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# ECOLOGICAL MONITORING OF LANDS IN RUSSIA: TRADITIONAL AND MODERN ASPECTS

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# ECOLOGICAL MONITORING

## definition, aim, tasks, base

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- ◆ **Ecological monitoring is the system of regular control observation for the receiving of the information about the environment and for the assessment of the modern its state and changing in future of those environmental parameters, that are important for humanity.**
- ◆ **In the ecological monitoring of soils the main questions are:**
- ◆ **a) the list of parameters of soils properties, that should be controlled;**
- ◆ **b) the available methods for their determination;**
- ◆ **c) the criteria's for the assessing the safety of the soils.**
- ◆ **The theory and practice of ecological monitoring are based on the fundamental laws of biogeochemistry.**
- ◆ **Vladimir Vernadskiy (1863-1945) – founder of science “biogeochemistry. 1926- book “Biosphere” (appearance of life on the planet has changed its state, quickened all processes on the surface of Earth); 1944- doctrine about Noosphere (appearance of Human has created the global transformation of the Nature on the planet; Human have to accept himself the responsibility for the modern and future state of the environment).**

# **INTERANATIONAL AND NATIONAL PROGRAMS OF THE ENVIRONMENTAL PROTECTION**

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**1968 Program UNESCO MAB (Man and Biosphere),**

**1972 Program OON “SKOPE”.**

**Result: the development of the Global System of the Environment Monitoring; its aim: the early finding and prevention of anthropogenic changing in the state of environment, that can be dangerous for people.**

**In Russia:**

**1972- Resolution of the Council of Ministers of Russia about organizing of the National System of observation and the Control of the state and pollution of Environment.**

**1993- Resolution of the Government of Russian Federation about the system of ecological monitoring.**

**In 1978 the Program of the Environmental Protection began to be fulfilled by the National Council on hydrometeorology and the Control of Environment.**

**Now this Program is fulfilled in Russia by organizations: Ministry of Natural Resources and Nature Protection; National Council on hydrometeorology; Ministry of Agriculture; Ministry of Health Protection.**

**Table 1. THE STRUCTURE OF LAND FUND IN RF  
(The National report on the land state and land use in RF, 2010).**

<b>Types of land use</b>	<b>Area</b>	
	<b>million ha</b>	<b>(% of total lands)</b>
<b>- agricultural lands</b>	<b>220,6</b>	<b>12,9</b>
<b>(arable lands)</b>	<b>121,6</b>	<b>7,1</b>
<b>- forest and bushes</b>	<b>784,7</b>	<b>64,3</b>
<b>- marshes</b>	<b>108,2</b>	<b>6,3</b>
<b>- submarine</b>	<b>71,8</b>	<b>1,6</b>
<b>- pasture of deer's</b>	<b>328,0</b>	<b>18,9</b>
<b>-population places</b>	<b>13,4</b>	<b>1,1</b>
<b>- plants</b>	<b>181,9</b>	<b>1,0</b>
<b>Total</b>	<b>1709,8</b>	<b>100,0</b>

# **TYPES OF ECOLOGICAL MONITORING OF SOILS WITH DIFFERENT TYPES OF THEIR DEGRADATION AND USE OF SOILS**

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## **TYPES OF SOIL DEGRADATION:**

**Water erosion, wind erosion, drowning, compaction, desertification, destroying of soil structure, exhaustion of elements of nutrition, acidification, pollution**

## **TYPES OF MONITORING OF SOILS ACCORDING TO THEIR DEGRADATION:**

### **LOCAL AND REGIONAL SOIL ECOLOGICAL MONITORING**

#### **Specific soil monitoring**

***monitoring of soils that are under pollution***

***agrochemical soil monitoring***

#### **Integrated soil monitoring**

***monitoring of desertification***

***monitoring of pasture***

***monitoring of irrigated- meliorated soils***

#### **Universal soil monitoring**

***control of soil quality***

***control of biological soil properties***

***distant soil monitoring***

### **GLOBAL SOIL ECOLOGICAL MONITORING**

## **TYPES OF MONITORING OF SOILS ACCORDING TO THEIR USE**

# **POLLUTION- THE MOST DANGEROUS TYPE OF DEGRADATION OF ECOSYSTEM**

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## **THE DANGER OF POLLUTION FOR THE ECOSYSTEM**

- 1) the influence of pollutants on all components of environment;**
- 2) toxicological influence on all biological types;**
- 3) influence of pollutants on living organisms can be fixed on genetic level, that is dangerous for future generations;**
- 4) environmental contamination can act both on local and regional and at global level.**

## **DANGER OF THE POLLUTION OF SOILS FOR THE ECOSYSTEM**

### **Influence on ecosystem processes:**

- 1) infringement of direct and return streams of chemical elements which connect all components of the ecosystem;**
- 2) infringement of trophic chains of chemical substances;**
- 3) preservation of pollutants in soils during long time, even for ever;**
- 4) the polluted soils can be sources of secondary environmental contamination**

### **Influence on soil properties**

- negative changes of soil properties (biological, chemical, mineralogical );**
- lowering of soil sustainability to pollution.**

# THE WAYS TO ASSESS THE SAFETY CONTENT OF CHEMICAL ELEMENTS IN SOILS

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## Statistical approaches for the assessment of chemical elements content in soils

-average content of chemical elements in the crust of planet ( F.U. Klark, 1889, 1909, USA).

- average content of chemical elements in the soils of planet (A.P.Vinogradov, State Standard, 1990, Russia)

## -Biogeochemical approaches for the assessment of the content of chemical elements in soils of Russia

-integrated environmental investigations, determination of *threshold concentration of chemical elements in soils* (V.V. Kovalskiy,1972, Russia)

-*sanitary - hygienic critical levels (SHCL)* of chemical elements in soils (State Standard, 1983, Russia).

- *field researches: the background content* of the chemical elements in soils of region plus 3 standard deviations,

-field registration of the flows of chemical elements substances in landscapes

## PARAMETERS OF PERMISSIBLE CONTENT OF CHEMICAL ELEMENTS IN SOILS (DEFINITIONS, METHODS OF DETERMINATION)

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**-Threshold concentration of chemical elements in soils (mg/kg)-** concentration, estimated at complex environmental researches and revealing of the borders of normal state of living organisms. V.V. Kovalskiy (1972) on this basis has allocated biogeochemical provinces in Russia.

**Sanitary - hygienic critical levels (SHCL) chemical elements in soils (mg/kg):** such concentration of chemical elements in soils when the state of adjacent environments (water, air) are safe for living organisms; parameter has defined in laboratory trials with animals on the basis of principle a dose: effect.

**Oriented critical levels (OCL) chemical elements in soils (mg/kg):** the differentiated parameters are calculated for 3 groups of soils with various properties (reaction, granulometric structure) on a basis exceeding of the content of heavy metals in soils of natural landscapes with similar properties.

**Sum index of soil pollution (Zc):** sum index of soil pollution (Zc), result of summation of the relative contents of those chemical elements in soils (ratio of absolute content of chemical elements (Ci) to its critical level (CL),  $K_k = C_i/CL$ ) that take into account the number of elements (n) for which parameter  $K_k > 1$ :  
Index  $Z_c = \sum K_k - (n-1)$ .



**Table 2. THRESHOLD CONCENTRATION OF CHEMICAL ELEMENTS IN SOILS, mg/kg (V.V.Kovalskiy, 1972)**

<b>Element</b>	<b>Normal content</b>	<b>Low boundary of threshold concentration</b>	<b>High boundary of threshold concentration</b>
<b>Co</b>	<b>7-30</b>	<b>2-7</b>	<b>&gt;30</b>
<b>Cu</b>	<b>15-60</b>	<b>6-15</b>	<b>&gt;60</b>
<b>Mn</b>	<b>400-3000</b>	<b>&lt;400</b>	<b>&gt;3000</b>
<b>Zn</b>	<b>30-70</b>	<b>&lt;30</b>	<b>&gt;70</b>
<b>B</b>	<b>6-30</b>	<b>6-30</b>	<b>&gt;30</b>
<b>Mo</b>	<b>1.5-4</b>	<b>&gt;1.5</b>	<b>&gt;4</b>
<b>Sr</b>	<b>600</b>	<b>?</b>	<b>600-1000</b>
<b>J</b>	<b>5-40</b>	<b>2-5</b>	<b>&gt;40</b>

Table 3. **Sanitary-hygiene critical levels of chemical substances (elements) in soils (mg/kg)**

Substance (element)	SHCL	Parameter of danger			
		Toxico-logical	Trans-location	Migration	
				Water	Air
<b>Total content</b>					
Nitrate	130	225	180	130	-
Benz(a)peren	0,02	0,02	0.2	0,5	-
Benzol	0,3	50	3,0	10	0,3
Mn	1500	1500	3500	1500	-
V	120	150	170	350	-
Pb	32	32	35	260	-
Hg	2,1	5,0	2,1	33	2,5
<b>Available species of substances (extracted by 1n. CH<sub>3</sub>COONH<sub>4</sub>)</b>					
Cu	3	3	3,5	72	-
Ni	4	4	4	14	-
Zn	23	37	93	200	-
Co	5	5	25	1000	-
Cr	6	6	-	-	-

**Table 4. THE AVERAGE CONTENT OF HEAVY METALS IN THE MAIN GROUPS OF SOILS IN RUSSIA**

<b>Soils</b>	<b>Zn</b>	<b>Cd</b>	<b>Pb</b>	<b>Hg</b>	<b>Cu</b>	<b>Co</b>	<b>Ni</b>	<b>As</b>
<b>Soddy-podzolic sand and loamy sand soils</b>	<b>28</b>	<b>0,05</b>	<b>6</b>	<b>0.05</b>	<b>8</b>	<b>3</b>	<b>6</b>	<b>2,5</b>
<b>Soddy-podzolic loamy clay soils</b>	<b>45</b>	<b>0,12</b>	<b>15</b>	<b>0,10</b>	<b>15</b>	<b>10</b>	<b>30</b>	<b>4,5</b>
<b>Gray forest soils</b>	<b>60</b>	<b>0.20</b>	<b>16</b>	<b>0,15</b>	<b>18</b>	<b>12</b>	<b>35</b>	<b>5,5</b>
<b>Chernozem</b>	<b>68</b>	<b>0,24</b>	<b>20</b>	<b>0,20</b>	<b>25</b>	<b>15</b>	<b>45</b>	<b>7,0</b>
<b>Chestnut soils</b>	<b>54</b>	<b>0,16</b>	<b>16</b>	<b>0,15</b>	<b>20</b>	<b>12</b>	<b>35</b>	<b>6,0</b>

**Table 5. ORIENTED CRITICAL LEVELS OF THE CHEMICAL ELEMENTS CONTENT IN SOILS ( total content; mg/kg) (State Standard, Russia,1994)**

<b>Group of soil</b>	<b>Ni</b>	<b>Cu</b>	<b>Zn</b>	<b>As</b>	<b>Cd</b>	<b>Pb</b>
<b>a) sandy and silty-sandy</b>	<b>20</b>	<b>33</b>	<b>55</b>	<b>2</b>	<b>0,5</b>	<b>32</b>
<b>б) silty and clay , acid (pH KCl &lt;5,5)</b>	<b>40</b>	<b>66</b>	<b>110</b>	<b>5</b>	<b>1,0</b>	<b>65</b>
<b>в) silty and clay, neutral and near neutral (pH KCl &gt;5,5)</b>	<b>80</b>	<b>120</b>	<b>220</b>	<b>10</b>	<b>2,0</b>	<b>130</b>

**Table 6. ASSESSMENT OF THE ECOLOGICAL STATE OF ENVIRONMENT ON THE BASE OF INDEX OF SUM POLLUTION ZC**

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<b>CATEGORY OF POLLUTION</b>	<b>Zc</b>
<b>Permissible</b>	<b>&lt;16</b>
<b>Moderate dangerous</b>	<b>16-32</b>
<b>Dangerous</b>	<b>32-128</b>
<b>Super dangerous</b>	<b>&gt;128</b>

**Table 7. HEAVY METALS CONTENT IN THE AGRICULTURAL SOILS OF MOSCOW DISTRICT (total content, mg/kg)**

<b>element</b>	<b>Level of contamination (<math>C_{me}/CL</math>)</b>	<b>% of lands</b>
<b>Pb</b>	<b>2CL</b>	<b>0,3</b>
<b>Zn</b>	<b>0,5-1 CL</b>	<b>1,2</b>
<b>Cu</b>	<b>3CL</b>	<b>0,1</b>
<b>Ni</b>	<b>3CL</b>	<b>0,01</b>
<b>Hg</b>	<b>0,1-1 CL</b>	<b>0,3</b>
<b>Cd</b>	<b>2CL</b>	<b>0,3</b>
<b>F</b>	<b>3CL</b>	<b>0,1</b>

# THE STATE OF TERRITORY OF CITIES AND INDUSTRIAL CENTERS

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The great sources of pollution of populated area are the mining, metallurgy plants and thermal electricity station. Their influence in many cases is revealed on the distance 5-10 km from these sources , the influence of the plants of mechanical engineering-on 0.5-1 km, auto transport 0,1-0,2 km. The danger situation on the mining lands takes place because of domination of the open way of extraction mineral raw.

The most density of lands with high manufacturing pollution takes place in Ural federal region. The content of heavy metals in soils of some cities exceeds the critical levels 10 or more times (for example Kirovigrad, Resh in 30-50 times). High level of heavy metals content is in the soils of Central region.

In Moscow is sufficient the influence of auto transport and oil refining plants. In Moscow district (population near 20 millions) is the great problem with utilizing of municipal wastes of production and consumption. The total volume of wastes is near 60 millions tons (20 mln consists of the industrial wastes). Every year their content is increasing 4-6%.

Monitoring during 10 last years has shown that in 1-5 km zone from the plants 8% of territory has the dangerous level of pollution, 14%- the moderate level of danger. On the territory of almost 22% of big cities the content of pollutants exceeds their permissible level. The replacement of the top layer of soil is regularly carried out in most cities. There is also conducted the isolation of the polluted lands from the settlements by buffer zones with green plants.

## CONCLUSION

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- 1) The ecological soil monitoring, its program and criteria for the assessment the content of pollutants in soils allow to receive the objective information about the ecological state of soils in Russia.
- 2) The state of soils of Russia are characterized by following features: a) near 20% of arable soils are polluted, the content of different pollutants (pesticides, heavy metals) in most cases exceeds their critical levels 1,5-2 times; b) soils of big cities are polluted predominantly by the wastes of transport and the wastes of mining and metallurgy. Modern ecological monitoring of soils in Russia has shown that the pollution of soils is increasing in time and it really make worse the state of ecosystem.
- 3) Parameters of permissible levels of chemical elements in soils that have been used under monitoring are informative, but they are not enough. It is necessary to improve criteria for an estimation of the content of pollutants in soils in following directions: a) they should have biogeochemical base, b) critical levels of the total content of pollutants and their available (mobile) forms should be worked out for soils with various properties, which provide stability of soils to pollution; c) critical levels of the total content of pollutants and their available (mobile) forms should be worked out for soils of various use; d) they should be able to reflect changes both a toxicological condition of soils, and change of other important properties, which provide the quality of soils.
- 4). The complex of environmental- medical monitoring should be recommended that can provide the simultaneous control of the environmental state and health of people.