51-75	70-100	101-150	151-250	251-500	>500
Sulfates	<25	25-50	51-75	70-100	101-150	151-250	151-250	>400

Block 2.Assessment of water quality in accordance with trophosaprobic criteria.

Saprobity refers to the degree of saturation of water with organic substances.

Ecological classification of surface water qualities in accordance with tropho-saprobiological (ecological and sanitary) criteria includes the following groups of indicators:

1. *hydrophysiological* – suspended substances, transparency;
2. *hydrochemical* - pH , concentration of ammonium, nitrate, phosphorus, phosphates, dissolved oxygen, permanganate and bichromar nitrogen oxidation .
3. *hydrobiologically e* - phytoplankton biomass, self-purification / self-pollution index (A/R) - the ratio of the gross primary production of phytoplankton to the destruction of organic matter in plankton; self-pollution of waters, deterioration of their quality due to the functioning of aquatic ecosystems, in particular the excessive production of organic matter by aquatic plants (primarily phytoplankton);
4. *bacteriological* – the number of bacterioplankton and saprophytic bacteria;
5. *bioindexation saprobity* – indices in accordance with the Pantle-Bucca and Goodnight-Wigley systems .

To obtain reasonable conclusions, the total number of indicators in this block must be at least 10.

Block 3. Special indicators (toxic and radiation effects).

Environmental assessment of the quality of surface waters of land and estuaries of Ukraine according to special indicators of toxic action is carried out on the basis of the presence and content of a chain of ingredients in water (mercury, cadmium, copper, zinc, lead, chromium, nickel, arsenic, iron, manganese, fluorides, cyanides, petroleum products , phenols, surfactants, pesticides).

The assessment of the quality of surface waters according to special indicators of radiation action is carried out according to the following indicators: total β- activity, concentration of strontium - 90 and cesium - 137.

Specific hydrophysical, hydrochemical, hydrobiological and special quantitative indicators are elementary signs of water quality. Complex quantitative characteristics, which are built on the integration of elementary characteristics, are used as generalizing indicators of water quality. Based on elementary and general characteristics, classes, categories and indices of water quality, zones and subzones are determined saprobity , categories and subcategories of trophism .

It should be borne in mind that since wastewater impurities are multicomponent , the toxicity of water is not always accurately determined using physicochemical methods of analysis. If such a threat and uncertainty exists, then in addition to physicochemical methods, it is recommended to use integral biotesting methods . They are based on recording changes in the reaction of living organisms (changes in photosynthesis of algae; changes in the motor activity of ciliates; survival of the crustaceans “ Daphnia magna ”, etc.

Biotesting using the crustacean Daphnia magna is recommended as the main method of toxic control

Both laboratory and portable instruments are being developed for periodic assessment of water toxicity, as well as biological alarms.

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The simplest biosignaling device has two aquariums: one contains clean water, and the other is filled with waste water. Hydrobionts (fish, shellfish, crustaceans) are placed in both aquariums. At the same time, fish move from toxic water to clean water , and shellfish close their shells.

Purposeful economic activities, as well as natural disasters, are the main reasons for the deterioration of land quality, soil degradation, reducing their productivity. The most widespread damage to land resources is caused by the processes of soil erosion, desertification, salinization, as well as chemical, bacteriological, epidemiological, and entomological pollution.

Erosion processes are divided into water, wind and agrotechnical. Water erosion manifests itself mainly as a result of soil erosion over an area on slopes steeper than 4°, which causes a sharp degree of soil erosion , as well as due to linear erosion, which forms a gully-gully topography. Wind erosion (deflation) involves blowing away dust particles from the soil.

Environmental control primarily focuses on chemical pollution of soils, since its anthropogenic origin is constantly increasing.

The main sources of chemical contamination of soils are:

- emissions of pollutants into the atmosphere (macro- and microelements, gases, complex organic compounds, etc.) by industrial, energy, and transport enterprises.
- chemical plant protection methods (pesticides) and fertilizers used in agriculture.

In some cases, chemical contamination of soils is associated with water flows.

The distribution of harmful chemical products of technogenesis over the soil surface is determined by meteorological, topographical, geochemical and hydrological factors, the nature of pollution sources, and the ability of soils to adsorb pollutants from the air.

Many of the listed types of soil modification are characteristic of mining processes.

The content and nature of observations of pollution levels and their mapping in various conditions (urban and rural) have specific features.

Depending on the tasks that need to be performed, the following types of observations are distinguished:

1. regime (systematic) – based on the level of chemical substances in the soil for a certain period of time.
2. comprehensive observations of the migration processes of pollutants in systems: atmosphere-soil; soil-plants ; soil-water; soil-bottom sediments.
3. study of vertical migration of pollutants in soil along the profile.

The results obtained on the basis of observations make it possible not only to determine the level of chemical contamination of soils, but also to evaluate trends in the development of processes

Due to uneven pollution of the natural environment, chemical contamination of soils is methodically controlled at the so-called key stationary sites. A key site is a site (1-10 hectares) that characterizes a typical combination of soil conditions and relief conditions, vegetation and other components of the physical-geographical environment. At these sites there is a network of reference sections, points and sampling sites.

In addition to the concept of “key site”, another concept is used to monitor the level of soil contamination - “soil-geomorphological profile” (SGP).

"GGP" is a narrow line-like strip of the earth's surface, cutting the territory along the prevailing wind direction.

Soil-geomorphological profiles and key sites will complement each other. To obtain objective observation results, their correct location is methodologically important . Various methods are used for this.

In accordance with the first method, sites are located taking into account the wind rose, focusing on two or three directions. In the second case, the sites are located at the intersection of the two-kilometer grid lines on the soil map. In the third case, the main wind direction is plotted on the soil map and the radii of the corresponding bearings are drawn.

As a rule, soil samples are taken at a distance of 5-10 km from the source of pollution along the axis of air mass transfer, along the predominant directions of dispersion of emissions, i.e., along soil-geomorphological profiles.

If there is reason to believe that the migration of heavy metals is associated with water flows, then the direction of the rays must be coordinated with the vector of water migration. The total number of study sites is 15...20.

ISSN NO: 2770-2936
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Particularly close attention when monitoring the level of chemical pollution of soils is paid to heavy metals (HM) in comparison with clarke , their distribution in space and the consequences caused by these changes. These patterns can be most clearly identified on soil-geomorphological profiles cutting the entire territory along the prevailing wind directions.

When studying soil contamination with heavy metals, special soil-technochemical maps are drawn up, which indicate the types, subtypes, types, varieties of soils and the degree of soil contamination with these substances.

Assessing and mapping the degree of soil contamination with various ingredients is carried out on a scale of the degree of soil contamination (in relative units: the ratio of the actual concentration of the pollutant to the maximum permissible concentration in the soil):

- uncontaminated soils – less than 1 (for growing environmentally friendly products);
- slightly contaminated soils – 1-3 (land for general use without restrictions on the structure of crops);
- moderately polluted - 3-5 (land for growing fodder crops);
- heavily contaminated soils – more than 5 (land with limited agricultural purposes).

In addition to this classification, maps are also used that highlight the following ecological classes of soils: unpolluted, environmentally friendly; slightly contaminated (accumulated heavy metals of toxicity class III : barium, vanadium, tungsten, manganese and strontium); moderately contaminated (metals of toxicity class II predominate: boron, cobalt, molybdenum, copper, antimony, chromium); highly contaminated (metals of toxicity class I are common: arsenic, cadmium, nickel, mercury, selenium, lead, zinc, fluorine, beryllium, thallium); heavily contaminated with nitrates; radioactively contaminated.

When collecting samples to study heavy metal content, the following must be taken into account. It has been reliably established that man-made emissions that pollute the soil through the atmosphere are concentrated in the surface layers of the soil. Heavy metals are sorbed, as a rule, in the first 2-5 cm from the surface. Pollution of the lower horizons occurs as a result of soil cultivation (plowing, cultivation, harrowing), as well as due to diffusion and convective transfer through cracks, passages of soil animals and plants. Therefore, the clearest picture of soil contamination with heavy metals can be obtained by taking samples based on soil substances from depths : 0...10 and 0...20 cm on arable land and 0...2.5; 2.5…5.0; 5…10; 10...20 and 20...40 cm on virgin soil or old deposits.

The selected sample is compiled, as a rule, using the so-called “envelope” method. After sampling, the soil is sent to the laboratory for analysis. Each sample is accompanied by a coupon containing the basic necessary information about the soil itself and the conditions of its selection.

This is the essence of the methodology for studying the level of soil pollution, based on sampling and analysis.

At the same time, the state and forecast of soil pollution cannot be based only on sample analyses, since soil is an element of the landscape, and therefore its study is inseparable from the study of all components of natural and anthropogenic complexes, all ways of accumulation of pollutants in natural, rural and urban conditions. For example, in addition to indicators of metabolic processes when monitoring the condition of soil exposed to mining, indicators of mechanical disturbances of the surface and violations of the territorial structure of the cover in the area of work are important . First of all, we are talking about a change in the soil water exchange regime due to deformation of the mountain mass as a result of subsidence. There is, on the one hand, the formation of depression craters, which are accompanied by soil salinization or another form of their degradation, and on the other hand (in the case of independence of groundwater located near the earth's surface) leads to a rise in the level of groundwater and flooding of territories . These processes are controlled by monitoring the deformations of the earth's surface, the growth of depression, the saturation of underlying rocks with moisture and the level of high water relative to the surface. Control points are located in the center and along the periphery of the subsidence trough. The number of measuring points is determined by the complexity of the trough contour.

On the territories of mining and mineral processing enterprises there are rock dumps. Their surface is also subject to control. In particular, processes that negatively affect adjacent ecosystems, such as wind erosion (deflation), surface wash-off, landslides, etc., are monitored. Measurements of the listed indicators are carried out using specially installed benchmarks, which are exposed or covered up in the event of negative phenomena (in case of erosion), move or tilt as slopes move.

ISSN NO: 2770-2936
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