International Journal on Emerging Technologies **10**(2): 147-149(2019)

ISSN No. (Print) : 0975-8364
ISSN No. (Online) : 2249-3255

Degradation of the Soil Humus Content in the Takhtamukaysky District of the Republic of Adygea

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(Received 05 May 2019, Revised 16 July 2019 Accepted 18 July 2019)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: The ecological monitoring of land resources is extremely relevant in modern times because at present, the soil cover both in the Republic of Adygea and the Takhtamukaysky district suffers such degradation processes as erosion and deflation, dehumidification, waterlogging, etc. The unique Ciscaucasian chernozems degrade: almost all arable lands are affected by erosion. The land pollution with heavy metals and toxic substances is observed; processes of the soil waterlogging, salinization, acidification and irrevocable humus loss develop rapidly.

Keywords : Soil, Takhtamukaysky district of the Republic of Adygea, degradation, humus.

I. INTRODUCTION

Land waterlogging and flooding in the Republic of Adygea are the major factors, determining the decrease in the fertility of agricultural lands and causing soil degradation. Reasons for waterlogging and flooding are divided into two groups: natural and anthropogenic. In some cases, the mixture of both types is observed [1-6].

In the last 30 years, the agricultural land in Russia has decreased by 12.2 mln. ha, the arable land – by 2.4 mln. ha, the hay field land – by 10.5 mln. ha. Reasons for the decrease are the soil cover damage and degradation resulting from waterlogging and flooding of the land [7].

The increase in the area of floodplain lands was caused by the transfer of degraded semi-terrestrial meadow chernozems into flooded meadow chernozems. Under these circumstances, for the prevention of water accumulation, flooding and waterlogging, it is necessary to build hydrotechnical facilities for water discharge from the flooded and waterlogged lands. Drainage channels must be constructed along the dams of hydrotechnical utilities, river embankments and in gullies and gulches of low-drained lands. For this reason, measures aimed at the prevention of land waterlogging and flooding provide for reasonable and scientifically grounded prevention of the soil cover degradation and achievement of an increase in the crop capacity. Together with environmental measures, they improve the ecological state [4, 6, 8].

In this connection, there is a need for detection and analysis of the degradation process development in the territory of the Takhtamukaysky district (the Republic od Adygea). Special attention must be paid to the humus content as an important indicator of land fertility [8].

The Takhtamukaysky district is located in the northwest of the Republic of Adygea. The district shares borders with the Teuchezhsky district of Adygea in the east, the Dinskoy district and the Krasnodar city in the North, the Seversky district in the west, the Belorechensk district of the Krasnodar region and the territory of the Goryachiy Klyuch city in the south. The Takhtamukaysky district is included in the agro-climatic area characterized by a moderate continental climate.

Depending on the terrain and hydrological conditions, the following soil types are formed in the Kuban valley: on flat terrain and ridge-shaped hills – meadow chernozem, alluvial meadow soil and meadow-bog soil.

The hydrographic system of the district is mostly represented by three reservoirs (Shapsugsky, Oktyabrsky (Takhtamukaysky) and Shendzhiysky), as well as by rivers (Kuban, Sups, Chiby and Chituk). In addition to the reservoirs and the rivers, there is the Chibiysky Canal and a number of ponds and lakes.

The groundwater in the Kuban and Sups valleys is brackish and does not cause significant salinization of ground and soil. The water in all ponds, in the Chiby brook and the Shendzhiysky reservoir is fresh and suitable for irrigation. In the north, the district is bounded by the Kuban river. The hydrological regime of the Kuban river is very uneven, as the regime of all mountain rivers. Two explicit flood periods are observed: spring flood in April and summer flood in late June. Depending on the relief features, the groundwater occurs at different depths in the district. The direct dependence of the groundwater on the water level in the Kuban river is observed in a small part of the territory – in the point bar area. Here, the groundwater occurs at the depth of 1.5-2.5 m. During periods of high water level in the Kuban, in some places, the groundwater goes up to the surface [3, 4, 8, 9].

During abundant precipitation periods, the temporary perched groundwater appears. Due to small slopes, the water stagnates for a long time, delaying agricultural works. During vegetation periods, it causes the damping of the crops [10].

In the Kuban and Sups valleys, zone factors of the chernozem formation type are blurred by intrazonal processes caused by specific conditions of the microrelief, moisture degree, vegetative cover peculiarities, etc. Semi-terrestrial and hydromorphous soil types are formed here. Here, meadow chernozem and meadow soil, as well as alluvial meadow-bog soil

and wet meadow soil, appropriate for more lowered microrelief elements, also form. Slope lands are exposed to water erosion and represented by compacted slightly washed and slightly flooded chernozem [8].

The object of the research is the land of the Takhtamukaysky district of the Republic of Adygea exposed to degradation processes.

The subject of the research is the degradation of the soil cover due to the land waterlogging and flooding in the Takhtamukaysky district of the Republic of Adygea.

The purpose of the research is to determine the humus content of the soil in the Takhtamukaysky district and to evaluate its degradation degree.

II. MATERIALS AND METHODS

For climate description, materials of meteorological observations carried out at meteorological stations located in the research area (the Krasnogvardeyskoe village) were used, as well as climate data published on the website of the Maikop Agricultural Research Institute in the information and analytical system "Agro-climatic potential of the Republic of Adygea". The soils of the Takhtamukaysky district were taken for analysis from control points by the envelope method, combining them in a laboratory sample. The analysis was replicated 10 times. The humus content in the soil was determined by the method of I.V. Tyurin based on the soil organic substance oxidation by chromic acid, causing carbonic acid formation.

III. RESULTS

The district climate is continental with moderately hot summer, short winter with little snow and long warm fall. The annual average atmospheric temperature is 10.4˚C. Winters are characterized as moderately mild. The monthly average atmospheric temperature in January is -4.0˚C. At the same time, the minimum temperature can decrease down to -34˚C. Snow falls often occur in early December. During the winter months, thaws are frequent, so the snow cover height ranges from 4 to 8 cm. The snow cover melting usually occurs in early March and the vegetation of plants resumes at the end of this month.

Compacted chernozem is abundant in 47% of the district. This type of soil can be found on flat terrain, slight slopes of the sloping Zakubansky plain. The soil located on slopes is exposed to water erosion. 50% of the chernozem area is used for agricultural production. Compacted chernozem is relatively inhomogeneous. The soil occurrence on different relief elements, on flat terrain, slopes and microdepressions has an impact on thermal and water availability, as well as the soil erosion activity. The given circumstances are most notably reflected in the thickness of the humus layer and the humus content. In terms of humus content, all chernozems are slightly humic. It was determined, that the arable layer of non-eroded soils contained 3.54±0.09% of humus.

The meadow chernozems occupy ridge-shaped hills in the Kuban and Sups valleys. They are mostly occupied by grazing lands. Alluvial clay and loam were parent materials for these soils. The soil water-physical properties are favorable. However, most of the contours of the meadow chernozems were used for many years in irrigated agriculture (rice planting), which led to a significant change in their natural properties. The soils compacted under the influence of long-term flooding, their structural state was destroyed, air and water exchange conditions were violated. The humus content in the upper layer amounts to 3.06±0.13%. The meadow chernozems are suitable for field and vegetable crops. Almost the whole area of the meadow chernozems was involved in the rice system. At present, it is used as grazing land. All meadow soils are of average thickness. In terms of humus content, the meadow soils are divided into slightly humic and low-humic types, the humus content in the upper layer amounts to 4.22±0.06% and 2.77± 0.07% of humus respectively [8].

The presence of absorbed sodium with a fairly high magnesium content (31%) provides the soil with a high profile density, low corrosion affection and low soil permeability. Altogether these factors lead to soil waterlogging and flooding, as well as limited availability of production use. The meadow soils are distinguished by certain indicators, at which agro-technical measures must be taken for the normalization of agricultural crop growth conditions.

The wet meadow soils are distinguished in river bottoms. These soils, being formed under conditions of long-term waterlogging caused by surface water and close groundwater occurrence, represent a transitional stage between meadow soils and meadow-bog soils. Their thickness is usually not very significant (40-50 cm), a humus profile of the soil contains up to 150 t/ha of an organic substance, providing the presence of 3.66±0.11% of humus in the A horizon. Unfavorable water-physical properties and long-term excessive moistening significantly limit the possibility of economic use of the soils. Without proper reclamation, the soils in the present state are suitable for pastures with a limited grazing period [8].

These morphological features are conditioned by meadow-steppe plants, which grew here earlier. The humus content in the degraded chernozem amounts to 5.35±0.04% of the soil weight.

The meadow flood plain soils of forest-steppe and steppe areas are distinguished by a thick humus layer with an intensive humus coloring and less iron accumulation in the lower part of the profile. Carbonate content, alkalinity and salinity can be observed in these soils.

The humus horizon A1 is dark gray or brownish-gray of heavy-loamy granulometric composition with a significant amount of residual humus (30-50 cm thick), brought with alluvium. In the upper part of the horizon, a heavy sod (3-6 cm) is distinguished. It has a grainy structure with rusty-brown specks and veinlets. B1 is a transitional horizon with gleyzation and ferruginization inclusions caused by hydrogenous processes. Bg is a gleyic horizon of bluish-green tones. Its gleyzation degree varies greatly and it often has a schistose texture. CDg is layered alluvium, which is usually very gleyed and has buried peat interlayers.

They are formed in a central floodplain during waterlogging with still flood water and deposition of a relatively small amount of loamy and clay alluvium. After the flood recession, the upper boundary of a capillary fringe is constantly or periodically present within the soil profile. It develops under wet grass meadows in steppe and forest areas.

Due to rice planting, so-called rice soils have formed in the district. They are formed when the meadow and meadow chernozem soils are used for rice fields. At present, these soils have obtained meadow-bog features and it will be difficult to regenerate them in the near future. Their humus content was 2.97±0.09%.

Land flooding and waterlogging in the Takhtamukaysky district are the major factors, determining the decrease in the fertility of agricultural lands and causing soil degradation. Reasons for flooding and waterlogging can be of natural, anthropogenic and natural-anthropogenic origin. Thus, the agricultural landscapes of the rice fields in the Takhtamukaysky district were formed coincidently by the anthropogenic transformation of the floodplain relief, flooding during water rising in the Krasnodar reservoir and rivers and flooding caused by heavy precipitation.

Hydromorphic soil degradation is caused by several topographical and technological factors according to the following scheme: deterioration of the soil hydrological regime, soil dehumidification, compaction and structural damage. As a result of the changes, calcium leaching from the soil solution and the soil absorbing complex occur at an increasing rate; the process of the soil gleying develops. These processes cause a profound restructuring of the soil components as a disperse multiphase system. The given changes lead to the soil compaction, destroying its structure, causing the deterioration of the soil permeability and, as a result, contributing to the increase in the waterlogged land area. There is a tendency towards an increase in the area of the waterlogged lands in the steppe part of Adygea (the Takhtamukaysky district), which leads to the redistribution of genotypes of all chernozem subtypes. At present, the waterlogged land area increase is observed not only during wet but also during drought seasons.

The main reason for flooding is the impact of the Krasnodar reservoir, which water level reaches a maximum in spring, due to the intensive accumulation of precipitation water in winter and spring. As a result of the water rising, flooding of the lower reaches of the Psekups, Marta, Pshish, Apchas, Dysh, Kamla, Shunduk rivers and other adjacent watercourses occurs [8].

The Krasnodar reservoir, the largest hydrotechnical object in the North Caucasus, was constructed in 1968-1975 on the Kuban river and its estuarine tributaries (Belaya, Pshish, Psekups and others).

Against the background of partially realized functions of the Krasnodar reservoir, the scale of the following adverse effects of its functioning is of extreme concern:

- land waterlogging and flooding caused by the groundwater level increase (from 0.5 to 5 m);
- degradation of fertile chernozem (at present, more than 20 thousand ha);
- change in the microclimate of the adjoining area, deterioration of the environmental and sanitary-epidemical situation;
- destruction of the reservoir's banks;
- increase of the groundwater level causing the flooding of the adjacent lands;
- withdrawal from the agricultural and economic use of extensive formerly fertile lands;
- reservoir construction resulting in the groundwater rising (hence the floods in nearby villages and auls and destruction of archaeological sites);
- significant annual erosion of banks, which causes the reduction of arable and settlement land area and the reservoir siltation. As a result of the reservoir siltation, its useful capacity decreases, creating a direct threat of flooding of adjacent territories.

Ameliorative measures aimed at the protection of agricultural land include the following: land levelling, selective furrowing, bedding, surface profiling, ridge plowing or ridge tillage, subsurface layer moling and subsoiling.

IV. CONCLUSION

In the territory of the Republic of Adygea and the studied Takhtamukaysky district, the flooding of agricultural land is observed mainly in fall and winter, as well as in spring given high precipitation. Therefore, a complex of agricultural, ameliorative and hydrotechnical measures must be taken to protect the fields from the excess water.

Implementation of the aforementioned measures on waterlogged and flooded lands allows preventing soil flooding and contributes to the improvement of its water-physical properties and the optimization of the humus content, as well as the rational use, protection and improvement of the district lands.

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How to cite this article: Tletseruk, I.R., Ashinov, Y.N., Astakhova, I.A., Tsipinova, B.S., Machneva, N.L., and Yurin, D.A. (2019). Degradation of the Soil Humus Content in the Takhtamukaysky District of the Republic of Adygea. *International Journal on Emerging Technologies*, **10**(2): 147-149.