HYDROMORPHIC SOILS - AS RESEARCH OBJECT OF AND UTILIZATION IN AGRICULTURE OF MOLDOVA

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Abstract.
In the paper are characterized hydromorphic soils of Moldova. The hydromorphic alluvial and non alluvial soils are an important group of soils as object of research for its use in agriculture and as an ecological niche for biodiversity conservation. Hydromorphic soils consists about 300 thousand ha or 8.4% of the total area of the land fund. The main degradation factors of hydromorphic soil are salinization, alkalization, compacting, gleyzation of middle and bottom part of the profile, swamping in terms of lack drainage, clogging by weak humus alluvia. Arable marshes are subject of intensive process of humus loss. Hydromorphic soils are influenced by extremely strong anthropogenic impact, therefore they must be included in the monitoring network of Moldova. Agricultural land use in accordance with the soil and climate resources of each agropedoclimatical zones, particularities of zonal and intrazonal soils will help guide Moldova's agriculture for subsistence in drought conditions.

Keywords: amelioration, hydromorphic, marshy, salinization, soil

1. Introduction

Republic of Moldova is characterized with a complex soil cover. Soil diversity is determined by climate change, topography and vegetation from north to south and vertical zonality of climate. The main soils of Moldova are chernozems, that occupies 2510 thousand ha or 70% of the land area and 78% of the agricultural land [1]. Under steppe and silvosteppe vegetation have formed zonal subtypes of chernozems: podzolic (3.5%); cambic (11.7%); typical (8.3%), common (18.8%); carbonate (19.9%); southern (0.1% of the land fund area) and intrazonal subtypes (7.3%), [2].

Under recent and previous forest vegetation (200-400 m of altitude) have evolved following zonal soils: grey (9.8%) and brown (0.8%) soils; chernozems xero-forestry (0.5% of the land fund).

Brown and grey soils, cambic chernozems of Central Moldova were formed as a result of vertical zonality and are distinguished from similar soils of Northern Moldova by a favorable temperature regime (amount t°>10°= 3000-3150°).

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An important group of soils as object of use in agriculture and an ecological niche for biodiversity conservation are hydromorphic soils (300 thousand ha or 8.4% of the total area of the land fund). Hydromorphic class includes the soils influenced by moisture excess: chernozemlike, marshes and peaty [4, 6].

The main types and subtypes of soils were included in the monitoring network, which allows detecting changes in their quality status. For hydromorphic soils the network of monitoring polygons has not been established and information on their quality status is unknown.

The distribution of hydromorphic soils in the investigated area of land fund with agricultural destination is presented in Figure 1 and 2.

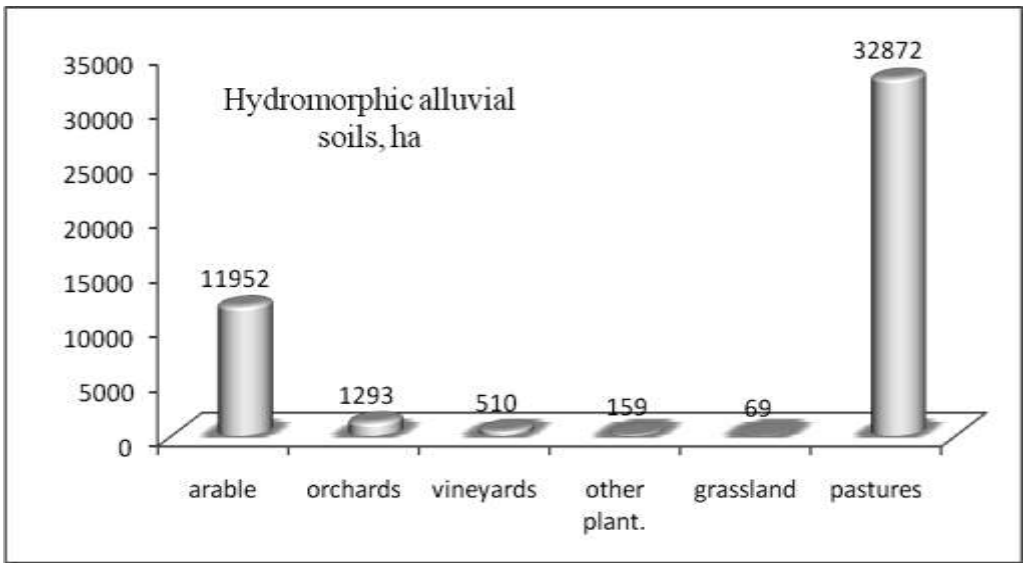

Fig. 1. Distribution of hydromorphic alluvial soils on land uses in the area of agricultural land

2. Hydromorphic soils

Hydromorphic soils divides into *non alluvial* and *alluvial.* They are represented by typical marshes, stratified marshes, swampy marshes, peaty soils, hydromorphic solonchaks and solonetzs [3].

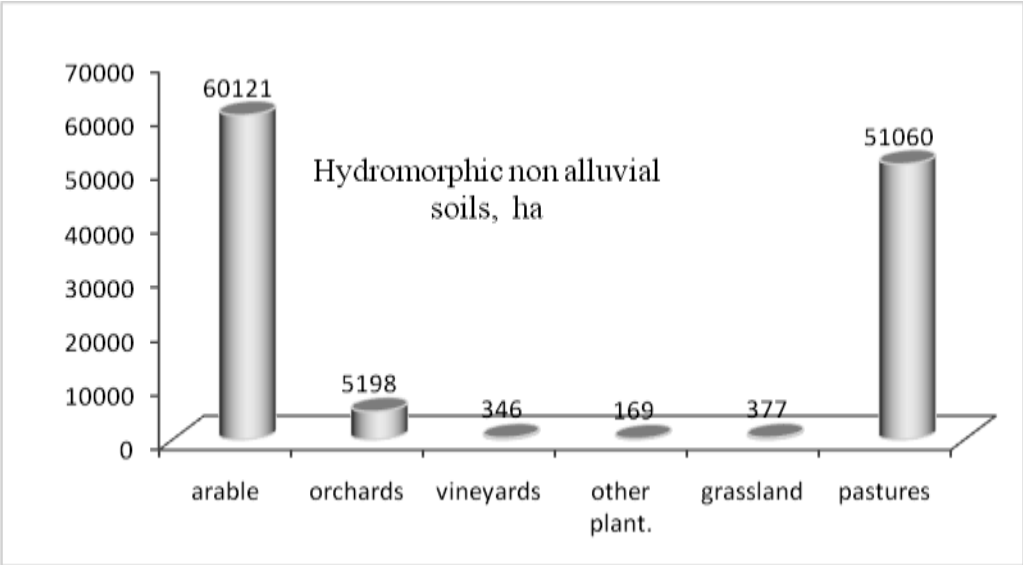

Fig. 2. Distribution of hydromorphic non alluvial soils on land uses in the area of agricultural land

Non alluvial hydromorphic soils occupies the area of 47 thousand ha or 2.54% and alluvial - 117.3 thousand ha or 6.3% of the investigated area of agricultural land [2]. These soils mostly in the past were irrigated. Currently the irrigation system can be achieved while restoring the drainage system regulating ground water level. As an object for use in agriculture the following hydromorphic soils are of interest: non alluvial and alluvial (fluvial) humiferous marshes, stratified marshes.

2.1. Non alluvial humiferous marshes

Non alluvial marshes area occupies 10.7 thousand ha or 0.58%. They are spread in all districts of Moldova. They were formed as a result of combination of humification and gleyzation accumulation processes in condition under permanent connection with groundwater. They are spread in the valleys, gullies, depressions, on the slopes and watershed in the form of small spots. They have a well-developed humus profile with thickness of 40-120 cm and signs of gleyzation in the middle and lower part of the profile. The humus content in the surface horizons of soils is 4-8% and in the arable layers - 3-5%. As a result of various share of precipitation and groundwater to wet these soils on seasons and years, the marshes formed a regularly percolating water regime which conditions the current instability of salinity profiles and properties, and also relatively rapid change in outcome improvement. This process lead to apparition on the comparatively small

territories, the combinations of hydromorphic soils, composed from marshes, swampy marshes and swampy soils [5].

2.2. Alluvial (fluvial) humiferous marshes

Together with the vertic marshes (8.8 thousand ha or 0.48%) these soils occupies the area of 52.5 thousand ha or 2.85%. They are spread in large river valleys of Dniester, Prut, Răut and small river floodplains. They were formed in the result of combining the humification, gleyzation and alluvial processes of accumulation in the floodplain of rivers. They were spread in the riverbed part, where alluvial regime manifests weakly and temporarily, or definitively ceased, and the accumulation of humus is pronounced. The shallow groundwater depth is 0.7 to 2.0 m and causes an intensive gleyzation in the middle and lower part of soils. They have a well-developed humus profile with thickness greater than 60-80 cm, sometimes more or less humus layers of buried soil, that differ by size composition [4,6].

They are characterized by high natural fertility, but their use as arable is possible only in the presence of drainage and protective dams. The main processes that cause their degradation are: salinization, alkalization, gleyzation, swampy at the irrigation without drainage, flooding in the case of floodwaters.

2.3. Stratified alluvial marshes

These marshes occupies 46.7 thousand ha or 2.52% [1]. It is more common in floodplains of Dniester, Prut and Răut rivers. They were formed on river stratified alluvium under intensive accumulation of alluvial deposits. The main criterion that distinguishes them is alternating layers of different texture and humus content in the profile. Soils are poorly evolved. Compared with alluvial humus marshes, they have a lighter color, lower humification, less developed structure, coarser texture. Morphological characteristics, composition and properties of these soils vary strongly in space. The humus content in arable layer is 1-3%, reaction - slightly alkaline. Natural fertility is low or medium. The degradation factors of stratified alluvial soils are the same as the fluvial typical marshes: salinization, alkalization, compaction, swamp at the irrigation without drainage, gleyzation [2].

3. Soil degradation by humidity excess

3.1. Periodic numidity excess and salinization processes of non alluvial marshes on the slopes and depressions

The formation and evolution of soils with excess moisture on the slopes and depressions is subject to prolonged stagnation of rainwater (from rainfall), the

appearance on the surface of coastal spring's water or groundwater, soil overeating with surface rain water and ground water.

The process of soil formation under hydromorphism is influenced by the content and composition of salts in ground water. In silvosteppe landscapes of Northern Moldova Plateau the ground waters have a low content of salts, the main component is calcium bicarbonate. In these conditions are formed non salinity marshes.

In Central and South Moldova landscapes predominate groundwater with high level of mineralization and the presence of toxic salts, under whose influence are formed the soils with different degrees of salinity and sodium enrichment.

The distribution of non alluvial marshes in Moldova is presented in the Table.

Table. Distribution of alluvial marshes in Moldova

Pedo-landscape Provinces	On the slopes		In depressions		Total	
	thousand ha	%	thousand ha	%	thousand ha	%
Silvosteppe of Northern Moldova	20.5	41.3	9.4	19.0	29.9	60.3
Silvosteppe of Central Moldova	6.5	13.1	2.8	5.6	9.3	18.7
Predanubian Steppe of South Moldova	4.2	8.5	4.1	8.3	8.3	16.8
Ukrainian Steppe of Southern Moldova	1.3	2.6	0.8	1.6	2.1	4.2
Total	**32.5**	**65.5**	**17.1**	**34.5**	**49.6**	**100**

The marshes on the slopes are distributed in the form of small spots with size from 0.1 ha to 1-5 ha. The mosaic of spots of hydromorphic soils on the arable land creates heterogeneity of soil cover of the plots, complicating the tillage and sustainable land use. In connection with the destruction of drainage facilities the surface of soil with humidity excess on the arable land increases intensive in recent years [3].

Marshes on the slopes have an area of 20 thousand ha, according to the land register are considered as arable and perennial plantation, however, the harvests on them, is practically impossible. Given the approximate cost of the annual harvest of 2 thousand lei per 1 ha, the annual loss caused by mosaic of marshes on the arable land reaches 40 ml. lei ($ 3.64 million). Annual total loss for the whole area of non alluvial marshes as a result of salinization and water excess is 49 ml. lei ($ 4.542 million), [2].

3.2. Periodic humidity excess and salinization processes of alluvial soils and marshes

The total area of alluvial soils and marshes is 259 thousand hectares, of which 99 thousand are salinization. Non salinization are soils in floodplains of small rivers from Northern Moldova and the most soils in the floodplain of Dniester river.

Salinization soils are widespread in the meadow of Middle and Lower Prut river and small meadow of Central and Southern Moldova. Ameliorative situation of these soils is very complicated. As a result of damming and regulation of flows by building ponds, restoring and deepening riverbeds have been excluded seasonal overflows that maintaining the saline balance in soil - groundwater system. Drainage facilities did not ensure evacuation of excess water and salts from the soils and lowering ground water level. In 75% of the floodplain soils groundwater depth is higher than the critical level, which favors evolution of salinization processes. Currently 47% of the alluvial soils are characterized by a satisfactory ameliorative status and 53% - unsatisfactory [3].

The annual loss of crops on alluvial soils with unsatisfactory ameliorative status (130 thousand ha) is 20-30%, equivalent to 500 lei per 1 ha and 66 million lei ($ 6023 ml) over the entire area affected by degradation processes. The annually damage across the entire alluvial soils with excess moisture and salinization soils constitutes 111 ml. 309 thousand lei ($10 ml.119 thousand), [2].

4. Amelioration of soils with humidity excess

Marshes, wetland marshes are found in all agropedoclimatical zones of Moldova on the slopes and depressions in the form of small spots. Mosaic of bogs on the slopes prevents the operation agricultural works. On the basis of the recovery and exploitation of soils with humidity excess are the drainage works, which include: rapid evacuation of stagnant water from the plane land; lowering the groundwater level in the landforms depression; capturing coastal springs and ground water. In the period 1970-1990 by drying-drainage works have been put in the agricultural circuit approximately 40 thousand ha (80%) of the total area of marshes. In the desiccation process of non salinization marshes they approach the zonal soils after quality status. Therefore, the models of improvement and rational use of hydromorphic soils will take into account only the relief particularities and salinization conditions.

Currently the system of soil drainage-drying with excess moisture on the slopes is partially or totally damaged and practically not functioning. Failure measures to restore and maintain the drainage-drying system, will lead to the exclusion from agricultural circuit about 40-50 thousand hectares of arable land [1].

Salinization soils with moisture excess from meadows are represented by alluvial (fluvial) marshes and alluvial soils (fluvisoils) alkalization and salinization.

Ameliorative status of these soils, as a result of the demolition of the drainage system, worsened considerably, primarily in small river valleys and in the Prut meadow. Most arable land of small meadows has been converted from arable land into grassland. As a result of overgrazing the pasture has worsened and is characterized by low productivity.

Drainage facilities have not ensured lowering of water ground level, evacuation of water and salts excess from the soils. In these circumstances have become dominant halogen - salinization and alkalization processes. Currently over 99 thousand hectares are salinization, 20 thousand hectares - wetlands and about 10 thousand hectares became slitizated (compacted). Over 75% of the floodplain soils have the depth above the critical groundwater level. According to the pedological, hydrological and biochemical indices, over 40% of the floodplain soils are characterized by favorable ameliorative status and 53% - unsatisfactory. Meadow soils in good condition are practically missing [2, 5].

Ameliorative works of alluvial salinization soil are integrated within the whole of the interventions to combat desertification and improve ameliorative condition of meadows territory in Moldova. Improving salinization soils is made based on projects developed for natural zones, river basins and is done in stages. Salinization soils require gypsum amendment, application of deep plowing, maximum fertilization. Without the application of mineral and organic fertilizers these soils cannot provide high yields being poor in humus, nutrients and low biological activity.

Conclusions

(1). The main degradation factors of marshes are salinization, alkalization, compacting, gleyzation of middle and bottom part of the profile, swamping in terms of lack drainage, clogging with weak humus silt. Arable marshes are influenced by intensive process of humus loss.

(2). The pedoameliorative measures for increasing production capacity of soils should include improvement of soils with humidity and salts excess, degraded as result of irrigation, in aim to combating drought and desertification.

(3). Monitoring polygons network of Moldova should be broadened and cover all pedoclimatical areas and vertical zones, and intrazonal soils (marshes, chernozemlike soils, solonetzs, solonchaks, diluvial soils, alluvial soils, etc.) that are formed in all pedogeographic districts.

(4). Agricultural land use in accordance with the soil and climate resources of each agropedoclimatical area will contribute to the recovery of low productive lands (hydromorphic) and orientation the Moldova towards the subsistence of agriculture in drought conditions.

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