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BIOSPHERE COMPATIBILITY: HUMAN, REGION, TECHNOLOGIES

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The edition address: 305040, Kursk, str. 50 let Octyabrya, 94
+7 (4712) 22-26-04, www.swsu.ru
E-mail: biosfera_swsu@mail.ru

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Contents

E.D. KONSTANTINOVA, S.G. ASTAHOVA, T.T. NEZAMUTDINOVA

INDICATORS OF HUMAN COMPATIBILITY WITH WORKING CONDITIONS: BIOLOGICAL AGE

The problem of human compatibility with the conditions of his work is considered. The concept of biological age as an assessment of the aging rate of the human body is given. It is shown that biological age can be considered as an integral indicator of the level of human health, reflecting the reserve potential of the organism.

The review of two methods for determining biological age - bicycle ergometric and antropometric - is presented. The data on workers of three industrial enterprises of the Urals region employed in harmful labor conditions were used in the present study. A total of 187 male workers were surveyed. The age range of the surveyed workers was 30–60 years; the average age was 46.89 years. All participants in the study performed veloergometry. Heart rate, arterial systolic and diastolic pressure, height and weight were measured. The aging rate and biological age were calculated on the basis of these physiological parameters by special techniques. The results of a comparison of biological age determined by two different methods are given. The categories of male employed in harmful working conditions who are most vulnerable from the point of view of adaptation to the environmental factors are identified. These are those with the highest mass of the body (BMI> 30), as well as individuals who cannot reach high loads (groups with FF1 = 600 kgm / min and FF1 = 750 kgm / min). In these groups of workers the biological age itself exceeds the calendar age (on average), which indicates an accelerated aging, respectively, of less adaptability to environmental factors. It is shown that the biological age values determined with the help of different approaches cannot always be equal to one another for one person.

Key words: *biological age, aging rate, anthropometric approach, veloergometric approach, biosphere compatibility.*

A.A. SELEZNEV

METHOD FOR RECONSTRUCTION INITIAL GEOCHEMICAL CONDITIONS FOR URBAN GROUND

Method for reconstruction of the initial geochemical conditions (before pollution) is suggested for urban ground. The method is based on the analysis of the relationship between the content of pollutant and typomorphyc element. Such relationship is proposed to be approximated by a linear model in which the concentration of pollutant is taken into account with weight. The weight is inversely proportional to the concentration of pollutant in δ degree. Index δ characterizes the degree of pollution of the territory. The reconstruction of the initial geochemical conditions was performed for specific geochemical trap of the recent urban sediments (puddle sediment in local surface depressed zones of relief). That environmental compartment accumulates the pollutants over space and time characterizing their migration processes. The sediment starts forming simultaneously with the development, construction, and landscape planning of an urban territory. The study was conducted for the territory of Ekaterinburg, Russia. The samples of sediments were collected on an irregular grid at the territories of residential yards in the city. The samples were taken from the upper 5 cm layer. The reconstructed relationship between the concentrations of pollutants (mg/kg) and typomorphic element (Fe, g/kg) were as follow: Pb= 45 +0.1·Fe, Zn= 141 +1.7·Fe and Cu= 32 +1.2·Fe. The main problem of the suggested approach is in choosing the appropriate value of the dimensionless δ index. To find the relevant value of δ degree, the background values for Pb, Zn and Cu obtained with Cs-137 as timescale tracer approach were used in the current study. The background concentrations of Pb, Zn and Cu reconstructed with the suggested approach are in consistent with the background values obtained with Cs-137 as timescale tracer method.

Key words: *geochemical conditions, background, metals, typomorphic element, sediments in local surface depressed zones of landscape, urban environment, artificial ground.*

G.P. MALINOVSKY

HEALTH EFFECTS OF INDOOR RADON RADIATION EXPOSURE: REVIEW

Ionizing radiation is an environmental factor that permanently affects a person and is associated with the risk of various health effects. The main natural source of radiation is radon and its short-lived daughter products. The formation of a human-friendly habitat requires the implementation of radon-protective measures, which are based on a reliable quantitative assessment of the prevented damage. When constructing a radiation risk model for the damage assessment, it is necessary to justify the form of the dose-effect relationship and to evaluate the numerical values of the parameters describing this dependence. The paper provides an overview of the main sources of epidemiological information on the effects of radon exposure, which underlie modern models of radiation risk. Three main types of epidemiological studies as follow are considered: miners' cohort studies, case-control studies of lung cancer and radon exposure in dwellings, geographically correlated studies. Studies of miners showed a statistically significant association of mortality from lung cancer with radon at high exposure levels. At the same time, due to the limitations of miners as cohorts for epidemiological research, extrapolation of relevant risk assessments to the area of low exposurein the dwellings is not justified. The risk of lung cancer due to radon exposure in the dwellings was shown by the results of the case-control studies. Geographically correlated data generally support the conclusions about the dose-effect relationship obtained in cohort and case-control studies. In general, all three types of studies yield results consistent with the linear non-threshold concept of radiation-induced carcinogenesis.Thus, available epidemiological data allow to create an effective system of population protection against radon exposure in homes.

Key words: *radon, lung cancer, risk.*

I.E. SUBBOTINA

DUST COMPOSITION OF THE ATMOSPHERIC AIR GROUND LAYER OF THE URBANIZED TERRITORY BASED ON THE ENVIRONMENTAL SCREENING DATA ON AN EXAMPLE OF EKATERINBURG (RUSSIA)

The population of industrial cities is exposed to polluted air, which increases the risk of cardiovascular diseases, lung cancer, chronic and acute respiratory diseases. Different approaches are used to assess the content of pollutants in the air. In the present work, sampling of atmospheric dust was carried out within the framework of environmental screening to determine the sources and causes of pollution of urban areas at six experimental sites in Ekaterinburg city (Russia). The following indicators were determined: dust concentration in the ground layer of atmospheric air, size distribution of dust particles, and elemental composition of dust. The data were analyzed using various techniques. Weighing method was used to determine air dust concentration. X-ray fluorescence analysis was used to determine the quality of the elemental composition of dust. Calculation of the amount of dust particles within different sizes intervals visible in the field of view of the microscope was used to determine the dispersed dust composition of atmospheric air. It was shown that the dust concentration on the study sites is insignificant and does not exceed the standardized parameters. Decrease in dust concentration and content of elements in dust on filters with height was not observed. Also, no dependence of the dimensions of dust particles in the atmospheric air on height was found. Most of the dust was made up of large particles larger than 10 μm and particles of 4-5 μm. The following chemical elements were detected on the filters: Sulfur, Calcium, Potassium, Titanium, Manganese, Iron, Copper, Arsenic. The greatest proportion of dust in the chemical composition falls on Sulfur, Calcium, and Iron. Most of the detected elements were contained in large particles with the exception of arsenic, whose content was higher in dust particles of small size.

Key words: *air pollution, particulate matter, ecological screening*

T.A. MASLAKOVA, L.A. KONEVSKIH, O.G. SMICHNIKOVA, M.M. NAZAROVA

THE INFLUENCE OF THE OCCUPATIONAL RISK FACTORS ON THE INDICATORS OF VARIABILITY OF HEART RHYTHM

A study was made of the influence of the harmful working conditions on the adaptation of workers in industrial enterprises to the environment. The industrial factors influencing workers of industrial enterprises of the Sverdlovsk region are studied and described. Among them the most common are: the severity of the labor process, the presence of harmful chemicals and air in the work area, the temperature and humidity of the production environment, the effect of electromagnetic fields, noise, local and general vibration, ionizing and thermal radiation. Correlation analysis of interrelation of heart rate variability indices and factors of industrial environment was carried out. It is revealed that the tension of the regulating systems organism increases with increasing length of working in harmful working conditions. One-way and two-way ANOVA analyses were carried out, during which the most significant relationships between the parameters of heart rate variability and factors of the production environment were revealed. Heart rate variability was calculated on the basis of the ECG scores taken in accordance with the European American and Russian guidelines. The heart rate variability indices determining the balance between sympathetic and parasympathetic parts of the autonomic nervous system were chosen for the analysis. It was found that an imbalance between the sympathetic and parasympathetic divisions of the autonomic nervous system develops under the influence of such production factors as the severity of the work process and emotional tension. This imbalance leads to a tension in the regulatory system, a decrease in the body's reserve capacities and the level of adaptation of workers to the surrounding environment. The practical importance of this study is due to the possibility of applying the results obtained to assess the level of adaptation of industrial workers to the environment. The practical significance of this study is due to the possibility of using the results obtained to assess the level of adaptation of workers in industrial enterprises with harmful working conditions to the environment.

Key words: *adaptation to the environment, heart rate variability, occupational factors (working conditions), analysis of variance.*

A.N. VARAKSIN, YU.V. SHALAUMOVA, E.V. BAHTEREVA

ADVERSE ENVIRONMENTAL FACTORS: COMPOSITE INDICES OF HUMAN HEALTH RISK

Environmental health risk assessment is one of the most rapidly developing interdisciplinary areas in solving medical and ecological problems. However, a large number of health risk factors make it difficult to calculate the probability of specific diseases appearance, and therefore composite indices are becoming more common because they convert a set of primary indicators to a single number.

The aim of the study is to develop methods for constructing composite indices that reduce the dimensionality of the space of environmental conditions, focusing on health indicators of the population. We used simple and weighted aggregation methods, as well as multiple logistic regression methods. We have chosen approaches in which composite indices play the role of risk indicators of the diseases symptoms appearance in a population living in certain conditions. Based on the example of two neurological diseases associated with working conditions and characteristics of human health, this article shows that composite indices constructed by the weighted aggregation method have the best properties. Even in cases where weighted aggregation and multiple logistic regression methods show only slightly more accurate estimates than the simple aggregation method, they are superior methodologically, since they do not require preliminary selection of variables.

Practical significance of the study is characterized by the following results: among three compared methods for constructing composite indices, the method with the best properties has been established; the applied problems of determining risk factors for the appearance of such symptoms of peripheral nervous system diseases as numbness of fingers and pain in wrist and interphalangeal joints of the hand in workers of industrial enterprises have been solved.

Key words: *composite indicators, weighted aggregation, human health, environmental factors*

A.N. MEDVEDEV, M.A. MEDVEDEV

ASSESSMENT OF THE INFLUENCE OF A SULFIDE COPPER ORE QUARRY ON GRASSY VEGETATION

The article is devoted to the assessment of an open mining influence on the biological objects on the example of the results of grassy vegetation pollution monitoring at the meadows and fields in the area of Safianovskoye deposit of sulfide copper ores. The deposit is located 9 km to the north-east from the Rezh town of Sverdlovsk region of Russia. The studies were carried out within the framework of a complex program of environmental monitoring, which was started from the moment of the deposit development beginning (1995). Since 1996, the research is carried out on the pollution of vegetation on agricultural lands and meadows used for growing fodder and cereals. The results of chemical analysis of the vegetation samples selected in July 2016 are presented in the article. The sampling was carried out in accordance with the recommendations of the acting methodological and regulatory documents. The quantitative chemical analysis was performed in accordance with the "Method for performing measurements of the metal content in solid objects by the method of inductively coupled plasma spectrometry" PND F 16.1: 2: 3: 3.11-98 in the analytical laboratory of JSC "Safianovskaya copper", accredited as a testing laboratory. The contents of copper, zinc, nickel, lead, cadmium, and arsenic were determined. The contents of metals in the samples were compared with the Maximum permissible levels (MPL) for fodder. The study showed the absence of dependence of vegetation pollution levels on the location of sampling points relative to the quarry, dumps of overburden and other objects of the mining enterprise. An estimation of the obtained values dynamics for all the years of observations was given since 1996. No any regular changes in the levels of vegetation pollution were revealed with time. The observed multidirectional fluctuations in the contents of the elements studied in different years seem relate to natural causes. The results obtained make it possible to make a conclusion about the absence of mining works influence on the quality of vegetation in the area where the deposit is located.

Key words: *monitoring, open mining works, sulfide copper ores, grassy vegetation, pollution.*

A.G. BUEVICH, A.V. SHICHKIN, I.E. SUBBOTINA, A.P. SERGEEV

ARTIFICIAL NEURAL NETWORKS IN FORECASTING CHROMIUM DISTRIBUTION IN THE SOIL OF THE URBANIZED TERRITORY

The work is devoted to the application of a relatively new tool - artificial neural networks for forecasting the anomalously distributed chemical element chromium (Cr) in the surface layer of the soil. The use of the models based on artificial neural networks leads to improved predictive accuracy and increased productivity. Generalized regression neural networks (GRNN) and multi-layer perceptron (MLP) are classes of artificial neural networks widely used for modeling and forecasting in environmental studies. In this work, we compared two types of neural networks: GRNN and MLP, as well as a traditional geographic method based on geostatistics - universal kriging. The study is based on the results obtained during a previous soil screening in NovyUrengoy, Yamal-Nenets Autonomous District, Russia, where an abnormality of the Cr content in the surface layer of the soil was described. The sampling area was about 8.5 square kilometers. In total, one hundred and fifty samples of the upper soil layer were collected to a depth of 0.05 meters. The network structures were selected by computer simulation based on the minimization of the relative mean square error (RMSE). The least error in forecasting was shown by the model based on the artificial neural network type GRNN. The obtained results confirm that artificial neural networks can be used to improve the accuracy of modeling the spatial distribution of concentrations of chemical elements in the upper layer of soil in urbanized areas, which, in particular, are characterized by high heterogeneity.

Key words*: artificial neural networks, kriging, modeling, chromium.*

A.F. TETERIN

POTENTIAL OF ATMOSPHERE DISPERSION IN YEKATERINBURG

Level of air pollution depends on variability of emissions and meteorological conditions of dispersion of pollutants in atmosphere. A complex characteristic of considering influence of meteorological conditions on dispersion of pollutions in atmosphere is the potential of atmosphere dispersion. Results of temporal variability of potential of atmosphere dispersion in Yekaterinburg are presented. According to data from the Handbook of the USSR climate and meteorological monthly from 1966 to 2011 monthly and annual values, basic statistical characteristics of the potential of atmosphere dispersion were calculated for the fourth populous city of Russia. Significant differences were found in the distribution of climatic and meteorological potentials of atmosphere dispersion (from extremely unfavorable to extremely favorable meteorological conditions). The nature of intra-annual course of climatic potential of atmosphere dispersion the long-term average worst and best conditions for dispersion of pollutants in atmosphere were identified. For many years the course maximum and minimum values of meteorological potential of atmosphere dispersion, trends, unfavorable periods for dispersion of pollutants in surface atmosphere were fixed. Practical recommendations for the implementation of specific measures for air quality control of air basin in Yekaterinburg were offered.

Key words: *Urals, Yekaterinburg, atmosphere, dispersion of contaminations, self-cleaning of atmosphere, potential of the atmospheric dispersion, temporal variability of potential of the atmospheric dispersion.*

D.D. DESYATOV, A.A. EKIDIN

EVALUATION OF TRITIUM'S ENTRY INTO THE ENVIRONMENT FROM NUCLEAR POWER PLANTS' EMISSIONS

The results of the analysis of electricity production at nuclear power plants in the world from 1954 to 2015 are presented. Six types of IAEA nuclear reactors used in the world for electricity generation are considered. More than half of the world's nuclear power plants (55%) operate PWR type reactors. An assessment was made of the contribution of each type of reactor to global electricity production. More than 65% of the world's electricity is produced at nuclear power plants with PWR-type reactor installations. According to the annual emission of radionuclides by European nuclear power plants, specific tritium emission values ere obtained in normal operation of nuclear power plants with different types of reactor installations. The average values and median of the specific index for each type of reactor installation are compared. On the basis of the obtained specific emission factors for tritium, an estimate of the annual intake of tritium into the atmosphere during normal operation of nuclear power plants in the world was obtained for each type of reactor facility.

The types of reactor installations with the maximum tritium emission per unit of electricity generated are determined. According to the assessment, heavy water reactors form the main contribution (more than 98%) to the accumulation of tritium in the atmosphere from emissions of nuclear power plants. The main power producers of NPPs with PWR type reactors form not more than 1% accumulation of tritium in the atmosphere from nuclear power plant emissions. The change in the content of tritium in the atmosphere due to the operation of nuclear power plants and other sources on the Earth is shown. The share of global emissions of nuclear power plants in the overall activity of tritium in the atmosphere is no more than 1%. The main pollution of the atmosphere by tritium is due to the testing of nuclear weapons.

Key words: *NPP, specific indicator, emissions, tritium, environment, atmosphere, reactor installation.*

E.M. BAGLAEVA

FUNCTIONAL ZONING OF THE MICROLANDSCAPE OF RESIDENTIAL YARDLAND

In this paper, we study the ecological aspect of organizing the landscape of the urban courtyard (microlandscape), which manifests itself in the formation and accumulation of a surface sediment of mud associated with the problem of the formation and accumulation of sediment of surface mud in the functional zones of the microlandscape. Analysis of normative documents and scientific publications on the subject of the study showed that functional zoning of the urban courtyard landscape takes place in the modern city at the stage of designing, building and commissioning residential buildings. Issues of functional zoning, arising both during the work of the yard, and with increasing anthropogenic load due to the intensive development of the city, attract little attention. With the functional zoning of the territory of cities and neighborhoods, transport, pedestrian and green zones are traditionally designated for which regulatory documents define their own organization rules and use regimes. The technique of functional zoning of the city's microlandscapes is proposed, which allows to single out the planning units from the ratio of the automobile, pedestrian and green zones of inside and outside yardlands. The ecological aspect of organization of microlandscapes of residential areas of the city of Ekaterinburg with the application of the method of functional zoning was assessed. An imbalance in the organization of the microlandscape was found: the absence of pedestrian zone in the yardland, most of the total area occupied by a poorly maintained green zone. The greatest contribution to the formation of urban mud both inside and outside the yard is due to the violation of coatings. Thus, in the yardland, on average, 34% of the grass area, 19% of playgrounds and 18% of internal sidewalk were destroyed. Unorganized car parking also leads to the breakdown of coverage by 19% of the land. The appearance and accumulation of urban mud in the yard are used as a criterion for the optimality of the functional zoning of the microlandscape to ensure safe and comfortable conditions for residents.

Key words: *microlandscape, urban environment, functional zoning, urban mud; automobile, pedestrian and green zones.*

B.A. KOROBITSYN

“GREEN” ECONOMY, INDICATORS OF "GREEN" GROWTH AND THEIR DYNAMICS IN THE URAL FEDERAL DISTRICT

On the basis of the analysis of documents of the international organizations and scientific literature the main stages of genesis and evolution of the concept of "green" economy and "green" growth since 1989 till present are allocated and analysed. Special attention is paid to transformation of maintenance of a concept "green" economy. The basic existing approaches to the quantitative description of "green" economy are considered. With their use quantitative assessment of a condition of "green" economy and dynamics of "green" economic growth for subjects of the Ural Federal District after 2010 is executed

The general approaches to the quantitative description of a condition of "green" economy and the characteristic of dynamics of "green" economic growth which can be adapted to realities of modern Russia are allocated. First, this use as the main measure of social progress not of traditional GDP, but one of ecologically corrected macroeconomic indicators. Secondly, it is the analysis of the indicators of "environmental capacity" of economy reflecting the volume of expenses of natural resources and volume of the pollutants coming to the environment on GDP unit. Thirdly, "carbon" characteristics of economy are widely applied to the quantitative description of a condition of "green" economy and dynamics of "green" economic growth.

For subjects of the Ural Federal District follows from the analysis of these indicators that any of them can't serve as the working tool for monitoring of process of transition to "green" economy at the level of the territorial subject of the federation yet. The problem of modernization of economy facing Russia and leaving from raw model is central and in the concept of "green" economy.

Key words: *"green" economy, "green" growth, green VRP, dekapling, low-carbon economy, Ural Federal District.*