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THE INFLUENCE OF DESERTIFICATION FACTORS IN THE REPUBLIC OF MOLDOVA AND THE TASKS TO COMBAT IT

Cojocaru Olesea*#, Bacean Ion*

*State Agrarian University of Moldova, Agronomy Faculty, Department of Agroecology and Soil Science, 50 Mircesti, MD-2049, Chisinau, Republic of Moldova,
e-mail: o.cojocaru@uasm.md

Abstract

Environmental protection is a problem of global importance, which must become a national priority, because it directly concerns the living conditions and the health of the population, the achievement of economic interests, as well as the capacities of sustainable development of the society. Desertification is considered one of the main global economic problems, in particular because of the reciprocal link between land degradation and food production. Desertification, land degradation and droughts are a danger to human food security, reducing agricultural production and even destroying homes. According to the evaluation of the United Nations Environment Program due to the desertification process, over 40 million ha were severely affected. Every year over 900 million people are subjected to the negative influence of desertification processes. In the Republic of Moldova, soil degradation and desertification processes are conditioned by both natural conditions and anthropogenic factors. Among the natural conditions are the climatic phenomena (torrential rains, frequent periods of drought and drought, strong winds), the rugged relief, the lithogenesis and the composition of the rocks from the earth's surface. Currently, on the territory of the Republic about 40 % of the agricultural lands have soils eroded of different degree: weakly eroded - 23.2 %, moderately eroded - 11.7 and strongly eroded - 4.9 %. Each year the surface of the eroded land increases by an average of 0.9 %, and the annual losses of fertile soil are estimated at 26 million tons. The balance of humus is profoundly deficient, the reserves of humus decrease annually by about 1 t/ha, the nutrients by 180 - 200 kg/ha. The damage caused to the national economy by the loss of production through soil degradation amounts to about 3.1 billion lei (251 million USD) annually. The degradation of the soil cover and the drying of the climate during the spring-summer period lead to the intensification and extension of the desertification processes of the lands.

Key words: environmental protection, chernozem, desertification, natural and anthropogenic factors, soil degradation processes

INTRODUCTION

Human influence on the environment is becoming more and more violent, and the consequences of intervention in the laws of natural processes are increasingly harmful. From the current processes conditioned by the anthropic activity, a special role belongs to the desertification. By definition, desertification is a complex process of land degradation in arid, semi-arid and sub-humid-dry areas due to climate change and non-human activities. Desertification affects the natural areas and soils of Moldova in different ways (Andrieș, 2005; Cerbari, 2000). Taking into account the need to address this new problem, the Parliament of the Republic of Moldova on December 24, 1998 adopted the Decision no. 257-XIV regarding the

Corresponding author

accession of the Republic of Moldova to the UN Convention for combating desertification in countries severely affected by drought and desertification.

In accordance with this Decision, the Government of the Republic of Moldova obliged the Ministry of Environment and Territory Planning, the State Service "Hidrometeo" and the National Institute of Ecology to elaborate the National Action Program for Combating Desertification in the Republic of Moldova. This Program was approved by the Government Decision of the Republic of Moldova no. 367 of April 13, 2000. The purpose of the mentioned Program was to identify the factors contributing to desertification and the practical measures needed to combat desertification and reduce the effects of drought in the Republic of Moldova. With the support of the international community, a systematization of information on degraded lands was undertaken in 1998-2000. Based on this assessment, maps of degraded-eroded areas and drought-exposed areas were published (Andrieș et al., 2008; Andrieș and Filipciuc, 2012). In the curricula for university courses in the field of agriculture and environmental protection, aspects regarding sustainable land management and combating desertification were introduced. The country also benefited from technical and financial assistance for the elaboration of the National Action Program for Combating Desertification and the National Report on the Implementation of the Convention.

The Republic of Moldova is located in the South-East part of Europe and occupies most of the territory between the Dniester and Prut rivers as well as a narrow strip on the left bank of the Dniester. In the West it is neighboring with Romania, and in the North, East and South - with Ukraine. Moldova has a special geographical position, being at the connection of three natural areas. The climatic conditions are characterized by instability - the dry periods happen to the period with heavy rains (Daradur et al., 1996; Constantinov and Nedealcov, 2008). The torrential character of the rains and the fragmented relief under conditions of maximum use of the soil layer condition the intense erosion. The eroded soil, ravines and landslides significantly reduces productivity of the land fund. The main natural wealth of our country are the soils (Ursu, 2011). At present agriculture occupies a significant place in the national economy of the country, its contribution in the volume of GDP being about 18 %.

Together with the agricultural raw material processing industry, the agrarian sector contributes about 32 % to the creation of GDP and with almost 65 % in the total volume of exports, in agriculture being involved more than 40.5 % of the occupied population of the country. In the rural area, about 54 % of the population of the republic operates (World Bank, 2017). Therefore, efficient and rational land use is a prerequisite for a prosperous economy and for ensuring the well-being of the population. The

intensive exploitation of agricultural land and the use of environmentally harmful technologies have led to a considerable reduction in productivity and have had a destructive impact on the soil. The state of the soil is essential for the development of an export oriented agriculture and sustainable food industry (Шабанова et al., 2000). At present, however, the productivity of agricultural soils is declining, which threatens the development of the agro-industrial sector and affects the national economy as a whole (Tărîţă et al., 2013).

MATERIAL AND METHOD

In accordance with this Decision of the Parliament it was elaborated and approved by the Government Decision no. 367 of April 13, 2000 "the national action program for combating desertification in the Republic of Moldova". The nominated program provides: determining the factors that contribute to the intensification of the desertification; elaboration and implementation of practical measures on combating desertification and mitigating drought consequences; maintaining the fertility of the lands that are affected by the desertification processes. According to the National Action Program in front of the line ministries and the bodies of the local public administration, concrete tasks and strict deadlines have been put in place, because the situation is quite acute. The accomplishment of the indicated actions will allow the organization in the Republic of the Integrated Ecological Monitoring System (including the monitoring of the desertification processes). Within the National Action Program are presented in detail the basic directions, the realization of which will contribute to the liquidation of shortcomings in the field of agriculture, urbanization, industry, energy and transport, significant importance for the prevention or diminution of desertification processes.

Combating desertification is a component part of the rational use of soil resources in drought-stricken regions in order to develop society in the long term (Ursu, 2000). Among the most important activities aimed at combating desertification processes in the Republic of Moldova are the following:

- improvement of the favorable legislative framework for the protection, improvement and sustainable use of soil resources, its connection to the European one;
- creation of the information system of the soil quality status;
- structuring and reconstructing the landscaping by extending forests, meadows and meadows, wetlands;
- implementation of phyto-ameliorative, silvotehnic and hydrotechnical measures to minimize soil erosion and stabilize landslides;

- increasing soil fertility by forming a balanced or positive balance of humus and nutrients in the soil by applying fertilizers;

- approaching a state policy in the field of soil resource management;

- consolidation of agricultural lands taking into account the relief, the structure of the soil cover, the correlation between natural and anthropic systems;

- organizing the monitoring of desertification and land cadastre;

- the restoration and extension of large and small irrigation;

- the rational use, the ecological protection and reconstruction of the grassland vegetation, the implementation of the controlled pasture;

- development and implementation of pilot projects to combat desertification at field level;

- strengthening of the financial assistance mechanisms;

- scientific assurance of actions to combat soil degradation and desertification;

- creation of a system of training, information and awareness of the population regarding the problems related to soil degradation and desertification.

RESULTS AND DISCUSSION

The lack of modern information and technologies, especially the limited access of the rural population to the information on the efficient use of the land, leads to the use of inadequate cultivation technologies and to the neglect of deserts. The reduced application of mineral or organic fertilizers has caused the reduction of humus and nutrients in the soil. Other factors, such as the reduced use of pesticides, land salinization, deep plowing and illegal logging of agricultural lands, have contributed to the erosion.

Desertification is land degradation in arid, semi-arid and dry sub-humid zones, caused by various factors, including climate change and human activities, resulting in a decrease or destruction of the biological potential of the soil, which can lead to desert conditions.

***Climatic factors as intensifiers of desertification*.** In accordance with the UNEP international classification of arid territories, the territory of Moldova for the most part belongs to the humid - sub-humid zones, in the South-Eastern regions - to semi-arid. The average annual rainfall is about 490-620 mm. The greatest amount of precipitation is observed in the North-Western part of the republic and on the slopes of the Central Moldavian Upland, the least (490-520 mm) in the South-Eastern and southern regions of Moldova. About 10 % of the territory of the Republic of Moldova is subjected to intense drought every 2-3 years, 50 % - once every 10-12 years. It should be emphasized that in connection with global and regional climate

changes, this phenomenon tends to increase and intensify (Stancu, 2000; Коробов et al., 2004).

Meso- and microclimate. Considering the hypsometry of the territory, the laws of structural, climatic, geomorphological changes and vegetation, 11 agroclimatic regions with different types of mesoclimates are distinguished in the country. A variety of mesorelief and vegetation has a significant impact on the change in the main agroclimatic indicators of heat and humidity.

The climate of Moldova is temperate continental and is characterized by mild, short-lived and low-snowy winters and long warm summers with low rainfall. Phenomena of drought and the changing nature of the weather constitute a negative aspect of the climate in the region. Located in southeastern Europe, in an area with insufficient humidity, in the territory of the Republic of Moldova a positive radiation balance is recorded for 11 months a year. Duration is 3806 hours. Moldova is called "solar" because the duration of insolation in the country varies from 1940 to 2180 hours. In winter, the air temperature is unstable. Frequent thaws and frost-free days have a negative effect on crops, and often resume vegetation (Constantinov et al., 2008; Daradur et al., 1996; Лалыкин et al., 2004).

The coldest month of the year is January with an average temperature of -2.5 ... -5.5 °C. With the penetration of Arctic air from the north and a delay in anticyclones, the air temperature may drop to -28 °C and in the south of the republic (in the north - to -36 °C). The average monthly soil temperature at the depth of the arable layer (20 cm) is generally positive in the winter or around 0 ^{o}C, however, in the absence of a stable snow cover, the soil can freeze up to 100 cm. During the winter, 100-140 mm of precipitation falls; this is 20 % of the annual norm. In most cases, precipitation falls in the form of snow and rain, and their intensity is small.

Snow cover appears in late November or early December; its height is negligible. Only in 10 % of winters does the snow cover reach 0.5 m in the northern regions and 20-30 cm in the southern and central ones. Summer is dry and hot. The hottest month is July, the average air temperature can reach 37-40 °C, and on the soil surface - 62-66 °C. In the warm period of the year, during 60-95 days, the air temperature rises to 25 °C and above, and only 10 days a year, the air temperature is above 30 °C. The total duration of air temperature is above 25 °C and varies from 300 to 600 hours. The absence of precipitation over a long period of time against the background of high temperatures leads to the occurrence of the drought phenomenon, which is observed once every 6-7 years in the central part of the republic, and 3-4 times in the southern part during this period. According to the modern concept, desertification factors have a climatic and anthropogenic nature (Ursu, 2000).

Anthropogenic factors as intensifiers of desertification. In the natural and economic conditions of the Republic of Moldova, the factor of intensification of the desertification process is agriculture, since agricultural lands occupy on average 75.5 % of the total territory of the country, and 81 % in the southeastern part (Andrieș et al., 2008).

Arable land: the negative aspect and the main factor in the intensification of desertification is the large area of arable land, including horticultural and viticulture, which on average in the republic is 64.4 %, and in the whole country varies from 85.1 % (in the north) to 93.1 % (in the south east).

High plowing of the territory of the republic (Fig. 1) will lead to an intensification of desertification processes: surface and linear erosion, deflation, landslides, which will lead to increased disturbance of the ecological balance.

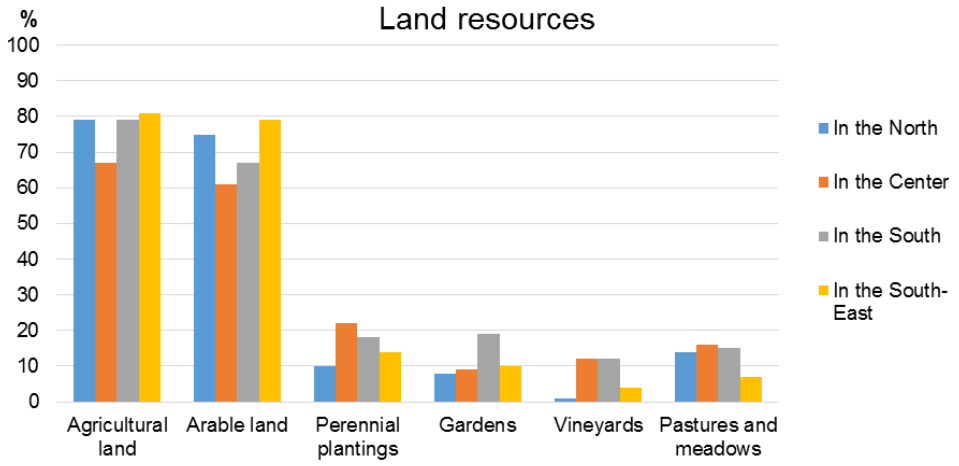

Fig. 1. Territorial use of land resources

Decrease in soil fertility. Neglect of modern environmental farming principles has led to a decrease in soil fertility. It has been established that over the past 100 years, 2.8 tons of nitrogen, 0.8 tons of phosphorus and 6.1 t/ha of potassium were extracted and exported from the soil together with the crop, a total of 9.1 t/ha. About 20 million tons of nutrients were exported from all agricultural land, including 4.8 million tons of nitrogen, 1.7 million tons of phosphorus and 13.8 million tons of potassium. Throughout the history of agriculture in Moldova, only during the period of intensive chemicalization (20 years, 1970 - 1990), a positive balance of nutrients in the soil was created. Currently, about 80 % of the total area is characterized by a very low level of nitrification (below 10 mg/100 g of soil) and 59 % of the total area is characterized by a very low (21 %) and low (38 %) content of mobile phosphorus. Over the past 5-6 years, only 8-110 kg/ha of nutrients

are introduced into the soil annually (Тюрин, 1965). Together with the crop, about 200-220 kg/ha of nutrients are extracted and exported from the soil. Thus, the balance of nutrients in agriculture is deeply negative - minus 190-210 kg/ha.

According to the regulations, the return of nutrients to the soil by applying fertilizers in optimal doses provides an increase in yield by 35-40 % and vice versa. Large annual losses of humus in the process of denitrification, a deeply negative balance of nutrients in agriculture lead to the depletion of chernozems, once so fertile, estimated by the founder of genetic soil science V.V. Dokuchaev as "First-class". Not compensation of losses of organic substances and a decrease in nutrients every year will undoubtedly lead to a decrease in fertility, to a significant change in the volume and quality of the crop, especially wheat (Ursu, 2011).

Managerial and technological implications. Currently, there is no scientific justification for field crops, horticulture, viticulture, vegetable growing and livestock farming in accordance with local pedoecological conditions and the existing landscape. Crop rotation is not observed, including anti-erosion, which provides for the necessary ratio of row crops, spikes, and leguminous crops, perennial grasses. Geographically limited systems: minimal tillage, the use of organic fertilizers originating from all possible resources, the introduction of integrated plant protection management. The areas of growing peas (3.9 times), soybeans (16.2 times), and sunflower (1.4 times) decreased significantly. The average annual global cereal production over the past 10 years amounted to 2584 thousand tons, or 500-700 tons less than planned (World Bank et al., 2003). The sharp decline in the yield of cereals, as well as sugar beets, tobacco and other crops is explained to a large extent by a sharp decrease in the doses of fertilizers introduced into the soil, failure to comply with timely agrotechnical measures to control weeds, pests and diseases, and to delay harvesting. The indicated managerial and technological aspects and the absence of a long-term strategy impede the transition of current agriculture to sustainable agriculture, which will effectively combat the desertification process.

The consequences of irrigated agriculture. In the Republic of Moldova, irrigated lands occupy 308,700 ha, or 0.07 ha per capita, while in the world irrigated land per capita is only 0.05 ha. Contrary to many convincing examples of increasing the effective fertility of irrigated lands by 1.5-2 times, the productivity of irrigated lands in the Republic of Moldova is low. The increase in productivity of such lands is due to water quality and irrigation regime, indicators of soil properties, features of crop rotation and agricultural technology used, as well as management system. The ill-conceived use of irrigated areas causes soil degradation and is a

factor in the intensification of dehydration and desertification processes. Irrigated agricultural land in an area of 12.8 thousand ha (4 %) is in poor meliorative condition, including 8.54 thousand ha (6 %) with an increased level of groundwater, 1.5 thousand ha are saline, 2.8 thousand ha are salt marshes and have an unacceptable level of subsurface water. Since most of the irrigated lands are represented by chernozems, they are easily vulnerable to degradation under irrigation conditions. Irrigation of chernozems even with the unsalted waters of the Prut and Dniester causes weak and moderate structural differences, forms a crust, reduces the overall porosity, aeration, and decalcification of soils. Mineralized waters with a total salt content of more than 1 g/l, and especially 2 g/l with an alkaline reaction, after a few years of use cause salinization of chernozems and a significant decrease in their productivity (Sandu et al., 2013; Sandu et al., 2016). In order to increase the productivity of irrigated lands, as well as expand the possibilities to combat drought and mitigate the negative effects of desertification. It is necessary to implement a number of organizational and technological measures outlined in Section II.

The use of pastures. Pastures in the country occupy 369.6 thousand hectares, or 10.9 %, and meadows - 2.4 thousand hectares, or 0.1 % of agricultural land. In the Northern, Central, and Southern pedoclimatic zones, pastures occupy 14.4–16.4 % of agricultural land and only in the Southeastern semi-arid zone do they make up 6.9 % of agricultural land. The increase in the number of cattle and sheep in the private sector, the lack of land regulation, and the location of pastures on the slopes led to the process of overuse of pastures. Irrational use of pastures without scientific justification leads to their degradation. As a result of increased impact on pastures, there is a successive change of two stages of degradation - destruction of the vegetation cover and destruction of the surface soil layer. If in the North the degradation of meadows as a factor in the intensification of the desertification process is delayed at the first stage, in the Southern and Southeastern zones the degradation of meadows covers both stages (Ursu, 2011).

The process of intensive degradation of meadows takes place especially in the Vulcanesti sector of Cahul city and in Tighina city. Studies have shown that overuse of pastures leads to a decrease in the biodiversity of pastures and their biological pollution with low-quality plant species (elderberry, nettle, lettuce, wormwood, etc.). Soil degradation leads to a decrease in the degree of anti-erosion stability, most pastures are highly eroded. Along with this, they are all significantly damaged by landslide processes. Within the geomorphological region of Reut - Ciuluc, pastures are subject to salinization and solonetzization processes. In this context, the integrated application of measures for the protection and ecological

restoration of pasture vegetation is necessary (Postolache, 1995; Medyanic, Mihailescu, 1992; Tărîţă et al., 2013).

Violation of territorial ecological balance. Anthropogenic activity caused a serious violation of the ecological balance in the republic. Natural and natural-anthropogenic ecosystems (forests, including forest strips, meadows, pastures, swamps, water systems) make up 17 %, which corresponds to a low level of territorial ecological balance (10-20 %). The southeastern semi-arid zone is characterized by the most unfavorable situation with a very low level of natural-anthropogenic systems (< 10 %) and a very large share of arable land (> 80 %). The available 325.4 thousand ha of forests are unevenly distributed (Fig. 2). Of the total area: 60 % fall on the central zone (afforestation rate is 13.5 %), about 26 % fall on the northern zone (7.2 % afforestation), and the southern zone, which is especially prone to drought, is characterized by water scarcity and soil erosion, only 16 % (afforestation - 6.7, i.e. 2 times lower compared to the central zone).

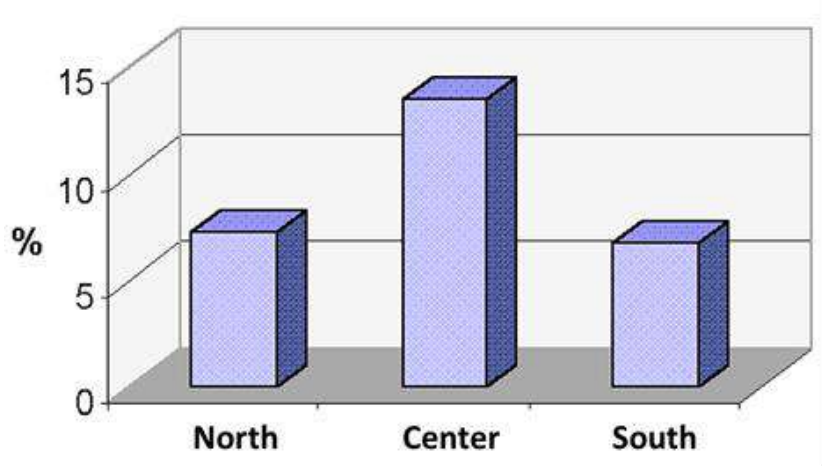

Fig. 2. Degree of afforestation in different zones of Moldova

Increasing the territorial ecological balance will make it possible to transfer modern agriculture to sustainable and landscape. In some regions, afforestation of lands not used for agriculture will significantly reduce the degree of soil erosion, especially in the south of Moldova, protect lands that are constantly threatened by landslides, and reduce the negative effects of arid climate.

Soil erosion and landslides. Soil erosion and landslides are the most important desertification agent, especially to speed up the process. A third of agricultural land susceptible to erosion is prone to accelerated development of the desertification process (Fig. 3).

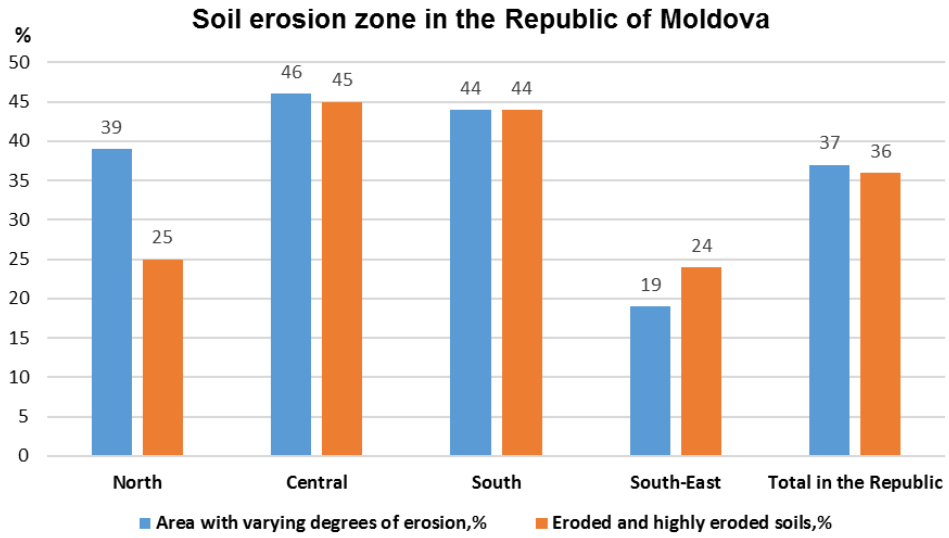

Fig. 3. Eroded agricultural land

Agricultural land in the center and south of the country is significantly damaged by erosion (Andrieș et al., 2012; Капчеля, 1990). The annual loss of fertile soil on all agricultural lands caused by erosion is 26 million tons, including: humus - 700 thousand tons, nitrogen - 50 thousand tons, phosphorus - 34 thousand tons, potassium - 597 thousand tons. These losses cause a significant reduction in crop yields. Indirect losses expressed in agricultural products are stable values that repeat from year to year. Currently, agricultural products annually lost due to soil erosion amount to 525 thousand tons of nutrient units on arable land and 57 thousand tons of fruits and grapes on orchard-viticulture lands, which amounts to annual losses of 221,365 thousand US dollars.

Indirectly, damage due to erosion is also reflected in other areas of human activity: siltation of lakes and other water basins, contamination of lowland and groundwater soils with pesticides and mineral fertilizers washed away from slopes, destruction of communication lines, hydraulic structures and buildings, and social facilities etc. The combination of the complex physical and geographical conditions of intensive farming on the slopes led to the development of linear erosion - from surface erosion to entire systems of ravines on area 8 800 ha, which is estimated at an annual loss of $ 7,622 thousand. The degree of intensification of soil erosion is also increasing due to landslides on the slopes, which completely destroyed the soil cover on an area of 24.1 thousand ha, causing annual damage in the amount of 8432 thousand US dollars. The National Program provides measures for land improvement, to prevent landslides and to fight with them.

Soil deflation. Dust storms are one of the main effects of soil deflation, wind erosion. In a short period of time, massive layers of crushed soil can move, which form precipitation and fall asleep crops, causing their death. According to the main climatic indicators indicating the potential conditions for the occurrence of dust storms, the territory of the republic belongs to the active zone, which is divided into regions with various degrees of manifestation of dust storms. The northern part of the Prut and Dniester valleys, as well as the Central Moldovan Plateau are regions with a low degree of dust storms, the steppe territories, the southern and southeastern border territories are regions with strong dust storms, and the rest of the country is the Balti steppe and the southern outskirts of Codri - with a moderate degree of storms. In the central and southern parts of the republic, dust storms are observed almost annually, in the northern regions - once every 3-5 years. The number of days with dust storms on average in the republic is 2-10 days a year and cannot be taken into account when developing and implementing measures to combat desertification.

Soil salinization. The intensity of soil salinization is determined by the degree of salinity (excessive content of soluble salts) and the level of alkalinity (maximum content of unstable sodium) of different horizons, taking into account the depth of their occurrence. Salinization of soils is associated with the accumulation of soluble compounds by evaporation of subsurface water in an arid climate, especially in the Balti steppe, in the Center and in the South of Moldova. In the conditions of the forest-steppe of the North of Moldova (hydrothermal coefficient > 0.7), saline soils are practically absent or have very limited ranges. The areas of automorphic solonetzes and a complex of solonetzic soils (most of the chernozems) formed in the framework of elluvial landscapes (interfluve, slopes) exceed 25 thousand ha. The areas of saline and solonetzic extra-elluvial hydromorphic soils in the lowlands are about 20 thousand ha, and saline elluvial (floodplains of the Dniester, Prut, small rivers) exceed 99 thousand ha. Since all agricultural lands have a comprehensive soil cover structure, it can be concluded that in the center and in the South of Moldova there is a risk of secondary salinization with all the negative consequences. The action plan provides specific measures to combat soil salinization and salinization.

The consequences of desertification.

Changes in soil properties - the analysis of factors, conditions and desertification agents confirmed the possibility of developing this process throughout the Republic of Moldova, especially in the Southern and South-Eastern pedoclimatic zones. First of all, physical degradation of soils takes place in these zones (crust formation, compaction, structure destruction, and porosity decrease). In the case of soils with heavy loamy and clay granulometric composition, high density (1.46 - 1.60 g/cm^3) and a moderate

degree of shrinkage, the frequency of unsatisfactory estimates of the total porosity is 40 – 60 %. For loamy soils, the frequency of unsatisfactory estimates of total porosity in this segment of compaction is 30 – 40 %. At higher density values, heavy loamy soils and light clays constantly have unsatisfactory porosity values. Even in the case of soils with loamy granulometric composition, the frequency of unsatisfactory values is 70 – 80 %. Consequently, the aridity of the soil and soil cover is accelerating. At the highest levels of soil organization (profile, horizon), aridity is due to the differentiation of the physical and hydrophysical profiles and its compaction and results in a decrease in water permeability. At lower levels of functioning of the soil system (aggregate, microaggregate, elementary particle), the aridity of the soil is due to a significant increase in the forces that hold water in the soil, as a result of compaction of the aggregates. It has been established that over the past 90 years, the humus content has halved (from 5 – 7 % to 3.0 - 3.5 %), or by 70 t/ha. Thus, about 147 tons of humus was lost from all agricultural areas. At present, the humus balance in agriculture is deeply negative (-1.5 t/ha), and its annual losses amount to 3.3 million tons. The annual losses due to erosion are about 0.6 million tons, only 3.9 million tons. The annual rate of humus mineralization is 0.02 %. According to the Agrochemical Service, 40.6 % of agricultural land is characterized by very low or low humus content (below 2 %). In the past 8 – 10 years, the amount of organic fertilizers used in agriculture has decreased from 5 – 6 to 0.8 – 0.9 t/ha. In the future (after 50 years), if an appropriate set of measures is not taken, the humus content will decrease from 3.0 - 3.5 % to 2.0 - 2.5 %. The area of agricultural land with humus content in the soil below 2 % will also increase. As a result, soil productivity will decrease by 30 – 40 %. On the outskirts of Central Codri and in the southern regions, the process of dehumification in ordinary and carbonate chernozems has intensified significantly (Ursu, 2000). The degree of manifestation of this process varies from medium to strong. It should also be noted that these soils are not very resistant to salinization. The decrease in resistance to solitonization is due to a decrease in humus reserves, the ability to retain cations, decalcification of the absorbing complex of the soil, an increase in the role of magnesia cations, a change in the carbonate regime, etc. Thus, in the process of desertification, the risk of saltification, therefore, a decrease in the productive potential of soils is significantly increased.

Change in the level of mineralization of water. Mineralization of subsoil water is associated with the hydro regime of rivers and the level of pollution. The water quality of the Dniester River, according to the standards, belongs to the second class - “moderate pollution”, in the lower zone - to the third class - “polluted”. The waters of the Prut River contain organic matter in increased volumes and inorganic in reduced ones, which

provokes high chemical oxygen consumption and a relatively low amount of dissolved oxygen. According to the standards, the water at the confluence of the Prut River and the Danube River belongs to the third class of quality - "polluted", and in the area of the Valea Mare settlement, the fourth class is "much polluted". The underground water in the floodplains of small rivers is heavily contaminated with nitrates due to the irrational use of nitrogenous fertilizers, dumping of manure from livestock complexes, garbage and other waste located on the ground without a protective layer, etc. In some places, the subsoil waters are heavily contaminated with oil products (Marculesti). About 50 % of the population does not have access to quality drinking water. The main risk factor that has a serious impact on public health in connection with water consumption is a high level of nitrates. Being the most common and most famous toxic substance in the subsoil waters of Moldova, they lead to the occurrence of metgemoglobulinemii, also known as nitrate intoxication, in concentrations above 50 mg/l. More often affected children under three years of age, especially artificially fed. The proportion of samples with a detected excess of the maximum permissible nitrate concentrations in central and local sources in 2005 was 50 %, and in local sources - 68.8 %, respectively, an increase is characteristic of all areas where the detected concentrations also increased - 500-1200 mg/l. Regarding the quality of groundwater to provide drinking water to the urban population through a centralized system (the proportion of groundwater is 50 – 60 %), more than a third of the sources do not meet the quality standards for chemical indicators. The main problems are the high fluorine content (2 - 18 mg/l) in the counties of Balti, Ungheni, Lapusna, Tighina, Chisinau, TAO Gagauzia; ammonia (2 - 10 mg/l) in all zones, often in the Center of the Republic; strontium (7 - 15 mg/l) - in the districts of Orhei and Chisinau; hydrogen sulfide (3 - 20 mg/l) - in the districts of Ungheni, Lapusna, Tighina, Chisinau, TAO Gagauzia; iron (1 - 2.5 mg/l) - in the districts of Balti, Edinet, Cahul (Vulcanesti village).

Changes in the plant world. Vegetation is a biological indicator of desertification. In the composition of vegetation, the ratio of xerophyte and mesophyte species changes. Xerophytization takes place by completing the vegetation cover with cereals (*Bolboscnoemus maritimus, Guncus genardii, Beckmannia aurici formus, Alopecurus arundinaceus*). Due to accelerated anthropogenic salinity, halophytization of vegetation develops (*Salicornia europaea, Halimione werrucifera, Lepidium latifolium,* etc.). An important indicator is the design density of natural vegetation and agrophytocenoses. The density of natural phytocenoses under conditions of desertification and aridity is sharply reduced due to excessive pasture areas and intense droughts. The design density of crops decreases from the north of Moldova with a temperate climate to the South and South-East of Moldova with a dry

sub-humid and even arid climate. If in the northern and central parts the maximum design density of corn for grain is 87 – 85 %, winter wheat – 79 %, sunflower – 99 %, tobacco – 97 %, in the conditions of the South of Moldova the estimate of the design density of vegetation decreases to 76, 68, 92, respectively and 95 %.

Depending on the nature of the design density, vegetation in various ways protects the soil from the harmful effects of rain during the rainy season:

- perennial herbs used in the second and subsequent years, and perennial plants can protect the soil throughout the entire warm period of the year (April-October);
- cereal crops (except corn), peas, winter crops and a mixture of spring herbs can protect the soil at the beginning of the rainy season (April-May);
- perennial herbs for use in the first year, corn, sunflower, tobacco protect the soil during the rainy season (July-August);
- sugar and fodder beets, cabbage and other late vegetable crops protect the soil after an active period of rains (September-October).

An important indicator of desertification is the biological productivity of soil and land, which implies the yield of phytomass and economic production per unit area, taking into account all crops that make up the structure of sown areas. In accordance with the biological productivity assessment scale, the northern zone is characterized by a very high level of biological productivity (more than 5.6 t/ha), the central zone is characterized by a high level (5 - 5.5 t/ha) and the southern and southeastern zone, where desertification factors are most intense, - low level of biological productivity (4.0 - 4.5 t/ha).

CONCLUSIONS

The Republic of Moldova acceded to the United Nations Convention to Combat Desertification on December 24, 1998.

The main intensifiers of desertification are climatic (sub-humid and semi-arid zones) and anthropogenic (unreasoned agriculture, irrigation of agriculture, overuse of pastures) factors. An important role belongs to the meso- and microclimate.

Desertification agents on the territory of the Republic of Moldova are:

- violation of local ecological balance, soil erosion, wind erosion, salinization (solonchaks and solonetzes) of soils;
- the consequences of the processes of drought and desertification consist in the development of trends in the deterioration of soil properties, including their degradation (dehumification and compaction);

- increase in the level of mineralization and water pollution, which is accompanied by a negative impact on human health and the plant world (reduction, herophilization, halophytization);

- the socio-economic crisis and the negative consequences of the processes of aridity and desertification on the territory of the republic require the immediate implementation of the strategy and tactical theses of the Program of Action to Combat Desertification.

REFERENCES

1. Andrieș S., 2005, Starea de calitate a solului: măsuri de protecţie, ameliorare şi sporirea fertilităţii. În: Lucrările conferinţei republicane ştiinţifico-practice „Protecţia solului". Chişinău, pp.47-51;
2. Andrieș S., Cerbari V., Rusu A., Lungu V., Donos A., Filipciuc V., Leah N., Dobrovolschii Gr., Boaghe Lilia, 2008, Condiţiile naturale și antropice de degradare a solului și procedee tehnologice de minimalizare a consecinţelor factorilor ecopedologici nefavorabili. În: Diminuarea impactului factorilor pedoclimatici extremali asupra plantelor de cultură. Chișinău, pp.41-92;
3. Andrieș S., Filipciuc V., 2012, Eroziunea solului: starea actuală, consecinţele și măsurile de minimalizare. În: Agricultura Moldovei, nr.5-6, Chișinău, pp.12-17;
4. Cerbari V., 2000, Sistemul informaţional privind calitatea învelişului de sol al Republicii Moldova (Banca de date). Pontos, Chişinău, pp.15-48, ISBN: 9975-938-24-8;
5. Constantinov T., Nedealcov M., 2008, "Evaluarea fenomenelor climatice nefavorabile". În: "Republica Moldova. Hazardurile naturale regionale", Chișinău, pp.57-68;
6. Daradur M., Nedealcova M., Smirnova V., 1996, Regional climate of Moldova: tendencies and regularities of its changes. Cracow, pp.299-333;
7. Hotărârea Guvernului nr. 367 din 13.04.2000 cu privire la aprobarea Programului Naţional de Acţiuni pentru Combaterea Deşertificării;
8. Шабанова Г.А., Витко К.Р., Постолаке Г.Г., 2000, Уязвимость, устойчивость и адаптация к изменению климата природных экосистем Республики Молдова. В: Глобальные и региональные изменения климата и их природные и социально-экономические последствия. Москва. ГЕОС. стр.148-156;
9. Капчеля А.М., 1990, История формирования оползнеопасных территорий. В: Оползнеопасные территории Молдавии и их рациональное использование. Кишинев, «Штиинца», стр.43-50;
10. Коробов Р.М., Николенко А., 2004, Новые проекции антропогенного изменения климата Молдовы в XXI столетии. В: Климат Молдовы в XXI веке: проекции изменений, воздействий, откликов. Кишинэу, стр.54-97;
11. Medyanic S., Mihailescu C., 1992, The Paleogeographical Stages of Moldova's Flora Development. Chishinau, pp.35-74;
12. Postolache Gh., 1995, Vegetaţia Republicii Moldova. Chisinău, Ştiinţa. pp.82-140;
13. Raportul III Naţional privind implementarea Convenţiei Naţiunilor Unite pentru Combaterea Deşertificării în Republica Moldova, 2007, (The 3rd National Report on the Implementation of the United Nations Convention to Combat Desertification in Republic of Moldova) /coord.: Ilie Boian et al., Ch.: (F.E.P. "Tipografia Centrală"), 88 p., ISBN 978-9975-923-72-9;

14. Sandu M., Tarita A., Lozan R., Gladchi V., Duca Gh., Turcan S., Mosanu E., Prepelita Af., 2013, The water springs - sources for water supply and irrigation in the Nistru river basin. In: Chemistry Journal of Moldova. No 2(8), Chisinau, pp.42-50, ISSN 1857-1727;
15. Sandu M., Tarita A., Lozan R., Zgircu N., Mosanu E., Goreacioc T., Zlotea Al., Comarnitchi A., Sidoren I., Turcan S., Tarita A., 2016, Ecological potential of surface waters in natural scientific reserve "Lower Prut". In: Chemistry Journal of Moldova. General, Industrial and Ecological Chemistry, Chisinau, 11(1), pp.21-26;
16. Stancu V., 2000, Studiu privind impactul schimbărilor climatice asupra răspândirii ascaridozei. Schimbarea climei: cercetări, studii, soluţii (culegere de lucrări). Chişinău, pp.108-110;
17. Tărîţă A., Lozan R., Sandu M., Stegărescu V., Cozari T., 2013, Evoluţia calităţii factorilor de mediu in ariile naturale protejate de stat (monumente naturale hidrologice). In: Buletinul Academiei de Ştiinţe a Moldovei. Ştiinţele vieţii. Numărul 1(319), Chișinău, pp.21-32, ISSN 1857-064X;
18. Тюрин И.В., 1965, Органическое вещество почвы и его роль в плодородии. М.: «Наука», стр.41-42;
19. Ursu A., 2000, Degradarea solurilor și deșertificarea. Chișinău, pp.11-14;
20. Ursu A., 2011, Solurile Moldovei. Chișinău, 323 p.;
21. World Bank, 2017, Rural Productivity in Moldova – Managing Natural Vulnerability;
22. World Bank et al., 2003, Poverty and Climate Change: Reducing the Vulnerability of the Poor through Adaptation;
23. Лалыкин Н.В., Сыродоев, И.Г., 2004, Некоторые подходы к оценке воздействий изменения и изменчивости климата на водные ресурсы. В: Климат в Молдове в XXI веке: проекции изменений, воздействий, откликов. Кишинэу, стр.176-212;
24. http://www.meteo.md
25. http://www.rural.md

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