SIGNIFICANCE OF PEDOLOGICAL STATISTICAL DATA FOR PROGNOSIS OF SOIL QUALITY STATUS OF MOLDOVA

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The paper presents statistical databases and their importance for soil science. Rational use of land is possible only through knowledge, inventory and systematic records of soil resources in terms of quantity and quality on farms and administrative territories based on a set of statistical information. The main database of information system for soil quality are statistical data on: state land characteristic factors of pedogenesis and soil cover, soil degradation through erosion, land quality fund of improvement, agrochemical indices of soil, etc. Information system consists of statistical databases will serve the citizens right of access to information concerning the quality of the soil cover, promoting prevention and control of degradation processes, soil damage and pollution caused by natural phenomena and anthropogenic. Statistics on quantitative and qualitative parameters of soil are significant in the forecast evolution of the soil cover, long term maintenance of agricultural and forestry production capacity of soils, land quality performance monitoring.

Statistics is an evolving science, attracting various fields, including soil science. The statistics object of study in soil science and agriculture chemistry is the soil quantitative and qualitative parameters. For functioning of information system regarding soil quality and agricultural surfaces uses dynamic of the country is necessary to organize a set of database using research generalized materials on field soil of long term experience. For this purpose it was necessary to create quality soil information system of the Republic of Moldova. In 1978 and 1981 were elaborated two informative guides on statistical parameters of composition and soil properties based on basic data accumulated by that time [1, 2].

In recent years in the Republic of Moldova were intensified processes of soil degradation and land deterioration. The main factors affecting the capacity of soils are: erosion, excess moisture and periodically salinity processes, sodium enrichment and swampy, arable layer secondary compaction, outcome dehumification and structure damage, negative balance of humus and nutrients (phosphorus and nitrogen), low clogging with humifer deposits; destruction by excavating soil and landslides. Intensive processes of soil degradation that followed after the land reform emphasized the need to supplement this data with information concerning the quality and dynamics of degradation processes of soil cover [3, 5].

Synthesized tables of information system on quality status of the soil cover of the Republic of Moldova must include information on the impact factors and forms of soil degradation, land status and impact of land reform, pedogenesis factors and average statistics parameters of soil properties, soil surface affected by erosion and damage caused to national economy, quality status of ameliorative land fund, annual data on the humus content and agrochemical indices of soil [4]. Soil Quality Information System contains the following generated information and presented in tables.

I. Data on status of land fund (changes of categories destination, forms of ownership of land and number of landowners).

Comparison of the land of the Republic of Moldova during 1972-2012. Land Fund of the Republic of Moldova on 01.01.2012 is 3 million 384.6 thousand ha. Agricultural land area is 2 million 498.3 thousand ha or 53.6% of the total area, including arable land - 1 million 812.7 thousand ha (72.6%), perennial plantations - 298

800 ha (12.0%), meadows and pastures - 352 000 ha (14.1 percent), fallow land - 34 200 ha (1.4%). Quota of land used for arable and perennial plantations is inadmissible as high - 65.6% of the total land area or 84.6% of agricultural land, which does not allow maintenance of ecological balance of natural ecosystems and man, but leads degradation of soil cover and biodiversity [6].

During the 40 years (1972-2012) land area decreased by 88 500 ha, mostly as a result of soil degradation and alienation of land for social needs covered. In the Republic of Moldova, as in other countries, there is reduction in per capita arable land which, according to recent data is 0.41 ha [5].

In recent years, due to land reform, there has been an adverse change in the structure of agricultural uses, perennial surface decreased in 1999 compared with 1989 to 93 700 hectares as a result of deforestation orchards and vineyards by new owners land. The high percentage of intensively used agricultural land (65.6%), unfavorable structure of agricultural uses, impaired integrity of the culture of the livestock and horticultural field have led to intensification of land desertification and worsening quality of the land of Moldova.

Land surface dynamic with different destination, ownership and the number of land owners. An important factor leading to increased degradation process of land resources, is making unreasonable land reform. The number of landowners has increased from 1891 in 1990 to 1391938 in 2012 [4]. The land fund was sprayed privatized more than 2 million lots of land. Land organization without preventive antierosion measures of villages lots, their location from the hill in the valley, management on small farms in the status of total economic crisis does not allow landowners to undertake protection measures, improvement and sustainable use of land resources. Land reform in Moldova has not created conditions for increasing soil fertility, sustainable land use, agricultural productivity, thus exerting a negative impact on the country's economy, led to the development of subsistence agriculture instead of trade. This agriculture system favors the development of degradation processes of soil cover and desertification of the territory of Moldova.

II. Data concerning characteristics of pedogenesis factors of soil cover.

Groups of land slopes in the geomorphologic districts of Moldova. The data collected confirmed that 57% of Moldova's territory is located on slopes with slope surface greater than 2° and is subject to erosion hazard. Land slope with inclination more than 6°, moderately or strongly affected by erosion, covers about 20% of Moldova's territory. Relief favors increased intensification of soil erosion and land development of desertification process [3,4].

Weighted average indices of slope farmland in the climatic zones of the Republic of Moldova. Location of 80% of farmland on the slopes with inclination greater than 1° confirms that in Moldova the sustainable agriculture, which protected the soil and contribute to combating the desertification can be arranging by territory antierosion measures and agricultural techniques application system.

Main characteristics of agropedoclimatic areas and subareas of Moldova. The main characteristics of agropedoclimatic areas of Moldova and assessed their suitability for crops are presents. According to the climatic characteristics the South and Central areas are most vulnerable to the desertification processes.

The table-legend of soils types and subtypes with different texture. The data confirms that the main soils of Moldova are chernozems occupying 70% of land area. Gray and brown soils are found on about 11% and hydromorphed alluvial and no alluvial soils - 19% of the total area of Moldova. Regarding to texture the most common is loam-clayey and clayey soils (62% of the total), which is characterized by high productivity. Less favorable soils are clay-loamy (8.5%), unfavorable - clay soils

(1.2%). Moderately coarse textured soils (loam-sandy and sandy-loamy) is characterized by unfavorable moisture regime and are vulnerable to desertification processes [3-5].

Average rating note of agricultural land in Moldova in dependence of soil characteristics in the climatic zones. Average evaluation note of agricultural land is 63 points. Soil fertility in general is good, but the degradation processes are widespread and cause decreased of soils fertility with 37 points of evaluation.

Arable land distribution by class of evaluation in dependence of the properties. The data confirm that 15% of agricultural land is characterized by moderate and low fertility, and are strongly or very strongly affected by processes of degradation and desertification.

Suitability of soil resources in terms of possible use in future. Given the status of soil quality is presented the land suitability for various uses. The data confirm that, to minimize the risk of soil degradation, it is necessary to decrease the arable land area of 812.7 thousand hectares today to 1 million 372 thousand hectares in the future (the land area of evaluation note 70 - 100 points which would ensure good agricultural production in the field crop rotations).

Average parameters and statistics characteristics of humus content of arable eroded and no eroded land area. Data characterize quality of eroded and none eroded soils for the reference years 1960-2000. Data on thickness and humus content in genetic horizons can be used for general characteristic of these soils. Considering that arable chernozems non eroded as a relatively standard, the humus content in 0-100 cm layer of soil erosion is less than the same layers of soil erosion by 10% - in very weakly eroded soils, by 15-20% - in weakly eroded soils, by 40-50% - in moderately eroded soils, by 50-60% in highly eroded soils, 80% - in very highly eroded soils. Comparison of humus content in the same subtypes of soils, investigated during the years 1960-1980 and 1990-2000 confirm a very slow degradation of humus profile. Humus content in arable layer decreases from 0.01 to 0.03% annually.

Average statistics parameters on standards depth of humus content, carbonates, exchangeable cations, total nitrogen in soil profiles. Statistical average parameters of the main characteristics of the soils can be used to assess the soil degradation degree and use as a standard index. Considering that arable no eroded soils as relatively standard, the humus content in 0-100 cm layer of eroded soil is less than the same layers of none eroded soils, 20-25% - in weakly eroded soils, 40-45% - in soils moderately eroded, 60-65% - in the highly eroded soils. Humus content is an indicator of quality status and degree of anthropogenic degradation of soils. Decrease of humus content in 0-100 cm layer of soil eroded soils compared with non eroded characterize the degradation degree of these soils.

The main factors limiting production capacity of farmland soils. The data presented the mail factors of degradation, surface of depredated area, indirect losses caused by soil degradation. The annual direct and indirect losses caused by soil degradation consists up 436 million US $.

III. Data on soil degradation by erosion (information about the dynamics of land areas with different degree of soil erosion and landslides)

Dynamics of soil erosion on agricultural land area. Soil erosion is the main factor of soil cover degradation and desertification of land in Moldova. Eroded land area increased from 594.200 ha in 1965 to 877.600 ha in 2012, increasing an average with 6200 ha. Eroded soils are found on 33% of the total agricultural land, of which 15.3% are moderately and highly eroded [6].

Dynamics of eroded soil areas in the agricultural uses. The data confirm a higher growth areas of soil erosion on arable land, in vineyards and orchards.

Indices modification of agricultural land damage by ravines. During 1911-1965 the ravines area increased from 14434 ha to 24230 ha (about 2 times), the number of gullies increased 3 times. After 1965, they carried out the leveling of gullies. This led to abrupt reduction in the number and surface of ravines on the land to 5.8 thousand hectares in 1982. Currently ravines occupy an area of 11.800 ha. The cessation of liquidation of the ravines proceedings and rational management in agriculture in recent years causing increase the surface of ravines and land desertification.

Dynamic growth in the length of gullies in average per year (m/year) in different morphological districts. The largest annual increase in the length of gullies was found in the years 1967-1970, until the beginning of work menagerie the erosion of agricultural land, and the lowest increase - in the years 1976-1980 when they made the largest volume of work for linear erosion.

The annual loss of fertile soil and nutrient in result of erosion. The annual loss of humus is 26 million tons, which contains: humus - 700 000 tons, nitrogen -50 000 tons, phosphorus - 34,000 tons, potassium - 597 tons. These amounts are equivalent to the complete destruction of 2000 hectares of land with normal profile and evaluation note of 100 points.

Dynamic of landslides growing surface on agricultural land. During 25 years (years 1970-1995), the landslide area increased by 62.6 thousand ha, increasing annually by 2.5 thousand hectares. Currently a landslide have every 200 ha of land. In recent years the annual increase landslide area is around 1000 ha. Based on the consideration that the soil cover is completely destroyed only 20% of this area (200 ha), irreversible losses are 8 million US $ 423000. According to the land cadastre 01/01/2012 landslides coated surface soil is almost 24300 ha.

Humus content in chernozems ordinary with different degree of erosion. It was established that in comparison with the absolute standard, ordinary chernozem fallow, the arable chernozems of different degree of anthropogenic degradation have lost initial humus content in the layer 0-100 cm: none eroded - 30%, moderately - 62%; strongly -74%, very strongly eroded - 90%.

Degradation and regeneration of humus profile of chernozems ordinary on the slope (2-3°) under different agricultural use (plowing and fallow). Intensive erosion on arable and weakly erosion led to loss 41% of the initial content of humus from 0-100 cm soil layer, compared with fallow soil, Anthropogenic soil degradation, being 30 years fallow, regenerated about 15% of the initial content of humus. This confirms that fallow land use as meadows sown is a useful method for regeneration of degraded land and desertification.

IV. Data on quality status of amelioration soil fund

Surface and distribution of alluvial and no alluvial soils. Alluvial soils on the slops are found most frequently in North and Central of Moldova. In the South part the surface of alluvial soils is small, but these soils are solonetzization. The alluvial soils on the slops are scatted as small patches area from 0.1 to 1.5 ha. Mosaic of patches of these soils on arable soil creates heterogeneity of soil cover of privatized lots and aggravated performance and sustainable land use.

Dynamics of soil surface unclogging and transformed anthropogenic. Unclog the 50-60 cm soil depth led to disruption of natural stratification of genetic horizons, to remove the underlying surface horizons with high carbon humifere. As a result decrease the fertility of these soils surface layer, cleaning process very pronounced in moderately and highly eroded soils. Use of unclogging land under field crops after clearing perennial showed a fall in their productive capacity.

Mineralization and ionic composition of ground water of alluvial lands, desalinated and saline. In the North of Moldova ground waters are characterized by

low mineralization, which determine the formation alluvial desalinated soils. In Central and South Moldova ground waters are low and moderately mineralized and contribute to saline and solonețizate alluvial soils.

Dynamic content and composition of salts in humic gley soil of drained land. Drainage and deeper groundwater level leads soil desalination under the action of rainfall (after 4 years from drainage). Clogging drains (after 9 years of drainage) and water raising drive to restore groundwater initial salt content in the upper soil profile.

Dynamics of exchangeable cation content in drained humic gley soils. Drainage contributes to decrease of exchangeable Na content in the soil adsorption complex and dealkalization of arable layer. Clogging of drainage system over 9 years lead to raising the groundwater, restore exchangeable Na content and sodium enrichment layer of arable soil.

Distribution of automorph solonetz and complex of salinization soils in areas of agropedoclimatic solonețizate soils. The largest areas of solonetz and salinization soils are determinate on the height hills of Ciuluc – Soloneț, in the Sangerei and Ungheni districts and in the South of Moldova.

Surface and improvement state of alluvial soils. Alluvial soils occupy an area of 259 thousand ha and is characterized mainly by improvement unsatisfactory condition, often critical. In recent years, as a result of clogging drainage system for draining land, worsened the critical situation of improvement in an area of 40thousand ha of arable alluvial soils of the Lower Prut. Improvement status is critical in most small meadows (Ciuluc, Raut Botna, Cogalnic, Ialpug etc.) of Central and South Moldova.

Dynamic surface and improvement state of irrigated land. According to the Land Cadastre in Moldova the area of irrigated land is 225 240 ha. Currently, in fact, can be 85 000 ha of irrigated land, but are real 20-25 thousand ha irrigated soils. In more than half of the area during the land reform past irrigated, the irrigation facilities were demolished. Reducing the irrigated areas, caused by the continues of economic crisis. The status of good improvement is 83%, satisfactory - in 13% and unsatisfactory - the 4% of the total irrigated land (225,240 ha).

V. Data concerning soil agrochemical indexes

Dynamic of quantity of fertilizers (active substance) used in different cultures annual average per year. High efficiency of fertilization caused increased rates of delivery of fertilizers in farming country. According to the years 1961-1965 from 1 ha of arable land and perennial plantations were used 6.2 kg of N, 8.7 kg of P_20_5, and 3.6 kg of K_20. Maximum amount of application of fertilizers was during 1981-1988. Every hectare of agricultural land received 70 kg N, 50 kg of P_20_5 and 50 kg of K_20 at the expense of mineral fertilizers; 30 kg of N, 18 kg of P_20_5 and 35 kg of K_20 at the expense of organic fertilizers. After this period the volume of deliveries of fertilizers has decreased considerably [3,4].

The agriculture history of Moldova the intensive chemical treatment lasted about 25 years. In this period of fertilizers account for every hectare of arable land and perennial plantations were applied 1200 kg of nitrogen, 960 kg of phosphorus and 860 kg of potassium, which made in the soil a considerable reserves of phosphorus and potassium. Without fertilizer application in the near future this reserves will be completely used up and exhausted.

Dynamic area of arable land with different humus content in soils. Researched area of arable land had decreasing values: from 1 926 thousand ha in the first cycle of research (1966-1970) to 845.4 thousand ha in cycle V (1986-1990). The surface of weakly humifer arable soils (1-2% humus) increased from 1.7% (1966-1970) to 8.6% (1981-1985), moderate humifere (2-3% humus) from 28.9% to 32%, respectively. Arable land with moderate humifere soil surface (3-4% humus) decreased

from 52.9% to 39.1%, and high content of humus - from 8.4% to 2.6%, respectively. In 1985 the soils with humus less than 3% in the arable layer occupied 77% of the total arable land. This confirms a significant dehumification of soil over 25 years of intensive farming.

Dynamic of arable land with different content of mobile phosphorus in soils. As a result of intensive application of fertilizers with phosphorus over 25 years soil assurance of mobile phosphorus has improved considerably. In recent years, shortage of fertilizers, soil phosphorus problem is getting worse - the accumulated reserves are depleting rapidly. In Moldova today are weak and poorly provided with mobile phosphorus on 785 thousand ha of land or 30.7% of the total agricultural land. During 5-10 years the surface of low and very low provided with mobile phosphorus will increase due to lack of phosphate fertilizers.

Dynamic of arable land with different exchangeable potassium content. As a result of intensive application of potassium fertilizer over 25 years providing soil exchangeable potassium has improved considerably. Arable areas with optimal and high content of exchangeable potassium were increased. Currently surface of low and very low soil exchangeable potassium are provided with small - 3 thousand ha. Potassium fertilization is necessary to moderate soil surfaces supplied with potassium (117 thousand ha or 4.6% of land area) used in vineyards, orchards, vegetable crops, tobacco. In recent years the exchangeable potassium content of soils decreases sharply from year to year, caused by lack of potassium fertilizers.

Degradation of biota chernozems in the farming. Research on monitoring polygons have found that after prolonged operation during the years 1958-1994 soil biomass quantity and soil biota decreased 2-3 times. Increased weight of biota species causing degradation of humus, their activity increased from 7.8 up to 15.9 million/g soil. Those changes lead to intensification of dehumification, dissolution and loss of self-purification capacity of the soil.

Modification of the humus content in the soil in dependence of fertility system into long-term field experiences. According to the results obtained in experiments of long duration, the humus content of fertilized variant over 30 years has decreased on average by 0.5%. Dehumificare speed depending on soil type and subtype is 0.016 to 0.023% annually. Degradation of soil humus profile as a result of their use in agriculture is one of the main factors which determine land desertification.

Dynamics of nutrient content in the unfertilized and fertilized chernozems. It was established that the variant without fertilizers in a period of 43 years (1953-1996) takes place gradually decrease the content of mobile phosphorus from 16 to 8 mg/kg of soil. Such a decrease has been established and nitrogen (from 4.0 to 1.2 mg/kg). The amount of exchangeable potassium were not changed. Accumulated reserves of nutrients in the soil decreases from year to year as a result of not applying fertilizers. The agrochemical indices of fertilized variant have improved.

Evolution of humus balance in soils. Evolution of humus status in soils during the 1971-2000 was influenced by the intensity of organic fertilizer and water erosion. Biochemical decomposition of humus losses were offset by more fully in the 1980-1990, the period in which the application of organic fertilizers in agriculture has reached maximum values (5.6 to 6.6 t/ha). Damage to soil fertility by erosion, is expressed by the loss from eroded arable soil of 600-700 kg/ha per year humus. During 1991-2000 humus losses have increased considerably (annual 1.1 to 1.3 t/ha) with negative consequences on the quality of soil cover.

Efficiency of fertilizers under different culture for production conditions. In the early stage of intensive application of fertilizers was highlighted dependence between the quantity of fertilizers and main crop production, especially of grain. After

1980 the crops great slowly, much slower than the rate of supply of fertilizers. The results show that the technical equipment of agriculture in the period 1970-1980 the yields of main crops in the country remained stable and no major increase average dose of fertilizers. Summary dose of fertilizer was sufficient to increase yield crops, but this increase was limited by moisture deficit and existing technologies in this period. Currently due to lack of fertilizers and extensive farming soil, crop yield decreases.

Conclusions

Information system for soil quality will contribute to the right of access to information to citizens on the quality status of the soil cover of the republic, to promote prevention and control of degradation processes, soil damage and pollution caused by natural phenomena or caused by human activities to maintain long term agricultural and forestry production capacity of the soil cover, the establishment of monitoring land quality.

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