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INTELLECTUAL ANALYSIS AND PREDICTION OF TOXIC ELEMENTS IN THE SOIL

Abstract. *PC innovation has opened up plentiful freedoms for contemplating the cycles happening in nature. Among the undertakings effectively recreated on PCs, ecological issues remain a blind spot. Because of movement, poisons from the dirt can enter surface and ground waters, get consumed by plants, and after-ward infiltrate the human body along with the natural pecking order. The point of the work is to contemplate the substance of substantial metals in the dirt front of Almaty. The research findings were surveyed accord-ing to the most extreme allowable concentration of metal in the dirt. Utilizing numerical techniques (least squares method) for processing natural data, it was conceivable to draw up a prescient model.*

Key words: *heavy metals, maximum permissible concentration, system analysis, mathematical model-ing, least squares method*

Introduction

In contrast to water and air, which are just movement media, soil is viewed as the most level-headed and stable marker of technogenic contamination, since it unmistakably mirrors the outflow of toxins (poisons) and their real conveyance in the metropolitan zone. Weighty metals (HM) amass in the dirt mass, influence the environment of soils, smothering the turn of events and organic action because of their high poisonousness [1]. The presence of most of HMs in the metropolitan soils of Almaty is related to an expansion in the quantity of vehicles on the city streets, since the primary wellspring of lead (Pb) is the utilization of leaded gas and the ignition of petroleum derivatives in nuclear energy stations; cadmium (Cd) - utilization of diesel fuel in motors and greasing up oils; zinc (Zn) - black-top asphalt, vehicle tires.

The investigation of the characteristics of the impact of poisonous components on organic cycles in the dirt and the systems of plant protection from them is the logical reason for the advancement of innovation for forestalling the negative impacts of contamination and strategies for foreseeing ecological hazards. The significance of the advancement of guaging ecological dangers is related with the amassing of various exploratory materials on the substance of hefty metals, pesticides, oil and other poisonous components of the climate in soil/water. In such manner, the improvement and usage of data innovation in the climate, as a need bearing, takes into consideration a brisk trade of data on a worldwide and neighborhood scale with negligible expenses of cash, work assets and with greatest markers of unwavering quality, exactness and objectivity, focused on viable counter-action of negative changes in the common habitat [2].

Different numerical models and projects are utilized [3] for definite investigation and prediction of the danger of soil contamination by harmful components. Numerical models make it con-ceivable to locate an ideal arrangement, a sufficient portrayal of the interaction of soil pollution with poisonous components, anticipating the results of upset soil measures and deciding on an ideal recultivation methodology. Models of soil/water contamination by xenobiotics are the major pro-gramming devices in the field of ecological insurance: Hydrus [4]; LEACHM [5]; WAVE, WISE, Ecologist. Numerical demonstration in the field of biology is being successfully implemented in Kazakhstan. A model of environment profitability has been created based on the reconciliation of regular zones ras per their geographic drafting, which permits applying the laws of the common bio-logical systems.

The principal errands of natural security are generally addressed by the executives administering data set frameworks. It ought to be noticed that in the Republic there is no single PC data set representing ecological contamination, although the Environmental Code of the Republic of Kazakhstan accommodates the production of a PC data set for recording ecological contamination [6]. The significance of making a solitary base will permit the national government to deliberately tackle significant issues related to the climate, for instance, the development of cutting edge offices for the burning of modern waste, and above all, for evaluating the genuine degree of technogenic contamination of the climate and their ecological hazards. In such manner, the advancement of a data framework for natural observation of the climate dependent on capacity innovation is needed for addressing significant natural tasks and issues for ensuring the safety of individuals living in environmentally hazardous locales.

Principles and indicators for assessing the impact of waste accumulators on the environment.

The main task of assessing the level of pollution of the environment with toxic waste substances is to obtain summary indicators of the state of the main components of the surrounding water environment, air and soil cover. Moreover, depending on the magnitude of a number of indicators, the state of the environment can be attributed to one of the four:

- permissible, in which the content of certain pollutants exceeds the background, but does not exceed the MPC in any of the environmental components;
- hazardous, in which the content of individual pollutants in some environmental components exceeds the MPC (pollutants of 1-2 hazard class up to 5 MPC, pollutants of class 3-4 - up to 10 = 50 MPC);
- critical, at which the excess of the MPC for the entire association 3V in some components of the environment becomes massive (3V 1-2 hazard class from 5 to 10 MPC, 3V 3-4 class - up to 20 h-100 MPC);
- catastrophic, in which the content of 3B exceeds the MPC in all components of the environment (3B 1-2 hazard class more than 10 MPC, 3B 3-4 class - more than 20-100 MPC).

Taking into account the literature data, the main parameters of the indicators must correspond to those indicated in Table 1.

Table 1 - Parameters of the ecological state of environmental components

Parameter name	Environmental state			
	Acceptable (relatively satisfactory)	Dangerous	Critical (over the top)	Catastrophic (disastrous)
A. Physical parameters 1. Overlapping of the soil surface, absence of abiot. technog. sediment, cm	Practically absent	to 10	10-20	more than 20
2. Increasing the density of the layer 0-30 cm, multiples. background	to 1,1	1,1-1,3	1,3-1,4	more than 1,4
B. Chemical parameters 1. Increase in the content of water-soluble salts, g / 100 g of soil in the 0-30 layer	to 0,1	0,1-0,4	0,4-0,8	more than 0,8
2. Exceeding MPC 3V - 1 class of hazard; - 2 hazard classes; - 3 hazard classes.	to 1 to 1 to 1	1-2 1-5 1-10	2-3 5-10 10-20	more than 3 more than 10 more than 20
3. Sum indicator, pollution	less than 16	16-32	32-128	more than 128
B. Biological parameters 1. Decrease in the level of microbial mass, frequency	to 5	5-50	50-100	more than 100

In accordance with the state of the environment, an appropriate decision is made on the possibility of keepin the production waste in this storage. In this case, the following gradation of loads on the ecosystem is provided:

- permissible, that is, such a technogenic load, at which the structure and functioning of the ecosystem is preserved with minor (reversible) changes;
- hazardous - load, at which the structure is still preserved, but there is already a violation of the functioning of the ecosystem with an increasing number of reversible changes;
- critical, that is, one in which there is a significant accumulation of changes in the components of the environment, leading to a significant negative change in the state and structure of the ecosystem;
- catastrophic load, leading to the loss of individual links of the ecosystem, up to their complete destruction.

Mathematical problem statement

Reason for the investigation: the chance of utilizing the greatest admissible fixation (MPC) and numerical techniques to make prescient models in the field of observing HM for their appraisal and estimate of ecological risk.

The reason for the paper work is the development of relapse conditions to portray the effect of soil defiled with hefty metals in various fixations (complete contamination level 227.4; 165.4; 20.0 mg/kg) on vegetation. It is accepted that based on the relapse investigation it is conceivable to survey changes in the condition of the environment, specifically, the phytotoxicity of sullied soils. Models that consider soil properties and the presence of, for instance, weighty metals are viewed as significant for anticipating phytotoxicity: for example, the properties of harmful components in the dirt stifle the development and advancement of higher plants [7]. In such manner, the strategy for least squares (OLS) was utilized to make a numerical model of the development energy relying upon the centralization of hefty metals in the dirt. OLS is one of the essential relapse investigation strategies for assessing obscure boundaries of relapse models from test information. The embodiment of the LSM is to pick the amount of the squares of the deviations of the left and right sides as a "proportion of nearness". The boundaries in the numerical model were upgraded by limiting the amount of squares of the lingering deviation of the information focuses from the model. Connections were viewed as huge at $p \leq 0.05$. The nature of the acquired relapse models was evaluated utilizing the coefficient of assurance (R2), utilizing examination of difference. The fundamental structure of the model of phytotoxicity of the model of phytotoxicity of soils for plants becoming on unpolluted and tainted with substantial metals, contingent upon their focus in the dirt, was determined [8-10].

Mathematical model

The experimental data on the growth kinetics were close to the logistic dependence; therefore, the sum of the squares of the deviations was calculated using the model of the values $\hat{y}_t$ from the actual y_t levels of the time series of the smallest:

$$\sum_{t=1}^{n}(y_t - \hat{y}_t)^2 = \sum_{t=1}^{n} e_t^2 \rightarrow min \quad (1)$$

$$e_t = y_t - \hat{y}_t \quad (2)$$

where, the remainder is the discrepancy between the actual and model values of the indicator y.

When estimating the parameters of the polynomial curves, the following formula was used:

$$y_t = a_0 + a_1 t + a_1 t + \cdots + a_q t^q \quad (3)$$

Further, as a result of minimization, a system of normal equations was obtained. The system consisted of $(q+1)$ linear equations containing, as known quantities, $\sum y_t, \sum y_t t, \sum y_t t^2, \sum y_t t^q$ and $(q+1)$ unknown coefficients a_j.

The solution of this system with respect to $a_0, a_1, a_2, \dots, a_q$ allowed us to calculate the required parameter estimates.

$$\sum_{t=1}^{n} y_t t = a_0 \sum_{t=1}^{n} t + a_1 \sum_{t=1}^{n} t^2 + a_2 \sum_{t=1}^{n} t^3 \dots + a_q \sum_{t=1}^{n} t^{q+1} \quad (4)$$

$$\sum_{t=1}^{n} y_t = a_0 n + a_1 \sum_{t=1}^{n} t + a_2 \sum_{t=1}^{n} t^2 + \cdots + a_q \sum_{t=1}^{n} t^q \quad (5)$$

$$\sum_{t=1}^{n} y_t t = a_0 \sum_{t=1}^{n} t + a_1 \sum_{t=1}^{n} t^2 + a_2 \sum_{t=1}^{n} t^3 \dots + a_q \sum_{t=1}^{n} t^{q+1} \quad (6)$$

$$\sum_{t=1}^{n} y_t t^{q-1} = a_0 \sum_{t=1}^{n} t^{q-1} + a_1 \sum_{t=1}^{n} t^q + a_2 \sum_{t=1}^{n} t^{q+1} \dots + a_q \sum_{t=1}^{n} t^{2q-1} \quad (7)$$

$$\sum_{t=1}^{n} y_t t^q = a_0 \sum_{t=1}^{n} t^q + a_1 \sum_{t=1}^{n} t^{q+1} + a_2 \sum_{t=1}^{n} t^{q+2} \dots + a_q \sum_{t=1}^{n} t^{2q} \quad (8)$$

Based on the calculation, it is possible to obtain an empirical regression equation for the kinetics of plant growth on contaminated and uncontaminated soil depending on the concentration, taking into account the value of the approximation reliability (Table 2).

Table 2 - Empirical regression equation for the kinetics of plant growth

Soil contamination level, mg / kg	Differential equation	Determination coefficient
Uncontaminated soil	$y = -0.0072x^2 + 613.17x - 1E + 07$	0.9845
Zc 165,4±17,1	$y = -0.0045x^2 + 380.46x - 8E + 06$	0.9614
Zc 20,0±3,1	$y = -0.0075x^2 + 636.39x - 1E + 07$	0.9843

Based on the coefficient of determination, it can be concluded that there is a close relationship between plant growth and the concentration of heavy metals in the soil (98%).

To model the theoretical curve of the kinetics of plant growth on soil contaminated with heavy metals at different concentrations and uncontaminated (control) soil, we used the logistic equation of the mathematical model of a single population described in the article by E.A. Gorbunova, E.P. Kolpak [11], since the experimental data on the growth kinetics were close to the logistic curve.

$$\frac{dl}{dt} = \mu l(1 - \frac{l}{l_{max}}) \qquad (9)$$

where t – is the time (days), l − is the current plant height (cm), l_{max} − s the theoretical maximum height (cm) that the plant can reach at the end of growth, μ − is a constant (specific growth rate, dimension - 1 / day).

The solution to this equation was the function (l_0 - initial plant height):

$$l(t) = l_{max} \frac{l_0 e^{\mu t}}{l_{max} - l_0 + l_0 e^{\mu t}} \qquad (10)$$

Based on the data of eq. (10), an empirical equation was obtained for the theoretical curve of the dynamics of plant growth on contaminated in different concentrations and uncontaminated soil (Fig. 1).

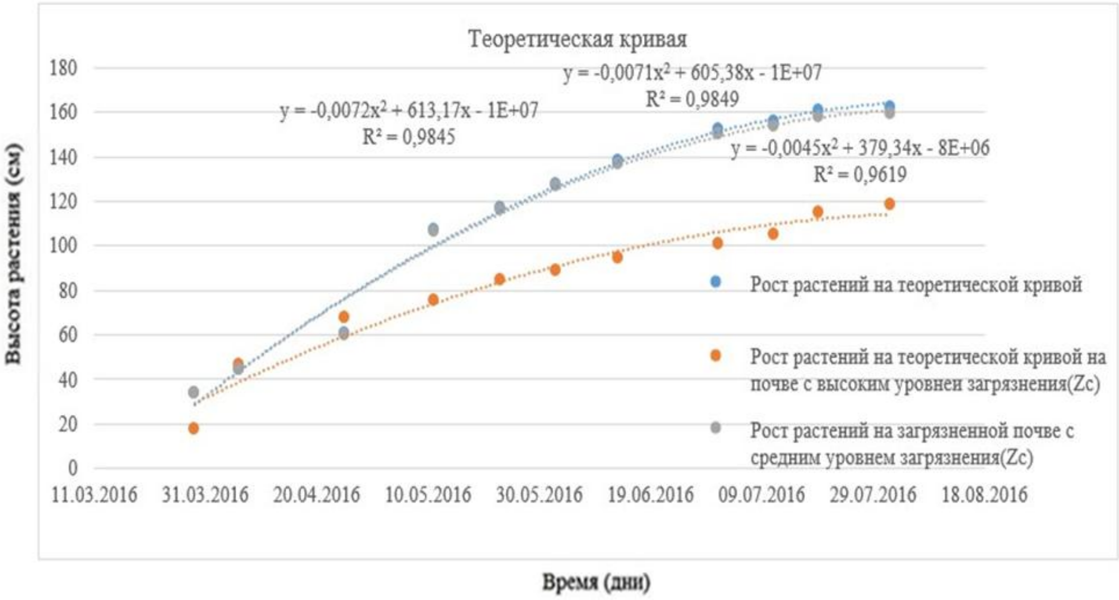

Figure 1 - Theoretical curve of the kinetics of plant growth versus growth time, taking into account the concentration of heavy metals in the soil

When constructing a theoretical curve, it was confirmed that plant growth depends on the concentration of heavy metals in the soil, the higher the concentration, the higher the inhibitory effect. The coefficients of determination R2 reflecting the degree of agreement of the calculation results with the experimental data, when using these data, were close to the value 1.

Thus, it has been established that the degree of soil phytotoxicity depends on the concentration of heavy metals in the soil. The greatest influence on the degree of soil phytotoxicity is exerted by high concentrations of heavy metals (Zn 281 and 165 mg / kg), which either cause plant death or suppress plant growth and development. According to the model, a plant can grow on soil with a total contamination level of 20 mg / kg; this dose of heavy metals is the optimal dose for plant growth and development. This calculation can be applied in resolving a wide range of problems of environmental regulation, when exposed to other technogenic pollutants.

Conclusion

Accordingly, because of the escalated development and advancement of industry, transport, industrialization and chemicalization of horticulture, the speeding up of logical and innovative advancement lately, the flood of HMs of technogenic source into the climate has essentially expanded and keeps on developing. Defilement of biosphere objects, including food crude materials, both of plant and creature inception, with HM salts, given their high harmfulness, the capacity to collect in the human body, have an unsafe impact even in generally low fixations, can have various genuine ramifications for human wellbeing, causing the advancement of purported ecologically related illnesses. Uncontrolled contamination of the climate with substantial metals compromises human wellbeing. The admission of poisonous substances prompts irreversible changes in the inner organs. Subsequently, serious infections create: problems of the gastrointestinal parcel, liver, renal and hepatic colic, loss of motion.

This shows the requirement for ecological monitoring of the HM content in air, water, and soil. Further investigation of HM movement affixes from their source to people may be conducted to create passable cutoff points for the centralization of metals in organic media, portraying the degree of anthropogenic burden and danger to general wellbeing. Appraisal of HM content in human organic media may be presented as an arrangement of social and clean observing.

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Найзабаева Л. [1], Аринова М. С. [1]

Жер қыртысындағы улы элементтерді интеллектуалды талдау және болжау

Аңдатпа. Компьютерлік технологиялар табиғатта болып жатқан процестерді зерттеуге кең мүмкіндіктер ашты. Компьютерлерде сәтті модельденген тапсырмалардың ішінде экологиялық проблемалар ерекше орын алады. Көші-қон процестерінің нәтижесінде топырақтан токсиканттар жер үсті және жер асты суларына түсіп, өсімдіктерге сіңіп, содан кейін қоректік тізбек бойымен адам ағзасына ене алады. Жұмыстың мақсаты Алматы қаласының топырақ жамылғысындағы ауыр металдардың құрамын зерттеу болды. Алынған нәтижелер топырақтағы металдың шекті рұқсат етілген концентрациясына қатысты бағаланды. Экологиялық ақпаратты өңдеудің математикалық әдістерін (ең кіші квадраттар әдісі) қолдану арқылы болжамды модель құруға мүмкіндік туды.

Түйінді сөздер: ауыр металдар, шекті рұқсат етілген концентрация, жүйелік талдау, математикалық модельдеу, ең кіші квадраттар әдісі

Найзабаева Л. [1], Аринова М. С. [1]

Интеллектуальный анализ и прогнозирование токсичных элементов в почве

Аннотация. Компьютерная технология открыла широкие возможности для изучения процессов, происходящих в природе. Среди задач, успешно моделируемых на компьютерах, особое место занимают экологические задачи. В результате миграционных процессов токсиканты из почвы могут попадать в поверхностные и подземные воды, поглощаться растениями и далее по пищевым цепям проникать в организм человека. Целью работы явилось изучение содержания тяжелых металлов в почвенном покрове г. Алматы. Оценка полученных результатов проводилась по отношению к предельно допустимой концентрации металла в почве. С помощью математических методов (метод наименьших квадратов) обработки экологической информации удалось составить прогнозный модель.

Ключевые слова: тяжелые металлы, предельно допустимая концентрация, системный анализ, математическое моделирование, метод наименьших квадратов

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