Solutions of contemporary problems of environmental safety as a component of national security

L M Popova¹, S A Skochko² and O V Nesterenko³

¹ Kharkiv National University of Civil Engineering and Architecture, Kharkiv, Ukraine;
² International Research and Design Center for Research and Examination of Climate Change and Community Development, Kharkiv region, Ukraine;
³ Kharkiv National University of Civil Engineering and Architecture, Kharkiv, Ukraine

*Corresponding E-mail: image.center@kstuca.kharkov.ua;
Liliya.herman01@gmail.com

Abstract. One of the priorities of the national interests of each country is to ensure environmental security as a component of national security. At the same time, among the current and projected threats to national security and national interests of almost all countries of the world are the consequences of climate change and the growth of man-made pressure on the environment. Therefore, today it is necessary to find ways to solve modern problems of environmental safety, including climate safety, which is the purpose of this scientific work. A promising way to reduce the risks of global climate threat is to ensure the environmental security of each country, which provides for the introduction of green technologies on the principle of construction of biopower plants in combination with poultry and livestock farms, as well as in combination with organic raw materials from the population, agricultural enterprises, utilities. In addition, it is planned to obtain biogas as an "alternative fuel", which will produce electricity and heat, which will be used in lighting and heating of buildings. To prevent the complication of the environmental situation and reduce the intensity of climate change, it is proposed to reduce the area of landfills for organic raw materials. Analysis of soil contamination was conducted near the landfill for solid waste in Lozova city (Ukraine), from which the results of research.

Keywords: Environment, Safety, Climate, Technologies

Track Name: Human, Social, Economic and Environmental Sustainability

1. Introduction

Climate observations confirm the fact that recent years have become the hottest for the planet in human history. This article examines the harmful factors influencing climate change and related to the
use of biogas in landfills for solid household and organic waste, including livestock and poultry farms, as well as treatment plants [1-5].

Atmospheric air, soil, water and adjacent areas that affect warming and climate are studied as general indicators of pollution. The study was conducted in the city of Lozova, Kharkiv region (Ukraine), where there are large enterprises and solid household waste. Areas were surveyed for "soil respiration" and other studies were conducted. In this region, the duration of droughts has increased in recent years. In addition, in this region there are periods when it rains and hails, hurricanes occur, which leads to the effects of climate change (including the emergence of new insect pests, road problems, etc.). The purpose of this scientific work is to find ways to solve modern problems of environmental, including climatic, safety. The following research methods were used in this scientific work: bioindication method (allows to determine the level of danger of man-caused load on soil ecosystems), envelope method (by means of which soil samples were taken at a depth of up to 4 centimeters). In addition, according to regulatory methods, chemical and physiological parameters of soil samples were determined.

2. Actuality

There are currently problems with the use of fossil fuels, such as oil, carbon and gas. There is a need to replace them with renewable and environmentally friendly energy sources, while increasing energy efficiency with the introduction of new technologies. It is also advisable to reduce CO2 emissions, which will lead to a transition to a "green" energy supplier. The establishment of an environmentally friendly food production system in agriculture will help reduce hydrofluorocarbons, which are chemicals. They are used both in agricultural machines of refrigerating type, and in the conditioners established in buildings. Reducing emissions of harmful hydrofluorocarbons into the atmosphere reduces the likelihood of an irreversible climate threat, as hydrofluorocarbons have a 9000-fold stronger effect on warming than CO2 emissions.

Based on observations of the steppe zone of Ukraine, a conclusion is made about the increase in the area of such a zone and the increase in aridity. Farming there is becoming increasingly difficult, because it requires constant irrigation. We see either a lack of water in rivers that dry up in the dry summer, or severe floods. The introduction of rainwater reclamation technologies is quite expensive and inefficient, which reduces the suitability for food needs of both humans and animals. Therefore, drip root nutrition of plants is more favorable for environmental safety not only in this region but also on a global scale. After all, in recent years we have seen that with irreversible climatic processes after heavy winter snowfalls in March there is a sharp warming, and all this water does not have time to absorb into the soil, but goes into rivers, and leads to flooding of many areas.

The problem of environmental safety, which is associated with the intensity of climate change due to man-made pressures on soil ecosystems, is now becoming increasingly important. As a result of the creation of large areas of landfills for the disposal of organic raw materials in the form of solid household waste, there was a problem of catastrophic reduction of biological activity of soils. Environmental protection, rational use of natural resources, ensuring the ecological safety of human life is an integral condition for sustainable economic and social development of Ukraine. To this end, the state implements environmental policy aimed at preserving the safe for living and inanimate environment, protection of life and health from the negative effects of environmental pollution, achieving a harmonious interaction of society and nature, protection, rational use and reproduction of natural resources [1-4].

Today, Ukraine is an active participant in international relations, maintains diplomatic relations with 150 countries, and economic relations with 75 countries. External relations are diverse in form, scope, areas of implementation and are characterized by certain specifics of life and development of foreign countries [2]. Therefore, an important issue for Ukraine is to adhere to the "culture of environmental security" [3] on the path to European integration and positioning itself as a developed country in the international space.
Existing state building codes in force in Ukraine establish climatic parameters that are used in the design of buildings and structures, heating, ventilation, air conditioning, water supply, energy passport of the house, as well as in the planning and construction of urban and rural settlements [6]; aimed at ensuring the rational use of energy resources for heating, cooling and hot water supply, ensuring the normative sanitary and hygienic parameters of the microclimate of the premises, the durability of enclosing structures during the operation of buildings [7]. However, the current period of production of electricity and gas, biogas [4, 8] from fossil fuel fields is characterized by their depletion and unprecedented pollution of all geospheres, along with excessive emissions of methane, carbon dioxide, hydrogen sulfide, oxygen and other emissions into the air, heat energy through the enclosing structures of buildings and infrastructure. In addition, there are other factors that contaminate soils, groundwater, water bodies, rivers and other objects. All this affects the destruction of the ozone layer and increases the greenhouse effect, resulting in climate change.

The most common sources of methane emissions into the atmosphere are "solid waste landfills", treatment plants [9] and infrastructure facilities with low "heat transfer coefficients" [6, 7]. To implement the climate project, the authors Popova LM, Skochko SS, Nesterenko OV propose the first test version of the software product series of automated climate safety design systems, which allows to automate the design of the project to protect the environment and climate in general, and allows to prepare and implement project documentation for the construction of bioelectric power plants of secondary organic raw materials and other buildings and structures.

Thus, in order to prevent the complication of the environmental situation and reduce the intensity of climate change, it is proposed to reduce the area of landfills of the disposal of organic raw materials imported to landfills for solid household waste in the form of household waste and industrial waste. Organic raw materials will be taken from the population, agricultural enterprises, utilities and exported to the bioelectric power plant of secondary organic raw materials to produce biogas as an alternative fuel [11 - 15], from which electricity will be produced. At the same time, organic raw materials after receiving biogas from it are converted into organic biological fertilizers, which can be an alternative to inorganic fertilizers. In general, biofertilizers can displace the use of pesticides and agrochemicals in the agro-industrial complex, which are inorganic fertilizers [16, 17] and belong to the class of inorganic chemistry.

The obtained solid biological fertilizers from liquid organic raw materials can be used for simultaneous hydraulic reclamation of lands [18] and application of organic fertilizers, which will ensure both reproduction and rational use of lands and hydraulic reclamation of lands by sub-root fertilization of plants. This will ensure the reproduction of surface water resources and will lead to the conservation, reproduction and inexhaustible use of biological diversity, reducing the likelihood of inorganic chemicals entering the soil and water bodies.

The method of bioindication allows to determine the level of danger of man-caused load on soil ecosystems. One of the most objective criteria for assessing the functional state of soil ecosystems is the enzymatic activity of soils [17]. However, as is known from the scientific literature, enzymes react differently to soil contamination by pollutants [18-20]. Experimental research was conducted on the basis of the research laboratory of the Department of Life Safety and Engineering Ecology of Kharkiv National University of Construction and Architecture. Soil samples were taken by envelope method at a depth of up to 4 centimeters. Sample preparation was performed according to regulatory methods. In
Soil samples were determined chemical and physiological (respiration rate - ID) indicators on MSW, 10-2 ml CO2 / g g. 

Soil sampling points in the areas adjacent to the landfill for solid household waste in Lozova Lozova city (Ukraine) are shown in Figure 1. In Figure 1 section №1 is the body of the landfill for solid household waste; №2 is a site located at a distance of 1 meter from the body of the landfill for solid household waste; №3 is a site located at a distance of 5 meters from the solid household waste landfill; №4 is a site located at a distance of 20 meters from the solid household waste landfill; №5 is a site located at a distance of 50 meters from the solid household waste landfill; №6 is a site located at a distance of 200 meters from the landfill for solid household waste. 

Figure 1 shows that directly near the landfill for solid household waste, the respiratory activity of soils is completely suppressed. The obtained research results are shown in Table 1.

![Figure 1. Soil sampling points in the territories adjacent to the solid household waste landfill in Lozova city (Ukraine).](image)

**Table 1.** Intensity of soil respiration and the distance to solid household waste.

| Name                        | Numbers of research points / Distance from the object of research (meter) |
|-----------------------------|-------------------------------------------------------------------------|
|                             | 1/solid  | 2/1  | 3/5  | 4/20 | 5/50 | 6/200 |
| Catalase activity           | 0,0125   | 0,0125 | 0,0125 | 0,0125 | 0,0125 | 0,02 |
| Intensity of "soil respiration" | 4,5 | 4,8 | 6,15 | 2,25 | 5,1 | 5,85 |

Soil respiration was determined by the Galstyan method, which is based on determining the intensity of CO2 release by the soil sample. Soil respiration was determined by a method based on determining the intensity of soil respiration by determining the concentration of carbon dioxide in the soil atmosphere. The intensity of carbon dioxide production was determined by the formula in mg CO2 per 100 g of soil per day.

\[
SR \frac{V_2 - V_1}{m \cdot T}
\]
where $SR$ – the intensity of soil respiration;
$V_1$ – the volume that $HC_l$ was used for titration without soil, ml;
$V_2$ – volume, $HC_l$ spent on titration of the experiment, ml;
$m$ – soil sample, g;
$T$ – exposure time, hour.

Catalase activity was determined by measuring the rate of decomposition of hydrogen peroxide when it interacts with the soil. This indicator was determined by the permanganite method - titration of soil aqueous extract with a solution of KMnO$_4$ [4, 7, 8]. Catalase activity was calculated by the formula:

$$KA_n = \frac{V_{KMnO_4} \cdot 3}{m \cdot T},$$

where $KA_n$ – catalase activity;
$V_{KMnO_4}$ – volume of manganese permanganate spent on titration of the sample, ml;
$m$ – sample of soil, g;
$T$ – exposure time, minutes.

Catalase activity was expressed in cm$^3$ of 0.1 normal KMnO$_4$ solution per 1 g of dry soil for 20 minutes. The results of the determination are presented in Table 1.

To determine the content of petroleum products in the soil, we used the gravimetric method, which determined the concentration of petroleum products in all soil samples. Soils were selected from the landfill according to the method based on extraction of organic matter from hexane, evaporation and removal of solvent, separation of polar compounds on a column of alumina, removal of solvent and gravimetric measurement of residual mass.

A soil sample weighing 20 g was placed in conical flasks with a volume of 250 cm$^3$ with a ground stopper, 50 cm$^3$ of hexane was added, closed with a glass stopper and shaken (using a special apparatus) for 15 minutes. The operation of processing soil samples with hexane was repeated three times. After settling, the extract was carefully filtered into a 250 cm$^3$ flask, avoiding contact with soil particles. The extract was then transferred to a porcelain cup, which was previously brought to constant weight, and evaporated in a water bath in a fume hood to remove the solvent.

The content of petroleum products in the sample volume was determined as the difference between the weight of the cup with the residue after removal of the solvent and the weight of the empty cup. The concentration of petroleum products in the studied soil sample ($C_{PPg}$, mg / kg) was determined by the formula:

$$C_{PPg} = \frac{(m_2 - m_1) \cdot 1000}{M_{ss}}$$

where $C_{PPg}$ – concentration of petroleum products in the studied soil sample;
$m_1$ – the mass of the porcelain cup used in the analysis, mg;
$m_2$ – weight of porcelain cup with extracted petroleum products, mg;
$M_{ss}$ - mass of soil sample, g;
1000 - conversion factor, mg / kg.

The research results are presented in the Table 2.
Table 2. The content of petroleum products in the soils adjacent to the landfill of solid household waste.

| Selection point / Distance from the landfill, meter | Distance from the landfill for solid household waste, meter | The content of petroleum products, mg/kg |
|---------------------------------------------------|--------------------------------------------------------|----------------------------------------|
| 1/solid                                           | solid                                                  | 180                                    |
| 2/1                                               | 1                                                      | 160                                    |
| 3/5                                               | 5                                                      | 140                                    |
| 4/20                                              | 20                                                     | 130                                    |
| 5/50                                              | 50                                                     | 120                                    |
| 6/200                                             | 200                                                    | 103                                    |

The tables show that directly near the solid waste landfill the respiratory activity of soils is completely suppressed, and catalase activity increased by 20% compared to point 3, selected at an environmentally friendly distance from the landfill for solid household waste. The concentration of petroleum products did not exceed 200 mg / kg. With increasing distance from the landfill for solid household waste, the concentration of petroleum products decreased by 2 times, which may have in some way affected the activity of catalase, which had a direct relationship with the concentration of petroleum products.

3. Conclusions

Thus, the intensity of soil respiration indicates the physiological state of soils, while catalase activity manifests itself as an enzyme of stress factor, which indicates an increase in the concentration of pollutants in the soil, which significantly increase their enzymatic activity. The research provides an opportunity to reduce the risks of climate threat and man-made stress, as well as to prevent the complication of the environmental situation and, accordingly, to ensure national security.

An integrated approach to solving environmental safety and rational use of organic raw materials allows to create high-quality organic biological fertilizers, the application of which into the soil both in liquid and solid or moist conditions will increase yields and protect and reproduce bioresources. This will ensure: protection of the environment and atmospheric air; reducing the likelihood of rapid development of the climate threat.

References

[1] Law of Ukraine “On environmental protection” dated 25 June 1991, №1264-XII. URL: https://zakon.rada.gov.ua/laws/show/1264-12#Text
[2] Popova L M 2018 Administrative and legal Bases of Control in the Field of Entrepreneurial Activity: a monograph. Kharkiv: Maidan 536
[3] Barbashev S V 2019 On the concept of safety culture and its application in the environmental sphere. Environmental safety: problems and solutions: Coll. Science. Articles of the XV International Scientific and Practical Conference “Environmental safety: problems and solutions” 326 p. 18-22
[4] UN Framework Convention on Climate Change. URL: https://zakon.rada.gov.ua/laws/show/995_044#Text.
[5] National Standard of Ukraine DSTU-N B 1.1-27: 2010 “Protection from dangerous geological processes, harmful operational influences, from fire. Construction climatology”. URL: https://dbn.co.ua/load/normativy/dstuzbv_1_1_27_2010/5-1-0-929.
[6] State Building Standards DBN B.2.6-31: 2016 ”Thermal insulation of buildings” Information Bulletin of the Ministry of Regional Development, Construction and Housing of Ukraine, 2017. URL: https://www.minregion.gov.ua/wp-content/uploads/2017/02/DBN-V.2.6-31-2016-Teplova-izolyatsiya-budivel.pdf.
[7] Sherenkova I A & Nesterenko O V 2009 Aerobic-anerobic bio-pond for biochemical treatment of wastewater contaminated with organic impurities and biogas production
[8] Yurchenko V A, Skochko S A & Nesterenko O V 2015 Possibilities of obtaining and utilizing biogas at solid household waste landfills. Scientific Bulletin of Construction. Kharkiv: KhNUBA, KhOTV, ABU 48 2 S.194-199
[9] Yurchenko V A, Skochko S A & Nesterenko O V 2016 Utilization of organic waste by processing in biogas plants to obtain biofertilizers Scientific Bulletin of Construction. Kharkiv: KhNUBA, KhOTV, ABU 84 (2) 329-332
[10] Zaitseva V G, Nesterenko O V & Onishchenko N G 2017 Greening of technologies and waste utilization Scientific Bulletin of Construction. Kharkiv: KhNUBA, KhOTV, ABU 1 (87) 225-228
[11] Zaitseva V G & Nesterenko O V 2017 Industrial waste management system in Ukraine Scientific Bulletin of Construction. Kharkiv: KhNUBA, KhOTV, ABU 2 88 С272-276c
[12] Skochko S A, Nesterenko O V & Samokhvalova A I 2018 Investigation of activated sludge biocenosis at treatment facilities Scientific Bulletin of Construction. Kharkiv: KhNUBA, KhOTV, ABU 2 (92) S.274-278
[13] Zaitseva V G et al 2020 Environmental protection measures to address the problem of environmental protection in Ukraine Scientific Bulletin of Construction. Kharkiv: KhNUBA, KhOTV, ABU 2 100 S.274-278
[14] Krasnyansky M Yu 2018 Environmental safety: a textbook. Kyiv: Condor Publishing House 180 p. P.46
[15] Khadoba V & Chikailo Y 2016 Ecology: teaching method. way Lviv: LDUFK 92 p.34 p.