The Balkans Scientific Center of the Russian Academy of Natural Sciences

1st International Symposium:

Modern Trends in Agricultural Production and Environmental Protection

PROCEEDINGS

Tivat-Montenegro
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SANITARY-HYGIENE AND EPIDEMIOLOGICAL STATUS OF LAND

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ABSTRACT

The paper deals with: the status of land as a natural environment for the decontamination of exogenous chemical substances, which fall into it; quantitative and qualitative composition of soil microorganisms; sanitary-hygienic and epidemiological importance of the land; sanitary and hygienic measures for the protection of land from pollution. This is significant from the aspect of organization of environmentally safe and health-safe agricultural production, protection of the environment and population.

INTRODUCTION

The land, as a factor of the surrounding environment, exerts an influence on the health of man. The land consists of mineral and organic matter, organomineral complexes, soil microorganisms, and also from soil moisture and air. One of the most important components of the soil is humus, which determines its fertility (Yemtsev, Djukic, 2000; Djukic et al., 2007).

The character of the soil (stony, sandy, clay, etc.) and its properties (porosity, water sustainability, capillary, water and air penetration) must be taken into account when selecting a plot for the construction of objects for different purposes. Water sustainability, ie. the ability to retain water, determines the state of the level of groundwater. The ability of the soil to pass through the air is important for self-cleaning processes, because the oxygen supply allows rapid oxidation of organic matter (Djukic et al., 2013).

The great hygienic nature of the soil, as an element of biogeospheric, is that it not only accumulates different waste, it is also the natural environment of its detoxification. It is used for the detoxification of solid municipal waste (CCW), solid industrial waste storage (CIO), purification and detoxification of wastewaters in the filtration fields and fields of soaking, etc. (Ayaz and Akc, 2000; Đukić et al., 2012, 2013). Pesticides, mineral fertilizers and a variety of chemical substances are introduced into the land, which are dangerous for human health.

Processes aimed at establishing the natural state of the soil are processes of soil self-purification. Organic matter (proteins, fats, carbohydrates) and the products of their metabolism under the influence of microorganisms are dissolved to inorganic matter (mineralization). At the same time, the processes of creation of humus take place in the soil - complex organic matter of the soil that ensures its fertility (Đukić et al., 2007). Mineralization of the final products of degradation of proteins occurs with the help of nitrification bacteria, with the formation of nitrates. Sampling processes of soil lead to its release from biological pollution, pathogenic microorganisms and helminth eggs.

Land as a natural environment for decontamination of waste

Land is a system that ensures life on earth, that is, a part of the biogeospheric process in which detoxification processes (decontamination, decomposition, transformation into non-toxic compounds) take place. The basic mass of exogenous organic matter that arrives at it. Organic matter (in the form of proteins, fats, carbohydrates and products of their metabolism), after falling into the soil, undergo degradation, until the formation of inorganic matter (the process of mineralization).

Along with this process in soil, the process of synthesis (from organic matter waste) of the new complex organic matter of the soil takes place. This matter has been called humus, and the process of its synthesis is called humification. Both processes (mineralization and humification), aimed at establishing the original state of the land, are called processes of self-purification of the land.

The process of detoxification of exogenous organic matter into the soil with wastewater is very complex and is carried out mainly by microorganisms.

Carbohydrates undergo aerobic conditions with transformations, part is oxidized to CO2 with energy separation, part (monosaccharides) goes on synthesis of glycogen microbial cells. Degradation of fat in aerobic conditions takes place very slowly to the formation of fatty acids with energy separation, and under anaerobic conditions - to the formation of H2, CO2 and others. Proteins break down to amino acids. Part of the amino acid is involved in the life activity of microbial cells. Products of nitrogen exchange are subjected to biochemical oxidation by aerobic bacteria. This process is called nitrification. Simultaneously with the oxidation processes in the soil, the reduction processes take place (Jemcev, Đukić, 2000; Garcia de Lomas et al., 2007; Đukić et al., 2012, 2013).

The degree of reducing effect of bacteria, in addition to their biochemical properties, depends on the composition of the environment, its reaction and other conditions. The denitrification process is followed by the separation of gases.

Quantitative and qualitative composition of soil microorganisms

The land is the basic reservoir of microorganisms in nature. Microorganisms condition the process of important processes in the soil, enable the circulation of all biogenic elements, participate in pedogenesis and soil fertility maintenance (Jemcev, Đukić, 2000, Đukić et al., 2007; Gougoulias et al., 2014).

The number of microorganisms in the soil depends on the type of soil, the content of organic matter and water, the climate conditions, the seasons, the degree of pollution of land with industrial waste and other factors and can reach several billion in grams. Even in the desert sand, in conditions of almost complete absence of moisture, in 1 g can be found up to 105 microbial cells. The basic mass of microorganisms is at a depth of 10-40 cm, in the lower horizons of the soil their number decreases according to the reduction in the amount of nutrients and water (Đukić et al., 1996).

It is known that increasing the amount of organic matter in the soil, as a rule, the number of microorganisms increases. Organic matter is a nutrient medium for most of the soil microorganisms. Total stocks of organic matter of the land reach 400 t / ha, many of which are in the surface layer (up to 30 cm) of land. The main component of the organic matter of the soil is the remains of plant and animal tissue, while the live mass of microorganisms per 1 ha of soil (fertilized) is over 5-6 t (Jemcev, Đukić, 2000; Đukić et al., 2000; Đukić et al., 2007). Microorganisms are the richest chernozem, chestnut soil, serozem and specially treated soils. The number of bacteria in 1 g of such land sometimes reaches several tens of billions. Microorganisms are poor sandy and mountainous terrain, as well as lands uncovered by vegetation (Mandić et al., 2002, 2004).

In qualitative terms, soil microorganisms are presented with bacteria, actinomycetes, mushrooms, algae and viruses.

The number and qualitative composition of soil microorganisms is closely dependent on the degree of soil contamination with faeces, urea, but also from the way it is processed and fertilized (Đukić, Mandić, 1993). Thus, for example, in arable land, there are twice as many microorganisms as in forests. Due to the lack of necessary nutrients, the destructive effect of light, drying, the presence of microbial antagonists and phages, pathogens of asporogenic bacteria are maintained in the soil for several days to several months.

Gram-positive sticks and spongy aerobes of the genus Bacillus (Bac. Mycoides, Bac. Subtilis, Bac. Mesentericus, Bac. Megatherium) are constantly found in the soil. They are thrown widespread everywhere, participating in the decomposition of various organic matter in soil and water, causing the deterioration of nutrients, and some species cause the disease of man, animals and plants.

Bac is most often found in the land. cereus, Bac. megatherium and Bac. subtilis. In the soil, spores of the pathogenic microorganism Bac have been maintained for a long time. anthracis, which is a black challenger challenger. Bac. Cereus belongs to microorganisms that are very widespread in nature. Its presence in the soil depends on the content of organic matter. It develops better in soil with neutral or weak alkaline reaction.

The strains of the genus Clostridium (Cl. Sporogenes, Cl. Putrificum, Cl. Perfringens) are also found in different types of soil, particularly in Cl. perfringens. It is found in land that is constantly contaminated. Cl. perfringens of type A and atoxigenic strains are constantly found in the intestine of animals, as they are often in contact with the soil.

In the soil, spores of tetanus (Cl. Tetanus), gas gangrene (Cl. Perfringens), batulism (Cl. Botulinum) and other soil microorganisms have been maintained in the soil for a long time. Getting into the soil, they transform into spores, which can be maintained in the soil for many years.

Cl. Botulinum is primarily a land saprofit. Its distribution depends not only on the geographical location of the area, but also on the season, the character of the chemical composition of the land, its pollution, etc. Cl. Botulinum is found both in forest (2.5 - 3.3%), and in abandoned soil (3.3 - 10%).

It is believed that under favorable conditions (watering, presence of organic matter) Cl. Botulinum in the soil can not only last but also reproduce (Peretruhina, 2005). It can also be isolated from the animals and fish that reside on land, in the sea and in fresh waters. It also develops at the expense of using dead organic soil substrates. In addition, botulism causes are found in a series of animals without any clinical signs; in animal carcasses Cl. Botulinum begins to reproduce and produces toxin.

In the soil there are also turbid aspheric aerobes and optional anaerobes of the genus Pseudomonas (Ps. Fluorescens), Proteus (Pr. Vulgaris) and others. (Djukic et al., 1994; Mandic et al., 1994)

An important indicator of the sanitary condition of the soil is the finding of bacteria of the intestinal stomach group - coliforms and close grampositive cocks - indicator of faecal contamination Ent. faecalis.

Presence in coliform bacteria and enterococcus soil testifies to its faecal pollution (Landry and Wolfe, 1999).

In addition to these bacteria in the soil, Azotobacter species Azotobacteria, nitrification bacteria of the genus Nitrobacter, Nitrospin, Nitrococcus, Nitrospir; Sumpo-oxidizing bacteria of the genus Achromatium, Beggiatoa, Thioploca, Thiospirillopsis and Thiothirix; gastric bacteria, saprophytic coca genus Micrococcus (M. albus, M. candicans, M. cereus flavus), Sarcina (S. ureae) and from the actinomycetes (genera Actinoplanes, Streptomyces, Kineosporia, etc.)

Pathogens of bacteria, viruses, mushrooms and protozoa can be found in the soil. Land as a factor in the transmission of a number of infectious disease agents is a very complex substrate. The length of maintenance of some pathogenic bacteria is presented in the following table (tab 1.3).

Tab. 1.3. Length of bacteria in soil

Bacteria	**Mid-term, Week**	**Maximum time, month**
Salmonella	2 - 3	12
Shigella	1,5 - 5	9
Vibrio	1 -2	4
Micobacterium	13	7
Bacillus	0,5 - 3	several years
Clostridium	1,5	several years

The land serves as a place of residence for different animals, for example, rodents, in which parasitic agents of plague, tularemia, fever, haemorrhagic fever, encephalitis, leishmaniosis, etc. are parasitized. In the soil, a certain stage of pure protozoa (ameba, for example) takes place. The role of land in the transmission of invasions of the mud (ascari, ankilostoma, etc.) is especially significant. Some mushrooms live in the land. Pouring into the body, they cause alimentary-toxic aloe vera, ergotism, aspergillosis, penicillosis, mucocromycosis, histoplasmosis, chromomycosis, and other fungal diseases.

Sanitary-hygienic character of the land

The great hygienic significance of the soil consists in the fact that it contains certain chemical components that the person enters through food, drinking water and, to some extent, through atmospheric air. Increased or decreased concentration of fluoride, iodine, manganese, selenium and other chemical elements leads to the creation of natural or artificial geochemical zones, which play a key role in the development of endemic diseases like fluorose, drowsiness, etc. (Đukić et al., 2011).

The hygienic assessment of the degree of soil contamination by inorganic compounds is based on the comparison of the quantitative content of the given element in the soil with its MDK: for mercury - 2.1 mg / kg, chromium - 0.05 mg / kg, lead - 20 mg / kg, manganese - 1500 mg / kg, arsenic - 45 mg / kg (Djukic et al., 2015).

Organic matter of the land is presented as organic matter (humic acids...), which were synthesized by microorganisms, as well as allochthonous organic matter, which have come to the soil from outside.

In the form of humus substances, huge reserves of carbon are concentrated. The increase in carbon content of organic compounds shows 2 to 3 times the potential contamination of the soil. The ratio of carbon to humus to carbon of plant origin is called the humification coefficient.

The level of soil contamination is also testified to the content of organic nitrogen and the value of the sanitary number or number of Hlebnikov, as well as the ratio of nitrogen humus to total organic nitrogen. In clean land, the sanitary number is close to 1. The smaller the sanitary number, the land is polluted.

Sanitary-bacteriological soil testing (tab 1.1) consists of determining the total number of microorganisms in 1 g, the number of thermophils in 1 g, the co-titer, the titer-perfringen, and in some cases, also from the presence of staphylococci, proteus and pathogenic microbes (Đukić et al., 2011). A very sensitive indicator of fresh faecal contamination of the soil is the vital helminth eggs (in 1 kg). The basic sanitary and anthropological indicator of soil contamination is per unit area of land (0.25 m2).Hygienic soil diagnostics can be performed on the basis of the chemical composition of the soil air (tab. 1.2) and based on the so-called complex parameters.

The increased content of organic nitrogen and carbon without increasing the amount of ammonium nitrogen, low-titer and a large number of helminth eggs testify to fresh faecal contamination of the soil in the absence of mineralization of organic matter. A similar situation, but with the emergence of ammonium nitrogen, indicates the process of mineralization begun. At the same time, the presence of organic nitrogen and carbon, ammonium nitrate, nitrite, nitrate and chloride indicates longer soil pollution and the presence of intense mineralization of organic products. The presence of nitrate, chloride and low titer perfringens indicates a longer-term soil contamination. High content of humus nitrogen and approaching the number of breadwinner units - a reliable indication of intense humification land.

Tab. 1.1. Hygienic soil assessment based on complex parameters

Characteristics of the land	**Number of larvae and puppets at 0.25 m2**	**Number of helminth eggs per 1 kg of soil**	**Koli-titar**	**Titar-prefringens**	**Sanitary Number of *Hlebnikova***
clean	0	0	1,0 and more	0,1 and more	0,98 - 1,0
little contaminated	1 - 10	Up to 10	1,0 - 0,01	0,1 - 0,001	0,85 - 0,98
contaminated	10 -12	11-100	0,01 - 0,001	0,01 or less	0,70 - 0,85
very contaminated	100 and more	more than 100	0,001 and less	0,0001 and less	0,70 and less

Tab. 1.2. Hygienic soil diagnostics based on the chemical composition of the soil air

Land character	**Content in the land air (at 00C, pressure 760 mmHg) at a depth of 1 m, volume. %**			
	CO_2	**O_2**	**CH_4**	**H_2**
Practically clean	0,38 – 0,80	0,3 – 19,18	-	-
Poorly contaminated	1,2 – 2,8	19,9 – 17,7	-	-
Medium polluted	4,1 – 6,5	16,5 – 14,2	-	-
Very contaminated	14,5 – 18,0	5,5 – 1,7	0,8 – 2,7 and more	0,3 – 3,4 and more

The hygienic significance of soil humidity consists in the fact that all chemical substances, as well as biological soil contaminants (helminth eggs, bacteria, viruses) can be moved in it only with soil moisture. In addition, all chemical and biological processes that take place in the soil, including its self-purification from organic compounds, are carried out in aqueous solutions (Djukic et al., 2012).

The hygienic significance of the soil consists in the fact that it is a huge, natural laboratory, in which the processes of synthesis and degradation of organic matter take place, photochemical processes, the formation of organic and inorganic matter, the death of many bacteria, viruses, protozoa and eggs of helminth. The land is used for purification and detoxification of waste, dirt, waste, exhibits influence on the climate, vegetation development, etc.

So, the land exerts a great influence on the health of the population, it has great hygienic significance and it appears: 1) the main factor in the formation of natural and artificial spaces that play a leading role in the formation and prophylaxis of endemic diseases; 2) the environment that ensures circulation in the system "external environment - the human" of chemical and radioactive materials, as well as exogenous chemical substances that fall into the land with the waste of industrial enterprises, autotransport, wastewater, etc .; 3) one of the sources of chemical and biological pollution of atmospheric air, underground and surface waters, as well as plants that people use for food; 4) the transmission factor of infectious diseases; 5) natural, most suitable environment for disinfection and detoxification of liquid and solid waste (Đukić et al., 2011).

Epidemiological significance of the land

The epidemiological character of the soil consists in the fact that it is a suitable environment for the development of microorganisms and eggs of helminth and serves as a factor in the transmission of many infectious and parasitic diseases.

The largest number of microorganisms are found in soil at a depth of 5 - 10 cm. Permanent landowners are sporadic aerobic and anaerobic bacteria, as well as other bacteria that participate in self-purification processes.

The epidemiological hazard of the soil consists in the fact that pathogenic spore anaerobic bacteria are constantly inhabited there in it - tetanus, gas gangrene, and spores of the black cauliflower and botulinum sticks, which cause severe human disease. Acute intestinal infections can be found in soil contaminated by human faeces. The contaminated land may have the role of transporter of abdominal typhus and paratyphoid, salmonellosis, bacterial and amebic dysentery, cholera, viral hepatitis A, polyomyelitis, tuberculosis, jersiniosis, lambliosis and helminthosis (ascoridosis, trichochecephalitis, etc.). The bacteria of the typhus-paratyphic group survive in the soil for about 2-3 weeks, and in favorable conditions and for several months. Tuberculosis myobacteria and poliomyelitis viruses in the soil can be maintained for more than 3 months (Flores-Tena et al., 2007; Ghodbane et al., 2014).

Egg geohelminate (ascorhide and nematode that parasitize in human blindness, causing trihocephalosus) carry in the soil the maturation stage to the invasiveness state, i.e. the ability to infect a person, for 2-3 weeks to 2 - 3 months. The eggs of these helminates can be kept in the soil for 7-10 years.

The epidemiological importance of the soil consists in the development and fertilization of the flies which are the transmitters of the pathogens of intestinal infections. In the soil, rodents often live in the soil for infectious agents of leptospirosis, jersinrosis, tularemia, etc.

When choosing a plot for the construction of buildings for different economic purposes, it should be kept in mind that the ability of the land for self-purification is limited. Land protection, self-cleaning, sanitation and the fight against insects and rodents is of great hygienic significance.

In order to determine the quality and degree of soil safety in the territory of settlements, hygienic assessment of the land is carried out in the spa zones and other important territories, with the compulsory compilation of the sanitary and epidemiological conclusion on its condition and the benefits for construction, recreation and other purposes (Đukić et al., 2011; Kalwasińska et al., 2012).

Sanitary-epidemiological assessment of soil is done on the basis of sanitary-bacteriological indicators in the presence of the causative agent of intestinal infections, pathogenic bacteria, enteroviruses, sanitary-indicator microorganisms; based on sanitary-parasitological indicators - in the presence of the triggers of intestinal parasitic diseases (geohelmintosis, lambliosis, amebiosis, etc.); based on sanitary and toxic indicators - on the content of chemical pollution; based on sanitary-chemical (sanitary number, content of organic matter) and presence of flies and fly dolls.

For land, maximum permissible concentrations of chemical substances, including heavy metals, pesticides, petroleum products, etc. are determined. Pathogenic bacteria, eggs of helminth, larvae and fly dolls must not be found in clean soil. The index (quantity) of the bacteria of the intestinal tract group (BGCS) and the enterococcus index must not be greater than 10 in grams of soil.

Sanitary-hygienic measures for the protection of land from pollution

The central methodological issue is the determination of MPK (maximum permissible concentration) of exogenous chemical substances in the soil (Figure 1.2). This means that its maximum quantity in the soil (in milligrams per 1 kg of dry soil) which in direct contact with man does not cause a negative effect on his health.

In the first stage, the physical-chemical properties of matter and their stability in the soil are studied.

The second stage is the explanation of the scope of experimental research and the orientation threshold concentrations in relation to each indicator of harmfulness (Semenov and Đukić, 2017; Đukić et al., 1999, 2000).

At the third stage of the study, a laboratory experiment is set up to demonstrate supportive concentrations for six indicators of harmfulness. The organoleptic indicator of harmfulness is characterized by the degree of change in the nutritional value of products of plant origin, as well as the odor of atmospheric air; flavor, color and aroma of water and nutrients.

The common-sense indicator of harmfulness is characterized by the influence of exogenous matter on the self-purifying ability of the soil and its biological activity. The accumulation indicator refers to the standardization of the chemical substance that passes from the soil through the root system to the plant and accumulates therein (Djukic et al., 2009, 2015; Mandic et al., 2009). The migration water indicator is characterized by the process of migration of the studied matter into surface and groundwater. The migration air pollutant characterizes the processes of transferring chemical matter from the soil into atmospheric air by evaporation. The toxicological indicator characterizes the degree of toxicity of exogenous chemical substances for warm-blooded organisms in complex and associated (land dust and chemical matter) the entry of compounds with water, food, etc. in the organism of experimental animals.

The fourth stage determines the size of maximum permitted levels of input (MDNU) and the harmless residual amount (BOD) for chemical substances in the specific soil-climatic conditions.

On the fifth stage, the impact of soil contaminated with exogenous chemical substances is studied on the health of the population in order to correct the hygiene norms for chemical contaminants (MDC, MDNU, BPK).

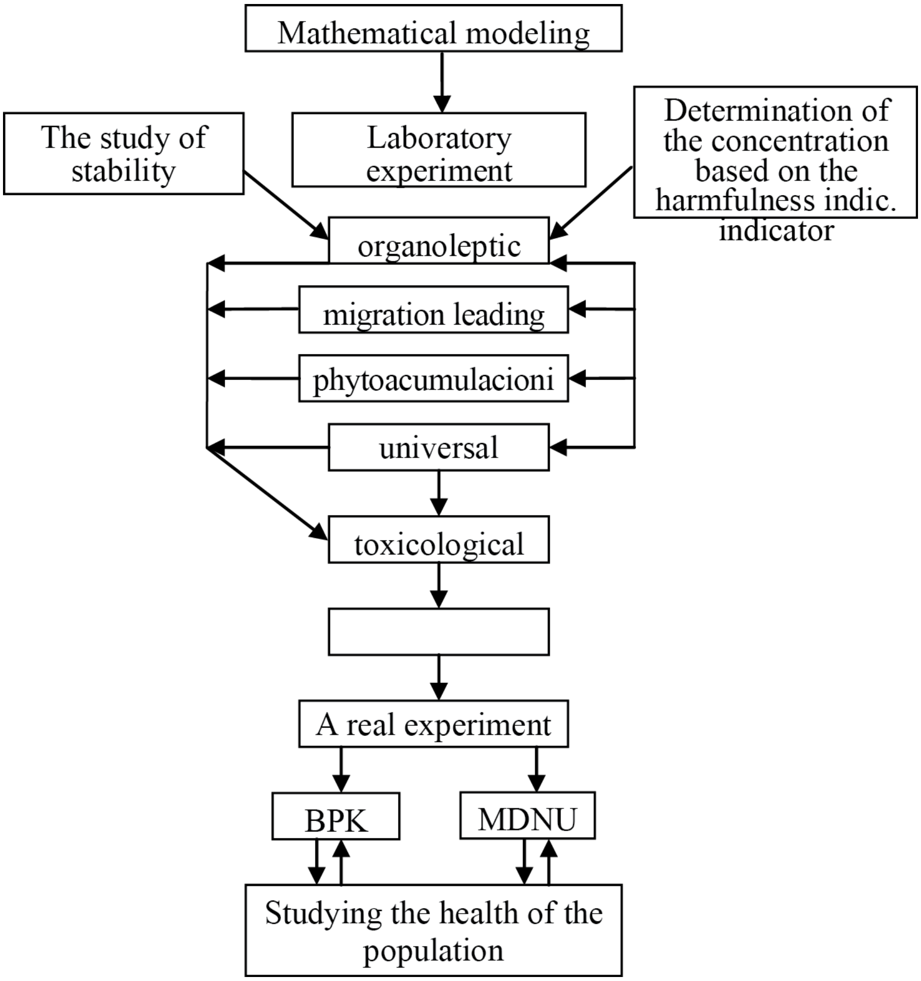

Fig. 1.2. Standardization of exogenous chemical substances in the soil

Sanitary protection of land means a complex of measures aimed at limiting the introduction of polluted land to quantities that do not disturb the processes of self-purification in the soil, do not cause the accumulation of harmful substances in plants in quantities that are hazardous to human health and which do not cause air pollution, surface and groundwater and deterioration of the sanitary condition of settlements (Đukić et al., 2000, 2008).

The objective of sanitary protection of the soil is the prophylaxis of infectious and parasitic diseases, for which the soil has the role of transmitter, and also acute and chronic poisoning with chemical substances.

Measures can be divided into several groups (Djukic et al., 2011):

1. Legislative, organizational and administrative measures, which implies a system of legally established measures aimed at preventing land contamination, ensuring rational utilization of land resources in the interest of preserving and improving the health of the population.

2. Plan measures that include the correct allocation of parcels for the construction of detoxification and waste utilization facilities and respect for sanitary protection zones around them, and others.

3. Technological measures aimed at raising technological production schemes with little or no waste.

4. Sanitary-technical measures for collecting, removing, detoxifying and utilizing waste (sanitary cleaning of settlements).

Sanitary cleaning of populated places means a complex of measures aimed at collecting, removing, detoxifying and destroying solid waste that occurs in populated areas in order to preserve the health of the population and overall editing.

Waste is divided into two groups: liquid and solid. Liquid waste belongs to impurities from the toilet, washed (from preparing food, washing of dishes), waste water (municipal, industrial, atmospheric, from wash of sidewalks, etc.). Solid waste belongs to garbage (household etc.), street garbage, social food waste (food residues), waste of industrial and commercial enterprises, solid manure and animal waste (animal corpses, manure), slag from liquids and industrial waste.

There are three systems of waste disposal:

1. rafting (sewage);

2. export (in non-analyzed populated areas). This way of removing solid waste is called cleaning, and liquid waste - asenization;

3. mixed (in partially sewed points).

Solid municipal waste can be collected by means of garbage pipes (in residential buildings), stationary and mobile containers. More recently, waste water pipelines are used (pneumatic removal of garbage).

The areas on which the containers are placed must be kept away from houses, children's institutions, sports grounds and resorts at a distance of at least 20-25 m.

Waste must be subjected to detoxification to prevent the spread of infection.

Detoxification modes must comply with the following requirements:

- harmlessness of waste, especially medical, in epidemiological terms;
- rate of detoxification of waste;
- preventing the development of fly flies and creating a favorable environment for the development of rodents;
- rapid transformation of organic matter into compounds that do not dissolve and do not pollute the air;
- protection of surface and ground waters against pollution;
- maximum and safe utilization of useful properties of waste.

Solid waste can be sprayed (processing into organic fertilizers, biological fuel, etc.) and removed (burying, landing, burning).

According to technology, detoxification methods are divided into:

1) biotermic (improved dumps, fields of scrubbing, fields of attenuation);

2) thermal (burning in special furnaces at a temperature of 900 - 10000C, pyrolysis with the production of gaseous fuel and naphtholic oils at a temperature of 16400C and a deficit of oxygen);

3) chemical (hydrochloric or sulfuric acid at high temperature for the production of ethyl alcohol);

4) mechanical (pressing into building blocks).

The most common are biochemical and thermal methods. It is a better biotermic way that is often applied in the form of composting. In order to form a compost, a flat surface is charged (blasting) with clay and surrounds it with a clay of 10-15 cm in height and a channel, the width of the space is 1.5 - 2 m, and the length - if desired.

Composting material (peat, soil) is applied to the selected area in a layer of 10 - 15 cm, then a layer of garbage up to 15 cm is applied, sprinkled with a layer of composting material. Then a layer of garbage is applied again, until the height of the compost reaches 1.5 m. Compost is covered by straw ages. Thanks to the activity of thermophilic microorganisms in the compost, biochemical processes take place, and the garbage is heated to 50 - 700C, organic matter is mineralized, and pathogenic microorganisms, eggs of helminth and larva fly are dead. Every 1 - 2 months the compost is shaken or otherwise periodically moistened. The maturation process lasts 3 - 12 months. The matured compost is loose, the bulk of the dark-earthy to the dark-yellow color. The advantages of composting consist in the fact that the surrounding environment is not polluted, pathogenic microorganisms are destroyed and valuable fertilizer is obtained (Đukić et al., 2012).

Conclusion

Theoretical and experimental experiences from this field point us to several basic conclusions:

- in the soil there are processes of humification and dehumification that contribute to the establishment of the original condition in it, which makes its self-purification;
- the quantitative and qualitative composition of the soil microorganisms is in close correlation with the degree and type of pollution, which can serve as reliable indicators of soil contamination;
- sanitary and hygienic assessment of the land is based on the content of soil moisture, air, various chemical elements, inorganic and organic matter, the total number of microorganisms, saprophytic and pathogenic microorganisms, helminth eggs and some insects;

- Sanitary-epidemiological assessment of the land is done on the basis of sanitary-indicator micro-organisms, sanitary-parasitological, sanitary-toxicological and sanitary-hygienic indicators, as well as the presence of flies and fly dolls;

- In order to protect the soil against pollution, measures of limited introduction of various pollutants are undertaken in order to preserve the self-purifying ability of the soil, prevent the accumulation of harmful substances in plants and their emissions into the air, surface and groundwater, thus maintaining the favorable sanitary condition of the settlements, etc..

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