THE MODIFICATION OF ECOPEDOLOGICAL INDEXES UNDER THE LONG TERM ANTROPOGENIC IMPACT

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Key words: impact, ecopedological indexes, ecosystems, adherence, moisture, degradation.

Abstract. This work is dedicated to the study of ecopedological indexes in different coenosis - steppe; agrocoenosis - arable field, autumn wheat, single-crop corn system (60 years), fallow soil (60 and 100 years), its modification estimated under different anthropogenic influences and agricultural management level and founding of diagnostic indexes in complex evaluation of anthropogenic impact. It was established that soil degradation impact is directly dependent on the level of agricultural management; the studied coenosis soils are significantly modified under anthropogenic impact, and the coenosis near old villages are strongly degraded. The physical degradations (structure modification, bulk density, adherence) prevail. The adherence can be used as diagnostic ecopedologial index for the appreciation of anthropogenic impact level on agro-ecosystem.

Introduction

To practice a sustainable agriculture and promote a sustainable development is needed a permanent supervision and estimation of ecopedological indexes under different types and levels of anthropogenic impact, characteristic to the agricultural sector. The emphasis of anthropogenic impact on soil and ecosystems in the main ecopedological regions of Moldova Republic at different management level allow the monitoring of soil quality, the rational use of its fertility and elaboration of measures of development of agriculture in conditions of high, medium and low management. The high level of management implies total mechanization of agrotechnical technologies and high anthropological activity; the medium level partial mechanization and medium anthropological activity; the low level presents limited mechanization and anthropological activity.

The aim of the paper is to study the ecopedological indexes in different ecosystems, the estimation of its modification under different levels of anthropogenic impact and agricultural management, and finding diagnosis indexes for the complex estimation of anthropogenic level impact. This is integrated in the elaboration of monitoring criteria of anthropogenic impact with regards to the rational use of the soil.

1. Materials and methods

The impact of agroecosystems degradation (Id) refers to soil functions as bases of agricultural production and represents the model reflection of level correlation by soil anthropogenic degradation and decreasing of its productivity at different levels of production organization (high, medium, low). In the conditions of medium level of organization of agricultural production the following indexes of soil degradation impact processes are emphasized (Table 1):

Id1 – minimum impact in the condition of general increase of productivity (the increase of profit from crop and no necessity for compensation for degradation impact);

Id2 – minimum impact in the condition of low increase of crop which hardly compensates the degradation impact;

Id3 – low impact in the condition of no increase of productivity, and the profit from obtained crop is insufficient to compensate the degradation impact;

Id4 – medium impact in the condition of low decrease of productivity and the obtained crop is insufficient to compensate the damage;

Id5 – strong impact which is expressed by general decrease of crop, and the efforts for the increase of soil productivity can be compensated only in a limited proportion;

Id6 – extreme impact in the condition of absence of soil productivity and presence of a high level of unstable situations.

Tab.1 - The ecosystems degradation impact in the function of management level and productivity (“SOVEUR Project”, Ungurean, 2003)

Productivity level	Management level		
	A) High	B) Medium	C) Low
1) Large increase	Negligible	Negligible	Negligible
2) Small increase	Slight	Negligible	Negligible
3) No increase	Moderate	Slight	Negligible
4) Small decrease	Strong	Moderate	Slight
5) Large decrease	Extreme	Strong	Moderate
6) Unproductive	Extreme	Extreme	Strong to Extreme

The degradation impact is directly influenced by the level of agricultural management and increase or decrease of productivity. At medium level of agricultural management, at slight decrease of productivity the impact of degradation is moderate. At the same level of agricultural management, but at large decrease of productivity the degradation impact is strong. At low level of agricultural management, when traditional agricultural system is practiced more than 25 years, in small or large decrease of productivity the degradation impact is respectively slight and moderate.

In the present conditions occurs an unreal image that degradation impact of soils, fields and ecosystems are the same on the entire territory of the country.

The investigations have been done on the chernozems from North Moldovian Plateau.

In conformity with Land Cadastre of Republic of Moldova (2005) the total area of investigated lands consists of 4829 ha, including 3293 ha (68%) arable land, 204 ha (4,2%) orchards and vineyards, pasture land - 692 ha (14,3%), agricultural lands - 86,7% from total area. The investigated area is characterized by high level of ploughing, low level of foresting (3.3%).

The present level of anthropogenic impact, calculated according to a special methodology that includes natural and anthropogenic factors, is evaluated as significant. Different ecosystems were investigated: steppe (600 years), agrocoenosis – arable field, autumn wheat, single-crop system (60 years), fallow soil (60 and 100 years).

In the investigated area 80% of the territory is under high and medium level of anthropogenic impact, but also under high level of agricultural management. 5-10% are under medium level and 5-10% have a low level of agricultural management.

The used investigation methods of ecopedological indexes are recommended by STAS of Republic of Moldova. The soils adherence (KPa) was determined by N. Kacinski method on metals surfaces of 10 cm^2, the pressure on the disc – 0,005 MPa, during 30 sec., ten repetitions.

2. Results and discussion

The investigations established that the soils of the studied ecosystems are significantly modified. The agro-ecosystems soils far off villages (3-4 km) are slightly changed by structure, bulk density, total, porosity, texture, humus content, Ca^{++} and Mg^{++} (Table 2).

It is known that in crop formation an important role plays soil moisture, active water. Data referring to moisture resources of soils and active reserves for different ecosystems are missing. The moisture determination in May 2007 indicated a significant variability: under the steppe is of 20.6-24.1%, in the arable field moisture was higher (22-26%). It is important to mention that moisture in the soils cultivated with autumn wheat varied considerably, from 22.8 % (0-10 cm) to

Tab. 2 - Physical-chemical characterization of studied ecosystems soils

Ecosystem	Depth, cm	Moisture, % May, 2007	Analytical coefficient, %	Humus, %	Ca^{++}, me/100 g soil	Mg^{++}, me/100 g soil	$\sum Ca^{++}$ + Mg^{++}, me/100 g soil	Hydrolytic acidity, me/100 g soil	pH_{H2O}	pH_{KCl}	Bulk density, g/cm^3	Fractions content, %	
												>0,01	<0,01
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
1. Anthropogenic (steppe)	0-10	24.1	4.82	3.49	26.8	4.8	31.6	3.1	6.3	5.7	1.03	49.45	50.55
	20-30	23.2	4.89	3.34	25.8	5.4	31.2	2.9	6.5	5.8	1.18	39.96	60.04
	30-40	24.5	4.97	3.27	25.5	5.2	30.7	2.8	6.7	5.9	1.34	41.79	58.21
	50-60	20.6	5.11	2.96	24.9	4.5	29.4	2.6	6.8	6.1	1.39	40.17	59.83
2. Agroecosystem (arable field)	0-10	24.5	4.67	3.65	25.2	5.4	30.6	3.3	6.2	5.6	1.11	53.50	46.50
	10-20	25.4	5.18	3.53	25.8	6.1	31.9	2.9	6.3	5.7	1.26	38.33	61.67
	30-40	25.9	4.82	3.16	24.8	5.6	30.4	2.7	6.4	5.9	1.38	45.63	54.37
	50-60	21.9	4.75	2.91	25.1	4.7	29.8	2.7	6.6	6.0	1.42	53.72	46.28
3. Agroecosystem (autumn wheat)	0-10	22.8	4.67	3.81	25.3	5.1	30.4	3.2	6.5	5.4	1.12	44.35	55.65
	10-20	16.9	4.75	3.77	24.8	4.8	29.6	2.8	6.6	5.6	1.27	43.03	56.97
	20-30	15.6	4.53	3.41	24.7	4.2	28.9	1.9	6.8	5.7	1.32	49.64	50.36
	40-50	18.6	4.60	3.19	24.3	4.3	28.6	2.1	7.1	6.0	1.34	48.43	51.57
	60-70	18.3	4.36	2.94	23.4	3.9	27.3	1.6	6.9	5.9	1.36	52.78	47.22
4. Agroecosystem (single crop maize, 60 years)	0-20	38.2	4.89	3.86	25.1	4.5	29.6	3.3	6.7	5.7	1.12	44.52	55.48
	20-30	23.7	4.67	3.79	25.8	4.6	29.4	2.7	6.9	5.8	1.26	45.18	54.82
	40-50	25.2	4.60	3.51	24.6	3.4	28.0	2.6	7.1	5.9	1.30	47.84	52.16
	60-70	24.9	4.60	3.19	23.9	2.7	26.6	2.0	7.2	5.9	-	50.13	49.87
5. Fallow (60 years)	0-10	21.4	4.53	3.74	24.7	3.9	28.6	3.4	7.0	5.7	-	49.43	50.57
	20-30	25.7	4.45	3.59	24.2	4.2	28.4	3.1	7.1	5.8	-	48.38	51.62
	30-40	25.2	4.36	3.41	23.7	4.2	27.9	2.9	7.3	5.9	-	50.25	49.75
	40-50	18.0	4.24	3.37	23.7	3.9	27.6	2.6	7.4	6.0	-	52.43	47.57
	60-70	20.3	3.66	2.89	23.8	3.6	27.4	2.0	7.4	6.1	-	56.69	43.31
6. Fallow (100 years)	0-10	20.1	2.39	3.71	22.8	4.0	26.8	3.4	6.6	5.7	0.97	75.21	24.79
	10-20	28.3	2.46	3.34	23.0	4.1	27.1	2.7	6.8	5.8	1.12	73.55	26.45
	20-30	23.6	2.53	3.12	22.9	4.7	27.6	2.9	7.0	5.9	1.26	71.85	28.16
	30-40	20.7	2.60	2.95	23.5	4.6	28.1	1.8	7.1	5.9	1.30	69.75	30.25
	40-50	22.5	3.44	2.64	24.4	3.5	27.9	1.6	7.2	6.0	1.34	57.03	42.97
	50-60	20.0	3.73	2.59	23.8	4.5	28.3	1.4	7.4	6.1	-	54.11	45.89
	60-70	19.5	4.82	2.47	24.5	3.9	28.4	1.2	7.5	6.2	-	43.20	56.80

Tab. 3 - The relation between adherence and moisture of arable and under arable levels of cambic chernozems

Depth , cm		Moisture, % and adherence, KPa								
		Anthropogenic fossil soil								
0-10	Moisture, (W), %	47.8	48.3	48.8	50.2	50.6	51.2	53.7	58.4	
	Adherence, kPa	0	0.07	0.05	0.2	0.19	0.20	0.07	0.21	
20-30	Moisture, (W), %	30.3	31.1	35.4	35.8	38.2	42.0			
	Adherence, kPa	0	0	0.25	0.22	0.35	0.22	0.12		
30-40	Moisture, (W), %	24.7	26.8	26.4	28.0	28.3	30.7	33.5	35.0	
	Adherence, kPa	0	0.08	0.09	0.28	0.31	0.27	0.21	0.35	
50-60	Moisture (W), %	25.2	25.6	25.8	26.5	27.2	29.2	30.4	35.2	
	Adherence, kPa	0	0.02	0.02	0.04	0.09	0.56	0.25	0.67	
		Agroecosystem (ploughing)								
0-10	Moisture, (W), %	26.3	27.9	31.0	33.4	35.4	36.8	38.7	40.1	
	Adherence, kPa	0	0	0	0.22	0.22	0.34	0.28	0.37	
10-20	Moisture, (W), %	25.9	26.4	30.7	30.9	33.7	34.3	36.5	37.7	
	Adherence, kPa	0	0	0.09	0.12	0.23	0.4	0.36	0.21	
30-40	Moisture, (W), %	29.5	30.4	30.8	31.4	33.3	36.0	36.8	36.9	38.0
	Adherence, kPa	0	0	0	0	0.3	0.15	0.12	0.05	0.16
50-60	Moisture, (W), %	25.0	29.5	29.9	30.3	30.4	34.8	34.9	36.8	
	Adherence, kPa	0	0	0	0	0.04	0.07	0.06	0.09	

Fig. 1 – Adherence and moisture of anthropogenic fossil soil

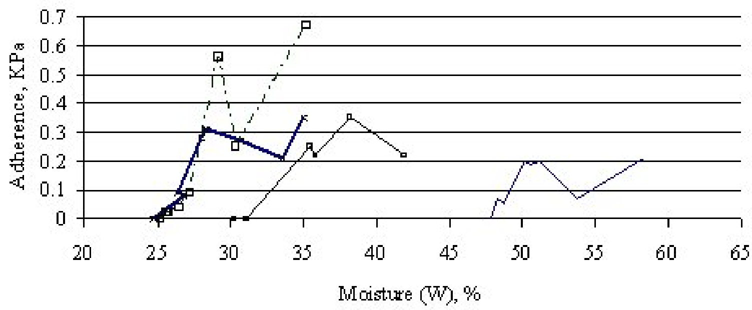


Fig. 2 - Adherence and moisture of soil in agroecosystem (ploughing)

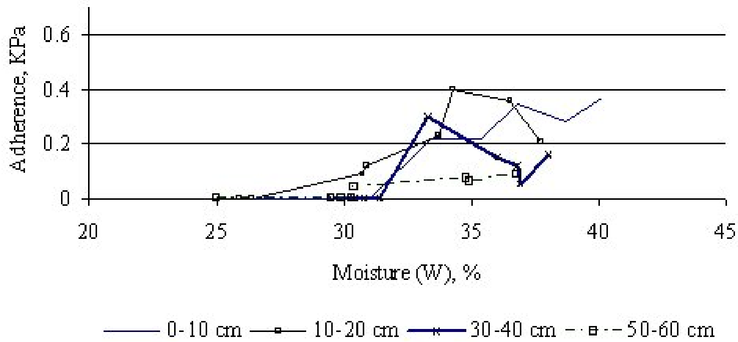


Fig. 3 - Adherence and moisture of soil in agroecosystem (autumn wheat)

15.6-16.9% at 10-30 cm, being near the wilting point, and only with 1-2% more at 30-70 cm.

Adjacent to this plot of land, in the single-crop - 60 years maize, where only base ploughing is done, soil moisture was increased (24-38%). This is explained by homogeneousness of arable layers at single-crop maize, less modified, with 1.10-1.15 g/cm^3 bulk density in arable layer and 1.15-1.22 g/cm^3 below. The high variability of moisture in autumn wheat agroecosystem is a result of depth base ploughing. The soil moisture in the fallowed land is close to that from single-crop ecosystem, but in the medium layers a part from moisture was lost due to the high capillarity of soil and the high level of compaction. The moisture of 100 years fallow varied between 20-28%, due to lower evapotranspiration.

The humus content analysis (Table 2) indicates medium levels (3.5-3.9%) for the arable layer and the organic matter deeply distributed in the soil profile. At 60-70cm the humus content is of 2.5-3.2%. It is obvious that the studied ecosystems are not significantly different by humus content in 50-60 cm layer, with exception of the single-crop maize where the humus reserves are higher. Under the 100 years fallow the humus content is >3% and is situated only at 0-30 cm depth.

The soil reaction (pH_{H2O}) in all studied ecosystems varied from low acid to low basic; pH_{KCl} is of 5.6 – 6.2; hydrolytic acidity is of 1.6-3.4 me/100g soil and don’t vary according to ecosystem types. Regarding the absorbed cations, the ecosystems are homogeneous, with the exception of the 100 years fallow, where in the 0-30cm layer this parameter is lower with 3-4 me/100g soil. This land before fallowing served as a pasture. The tendency of absorbed calcium decrease from under grazing influence has been observed in previous investigation. Grazing reduces with 30-40% the content of absorbed Ca^{++}. According to Andries S. et al, 2005, the total medium consumption of nutritive elements from soil in the formation of one tone of biomass for hay field and pasture is of 54.7 kg, 3.6 kg/t CaO and 1.5 kg/t MgO.

The data referring to the total biomass of pastures is missing, but it is sure that are at the same level or less then arctic tundra (5t/ha).

The soil texture in the studied ecosystems is clay loamy, except the 100 years fallow, where under pasture, the 0-50 cm layer is clay loamy to sandy loamy in the upper part (0-40 cm) and loamy at 40-50 cm. This indicates a critical level of influence, when profound modification of grain-size distribution takes place. This process of physical-chemical and physical degradation is a result of long term pasture, over 500 years, of the decrease of biomass content, of organic remains. Only regarding soil texture the qualitative estimation decreases from 90-95 to 60-65 points. In the Republic of Moldova the hay fields and pasture make up 380000 ha (14.8 %), and in the future they will be extended. These categories of lands are included in areas that increase ecological equilibrium indexes.

Fig. 4 - Adherence and moisture of soil in agroecosystem (single-crop, 60 years)

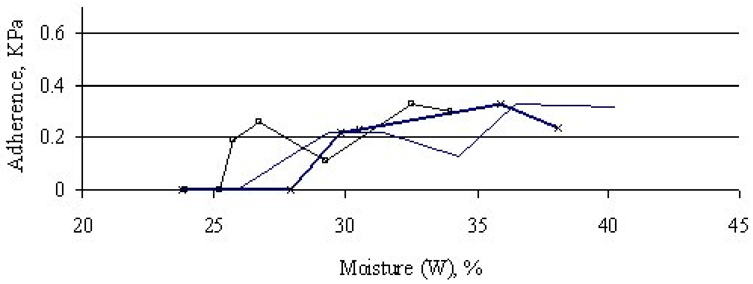


Fig. 5 - Adherence and moisture of soil in unploughing ecosystem, fallow soil (60 year)

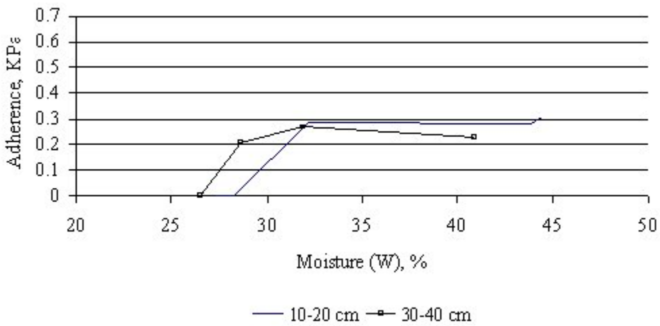
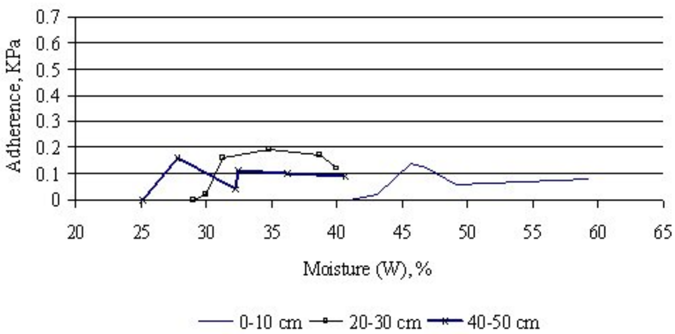


Fig. 6 - Adherence and moisture of fallow soil (100 years)



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Depth, cm		Moisture, % and adherence, KPa								
		Anthropogenic fossil soil								
0-10	Moisture, (W), %	47.8	48.3	48.8	50.2	50.6	51.2	53.7	58.4	
	Adherence, kPa	0	0.07	0.05	0.2	0.19	0.20	0.07	0.21	
20-30	Moisture, (W), %	30.3	31.1	35.4	35.8	38.2	42.0			
	Adherence, kPa	0	0	0.25	0.22	0.35	0.22	0.12		
30-40	Moisture, (W), %	24.7	26.8	26.4	28.0	28.3	30.7	33.5	35.0	
	Adherence, kPa	0	0.08	0.09	0.28	0.31	0.27	0.21	0.35	
50-60	Moisture (W), %	25.2	25.6	25.8	26.5	27.2	29.2	30.4	35.2	
	Adherence, kPa	0	0.02	0.02	0.04	0.09	0.56	0.25	0.67	
		Agroecosystem (ploughing)								
0-10	Moisture, (W), %	26.3	27.9	31.0	33.4	35.4	36.8	38.7	40.1	
	Adherence, kPa	0	0	0	0.22	0.22	0.34	0.28	0.37	
10-20	Moisture, (W), %	25.9	26.4	30.7	30.9	33.7	34.3	36.5	37.7	
	Adherence, kPa	0	0	0.09	0.12	0.23	0.4	0.36	0.21	
30-40	Moisture, (W), %	29.5	30.4	30.8	31.4	33.3	36.0	36.8	36.9	38.0
	Adherence, kPa	0	0	0	0	0.3	0.15	0.12	0.05	0.16
50-60	Moisture, (W), %	25.0	29.5	29.9	30.3	30.4	34.8	34.9	36.8	
	Adherence, kPa	0	0	0	0	0.04	0.07	0.06	0.09	

For the anthropogenic impact appreciation on the ecosystems an important role could have diagnostic ecopedological indexes. For this purpose soil adherence was studied, integral characteristic which depends on texture, structure, humus content, bulk density, absorbed cations. More than 1500 determinations have been conducted in the studied ecosystems. Results are presented in tables 2 and 3 and figures 1, 2, 3, 4, 5, and 6.

Previous and recent studies show that adherence can be used as diagnostic ecopedological index in the anthropogenic impact level appreciation. The soil from the steppe ecosystem is characterized by high level (maximum 0.67 KPa), in comparison to the normal levels for cambic and haplic chernozems of 0.2-0.4 KPa. The adherence of soil with high anthropogenic impact is not returning at initial level even after long fallow.

The soil adherence in single crop system is lowest compared to other agroecosystems (tables 2, 3 and figures 1, 2, 3, 4, 5, 6). The adherence of anthropogenic soils – 100 years fallow do not outrun 0.2 KPa at very high moisture (35-48%).

Conclusions

The soils impact degradation is directly influenced by agricultural management level.

The studied ecosystems soils are significantly modified under the influence of anthropogenic impact and duration of its pressing. The ecosystems near from old villages are strongly degraded.

The physical degradations (structure modification, bulk density, adherence) are prevailing over the physico-chemical degradations.

The adherence can be used as diagnostical ecopedological indexes for the appreciation of anthropogenic impact level on agroecosystemes.

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