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THE ANALYSIS OF BIO-INDICATION METHODS OF SOILS' ECOLOGICAL STATE IN NEARBY TERRITORY OF GRANITE DUMPS

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Проведено аналіз методів біоіндикації з метою оцінки впливу відвалів гранітних кар'єрів на стан ґрунтів прилеглих територій. Визначено переваги та недоліки сучасних фізико-хімічних методів оцінки якості ґрунтів. Обґрунтовано необхідність застосування методів біоіндикації, які дають змогу отримати повну та достатню інформацію не лише про об'єми забруднення, а й оцінити результати впливу такого забруднення.

Ключові слова: *біоіндикація ґрунтів, гранітні відвали, екологічна норма, фітотоксичність.*

There are zones of negative influence on environment which form around the granite quarries. They are divided in two groups: according to the sphere of activity (soil, water and atmosphere) and according to the type of its influence (ecological, mechanical, physical and technical, biological, etc.). Uncontrolled influence of mining factory on environment leads to degradation of people's living conditions and to general exacerbation of nearby territories' ecological problems. The dumps of rock mass are one of the objects of mining companies, which have negative impact on environment [1].

The problem of soil pollution in nearby territories with dust from quarry dumps is topical because enhancement of dust concentration affects state of region's environment in general and degree of soil productivity and also accommodation of hazardous substances in crops which are grown there as well [2]. At this stage the observation and control of soils' state, as a rule, take place only when physical and chemical analyses are used, which determine the amount of exact pollutants. The pros and cons of the main modern physical and chemical methods of soil quality estimation are shown in table 1 [3].

These analyses don't allow to rate the impact of pollutants on living organisms, including humans though [4]. Nowadays biological methods are alternative in process of research of soils state in nearby territories of quarries, in particular bio-indication. Bio-indication allows definition of consistent biological activity of physical and chemical factors' impact on environment.

A lot of leading scientists were occupied in the study of the definition of soil pollution rating via bio-indication methods issue. Some of them are: Horova A., Hubatchov O., Maiatchkina N., Tchuhunova M., Beshlei Z., Baranov V., Terek O., Milen'ka M., etc.

The aim of work — the analysis of bio-indication methods in order to get rate of granite quarry dumps' impact on state of nearby territories soils.

Bio-indication methods are capable of bringing in authentic information about soil quality on the territory under research. The essence of these methods lies in determining the impact of research substances on specially selected organisms under standard conditions with the record of different behavioral, physiological or biochemical test reactions. Test reaction (or test-function) is determined as one of the naturally occurring reaction responses of test-system to a complex of external factors [5].

Phyto-toxins can make a significant impact on plant cells, their physiological and biochemical processes, chemical composition, which can lead to productivity decrease and violation of phyto-sanitary state of soils [6]. For bio-indicating analysis different test-samples (such as microorganisms, plants and animals) are used, but only those that react to negative changes in soil.

There are several different methods of soil rating bio-indication. Each of them has its advantages, disadvantages and limitations (table 2).

The analysis of presented methods of soil bio-indication suggests that the most approachable method of bio-indication is growth test, which allows definition of phytotoxic soil effect fast and without big expenses. It's a great advantage that enables systematic monitoring of soil toxicity.

On the other side the most precise is the «Chromosome aberration» test, which develops

Table 1

The pros and cons of the main modern physical and chemical methods of soil quality estimation

Title of method	Pros	Cons
Gravimetric	High precision; Absolute method which does not require comparison of the result with standards.	Long-term research; Possibility of definition of only certain chemical components.
Potentiometric method	Possibility of field research; The method is non-destructive, which means that the analyzing probe in process of analysis doesn't loose or change its properties; High rate of reproducibility.	Long-term research, including difficult preparations of soil samples; Possibility of definition of only certain chemical components; Need of highly qualified specialists; High material costs.
Optical method	High precision; High rate of reproducibility.	Long-term research, including difficult preparations of soil samples; Possibility of exploration of only previously defined chemical components; Need of highly qualified specialists.
Molecular-absorbing spectroscopy	High precision; High rate of reproducibility.	High material costs; Long-term research; Possibility of exploration of only previously defined chemical components; Need of highly qualified specialists; Need of large amount of chemical reagents.
Flame emission spectroscopy	Simple and cheap appliance; High sensibility of alkaline elements determination.	Long-term research; Considerable imposition of adjoining spectral lines of chemical elements one on another which results in analysis' not constant high precision and selectivity; Determination of only alkaline elements content.

Table 2

Comparative features of soil bio-indication methods

The title of method	Tools and reagents needed	Method description	Advantages	Disadvantages
Growth test (Berestetski O. method)	Petri dish; filter paper; distilled water; sand; test seeds (*Allium cepa* L.; *Lepidium sativum* L.; *Raphanus sativus var. radicula* Pers)	Soil samples weighing 50 g are placed in a Petri dish, surface is aligned and a layer of dry sand 0.5 cm thick is placed, then it is moisturized with equal amount (10 ml) of distilled water. Dishes are closed and last 24 hours at room temperature to permeate toxic substance into sand and then seeds are planted. Substrates' humidity must be within 70–80%. For control dampish sand (70–80%) is used. The seeds are grown at 23–25°C in darkness during 7 days.	Possibility of living organisms' reaction on pollutants estimation; Availability of experiments (does not require special laboratory and highly skilled staff); Low labor loss; Relative cheapness.	The need for a large number of repetitions to calculate more accurate phytotoxic effects; The level of organisms' organization is under research, with relatively low sensitivity and precision in comparison with cell research.

Continuation of Table 2

The title of method	Tools and reagents needed	Method description	Advantages	Disadvantages
		Test-parameters are similarity of seeds and seedling parameters. Basing on the final results phytotoxic effect is calculated and the conclusions on soil toxicity are made [7].		
Growth test (Horova A. method)	Petri dish, filter paper, sieve, test-seeds (*Allium cepa* L; *Raphamus sativus var. radicula* Pers; Trīticum dūrum), settled water.	Dried soil samples are sieved through fine sieve. Bio-testing processes in the Petri dishes with 1g of soil on top of the filter paper and 30 test seeds. The soil and seeds are spread in dishes, the settled and boiled water is poured in dishes as well. For each spot of selection there are three repeats. After 96 hours the roots, stems are measured, the wet and dry masses of seedlings are measured. Cultivation of the gained data is conducted by analysis of variance and determined phytotoxic effect of soil [8].	The level of cell structure is under research, that helps to provide high precision and pollutant sensitivity (allows to define even minor concentrations of pollutants); The speed of realization.	Need of highly qualified specialists; Need of special laboratory and equipment; Comparatively high material loss.
«Chromosome aberration» test	Petri dish, filter paper, distilled water, test seeds (*Allium cepa* L), ethanol 700, ethyl 960, acetic acid, Schiff test, hydro-chloric acid, covering glass, melted paraffin, microscope.	The filter paper is placed into the Petri dish, 1 g of soil is placed on top evenly. The soil is moisturized with 5 ml of water and on top 50 test seeds are placed. When roots reach 7–9 mm point, they are secured in acetic alcohol for 1 hour and are transported into ethanol 700 for preservation. Retainer is prepared by mixing of 960 ethyl and acetic acid. The roots are painted with Schiff test with previous hydrolysis in 0,1 n hydrochloric acid at 600 C. The roots are stored in ethyl. Cytological preparations are made of 1mm roots, placed in a drop of 45% acetic acid. The preparation is covered with the glass, edges are sealed with melted paraffin. It is used for microscopic analysis. Basing on these researches mitotic index is found, and the overall chromosome aberration and the average integrated conditional index of soil damage are found [9].	The level of cell structure is under research, that helps to provide high precision and pollutant sensitivity (allows to define even minor concentrations of pollutants); The speed of realization.	Need of highly qualified specialists; Need of special laboratory and equipment; Comparatively high material loss.

Continuation of Table 2

The title of method	Tools and reagents needed	Method description	Advantages	Disadvantages
The soil state estimation via the change of species bio-diversity of invertebrates	Shovel, pegs, oilcloth	The size of chosen trial area depends on the soil moisture degree (the most often 0,5×0,5 m). Distance between excavations is 5–10 m. Depth is 30–50 cm. Excavations are conducted by the following way: the size of area is established, in corners the pegs are hammered in, ropes are tensed between them. Near the areas oilcloth or cloth is placed and selected soil from area is put on top of it. At first atmospheric precipitations and plant remains are removed and manually sorted, including animals in soil. The grass is plucked in order to ease sorting of the upper layer soil. The animals from the inside of soil are separated from those collected from top of it. According to gained data the Simpson index is calculated — relative indicator of species biodiversity and the conclusion on ecological state of the soil is made [10].	Financial efficiency; Availability of experiments	High labor input, usage of this method leads to soil disruption; Shouldn't be used for seasonal fluctuations of soil fauna; During excavations mobile species of fauna react to violation and disappear (increasing of result inaccuracy).
Toxicity of water extracts of soil	Watering can, glass, distilled water, folded filter, test objects Daphnia magna.	To prepare water extract, 100 g of air-dried soil probe is transported via watering can in a glass with a wide neck, 750–1000 ml capacity. 500 ml of distilled water is added in the glass. The glass is closed and is shaken for 5 minutes. During this time water-soluble salts and organic matter move in solution or create suspension. The solution is filtrated through the folded filter into 500–700 ml bulb. The process goes on until the filtrate is clear. When the solution is completely filtrated, the water extraction is received. To determine the toxicity Daphnia magna are used. Experimental and control vessels contain 10 test objects under 24 hours age in each. Results are checked at points 1, 2, 24, 48 hours. This method is based on the difference between dead Daphnia in test samples and in control [11].	Usage of distilled water simulates effect of atmospheric precipitations on soil. It kind of imitates natural situation; This method can be used with different kinds of soils and doesn't require preparations of soil; Water extract can be prepared even from soils with field humidity.	Comparatively low credibility of toxicity definition (some pollutants are insoluble in water); Comparatively high material use; Additional time loss to prepare extraction.

Continuation of Table 2

The title of method	Tools and reagents needed	Method description	Advantages	Disadvantages
Soil diagnostics via enzymatic activity (following the methodology of Lysak L.)	Scales, toluene, test tubes, acetate buffer solution (acetic acid, sodium acetate), phosphate buffer solution (sodium phosphate), thermostat, stopwatch, dry heat, distilled water.	The soil is filled with toluene, adding buffer solution with defined pH and some essence. The reaction mixture is kept in thermostat and reaction products are counted. Enzyme activity is expressed through the amount of processed substrate or reaction product created during exact period of time and is calculated per soil mass unit. To adjust the results there are control points settled: 1) the soil is sterilized for 3 hours at 1800; 2) unsterilized soil with no substrate (H_2O); 3) substrate without soil, but with all the reagents [12].	The research of soil enzyme activity shows biochemical processes in eco-tope and is one of integrated indicators of its biotic activity.	Need of highly qualified specialists; Need of special laboratory and equipment; High material input.

at cellular level, provides high accuracy and identification of small pollutant concentration. It is a very important characteristic in process of granite dumps in nearby territories effect research that is used by people in domestic economy.

Taking everything mentioned earlier into account it is recommended to use the growth test together with the «Chromosome aberration» test for soil toxicity estimation. Herewith, it is worth using several different test objects to get more precise outer estimation. The suggested complex of bio-indication methods enables systematic phytotoxic soil effect determination and degree of toxic effect on soil fertility in nearby territories of granite dumps and degree of pollutant effect on living organisms.

CONCLUSIONS

It is established that in order to get the fullest and objective information about ecological state of soil in nearby territories of granite dumps the most rational is a complex of bio-indication methods of granite quarry dumps' harmfulness rating which should include the growth test and the «Chromosome aberration» test.

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АНАЛІЗ ЕКОЛОГО-ЕКОНОМІЧНОГО ПОТЕНЦІАЛУ МІСТА КИЄВА В УМОВАХ СТАЛОГО РОЗВИТКУ МІСЬКОЇ АГЛОМЕРАЦІЇ

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Проаналізовано еколого-економічний потенціал міста Києва для забезпечення сталого розвитку міської агломерації. Установлено основні тенденції та причини змін еколого-економічного стану міста.

Ключові слова: *агломерація, міське землекористування, земельні ресурси, еколого-економічний потенціал.*

Земля як фактор виробництва займає особливе положення в господарській діяльності міського населення. Земельні ресурси у великих містах є не лише територіальним базисом для розміщення об'єктів промисловості, продуктивних сил, а й простором для життєдіяльності міського населення в цілому. Для оцінювання ефективності міського землекористування насамперед слід визначити еколого-економічний потенціал використання міських земельних ресурсів з метою збалансованого розвитку міської агломерації [1].

Проблемам розвитку земельних відносин у великих містах та формування міських агломерацій присвячені праці вітчизняних дослідників Д.С. Добряка, О.І. Драпіковського, Ю.Ф. Дехтяренка, І.Б. Іванової, Ш.І. Ібатулліна, Ю.П. Кулаковського, А.Г. Мартина, І.О. Новаковської, В.І. Нудельмана, Є.Н. Перцик, Г.М. Лаппо, А.М. Третяка та ін. Водночас набувають актуальності дослідження, пов'язані з аналізом еколого-економічного потенціалу міста Києва та встановленням основних тенденцій і причин негативних змін для забезпечення сталого розвитку міської агломерації. Поза сумнівом залишається й той факт, що великі міста, такі як Київ, залишаються центром несільськогосподарського виробництва, постійно розширюючи свій вплив на навколишню територію [2].

Метою статті є аналіз еколого-економічного потенціалу м. Києва для забезпечення сталого розвитку міської агломерації.

На сьогоднішній день у місті Києві спостерігається стрімка динаміка зміни площ земель, яка полягає в зменшенні частки сільсько- та лісогосподарського призначення й збільшенні площ земель інших категорій.

Так, за даними Головного управління Держгеокадастру, станом на 01.01.2016 р. загальна площа м. Києва становить 83 558,00 га (83,6 тис. га), з них 4,6 тис. га — землі сільськогосподарського призначення, 35,1 — ліси та інші лісовкриті площі, 6,7 — під житловою забудовою, 3,3 тис. га — землі промисловості (рис. 1).

Аналізуючи динаміку використання земельних ресурсів м. Києва за 1995–2016 рр., по-

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