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Land use impact on soil structure of Pseudogleys in southern Mačva and Pocerina, Serbia

Mladen Dugonjić*[1], Aleksandar Đorđević[2], Slađana Golubović[3], Svjetlana Radmanović[2]

[1]Academy of Applied Studies Šabac, Unit for Agricultural and Business Studies and Tourism, Vojvode Putnika 56, 15000 Šabac, Serbia
[2]University in Belgrade, Faculty of Agriculture, Nemanjina 6, 11080 Beograd, Serbia
[3]Academy of Vocational Studies of Southern Serbia, Faculty of Agriculture and Food Technology, Ćirila i Metodija 1, 18400 Prokuplje, Serbia

* *Corresponding author*: Mladen Dugonjic, dugonjic015@gmail.com

Abstract

The impact of various types of uses of Pseudogley soils in southern Mačva and Pocerina on theiraggregate distributionand stability was studied on soil samples collected from profiles under forest, meadow and arable land, at three localities. The aggregate composition and stability were determined by Savinov'smethod. The soil structure was assessed by using Revut's coefficient of soil structure (Ks) and Vershinin's coefficient of soil aggregate structure (K_A). The results show that the studied Pseudogley soils are characterized by an unfavorable structure, while the type of land use has a significant impact on the aggregate composition and stability, especially in surface Ah and Ahp horizons, where these differences are the most pronounced. The most favorable aggregate composition and highest wet-stability are found in Pseudogley profiles under forest vegetation. The aggregate distribution of meadow profiles was intermediate and of arable land the poorest. Statistical analysis of the collected data shows that Ks values, determined by dry sieving, were the highest in forest profiles (2.26±1.21 on average), while the values for meadow were 1.59±1.09 and of arable land 1.14±0.62. The values of K_A, used to assess the aggregate stability to water, also show that forest Pseudogleys have the highest average values (2.05±1.03), followed by meadow (1.96 ±0.99) and cultivated soils (1.93±1.22). The results of correlation analysis indicate that Ks is negatively correlated with clay, pH value and base saturation, but positively correlated with soil humus (r=-0.77, -0.70, -0.81 and 0.79, respectively, p<0.01). Conversely, K_A is negatively correlated with humus and positively correlated with clay, pH value and base saturation (r=-0.21, 0.82, 0.69 and 0.69, respectively, $p<0.01$).

Keywords: Pseudogley, dry aggregate distribution, aggregate stability to water, forest, meadow, arable land

Introduction

Pseudogley is among the most widespread soil types in Serbia. More than 400,000 ha of land has been mapped (Đorđević and Radmanović, 2018) and roughly 75% of this type of soil is found in western Serbia. Pseudogley occupies 70,640 ha in the regions of Mačva, Pocerina and Jadar (Tanasijević and Pavićević, 1953). Forest vegetation used to be the Pseudogley cover in the study area, but was replaced over time by meadow and arable land (Tanasijević and Pavićević, 1953; Tanasijević et al., 1966). Today, there are 3,200 ha of forests in southern Mačva and Pocerina, in the form of small oases. Meadows occupy only about 2% of the study area. Only a small part are meadows that have been used for decades; the majority are fields grassed in the past 10-15 years. There is roughly 14,000 ha of arable land, where largely cereal crops are grown with generally low yields. It is for those reasons that southern Mačva and Pocerina were selected for this research. The study area is about 18,000 ha and highly suitable for investigating the differences in Pseudogley properties potentially caused by various long-term land uses.

The soil structure from a fertility perspective plays a very important role, especially in the case of soils with a heavy mechanical composition such as Pseudogley, because it directly affects the other physical, chemical and biological properties. Plant access to water and nutrients, aeration, and biological activity directly depend on the soil structure, so that soil structure needs to be considered as the focal point of soil fertility (Hađić et al., 1991; Oades, 1984; Six et al., 2000). From an agricultural perspective, the most favorable soils are those with a lumpy and crumbly structure, with an aggregate size of 1-10 mm, optimally 2-3-5 mm, which are also water-stable and with a high aggregate porosity (Kachinsky,1956; Voronin,1986). Vershinin (1958) determined that the best aggregates for plant growth are 2-3 mm, closely associated 1-2 and 3-5 mm. After studying arable land Pseudogley at southern Mačva (Dugonjić et al., 2008) report that the largest content of the optimal diameter (1-10 mm) aggregate was found in the plow layer and that it was dominated by the most agronomically favorable aggregates –1-5 mm. However, the plow layer also exhibits the lowest stability of structural aggregates, which is a result of intensive use, high acidity and low base saturation, primarily with Ca-ions (Resulović et al., 1969). In addition, long-term use of mineral fertilizers has had a negative effect on macroaggregate stability, at times by as much as 50% compared to the control (Vojinović, 1973). The objective of the present research was to show how land use has affected the Pseudogleys of southern Mačva and Pocerina, in terms of dry aggregate distribution and stability to water.

Materials and Methods

The study encompassed three locations in southern Mačva and Pocerina (Fig.1). The Pseudogley profiles opened at Petkovica (profiles No 1 forest 44º41'34" N, 19º27'01" E; No 10 meadow 44º41'35" N, 19º27'00" E and No 19 arable land 44º41'35" N, 19º27'04" E, 132-133 m al) and Bogosavac (No 3 forest 44º43'59" N, 19º35'05" E; No 12 meadow 44º44’03 N, 19º35'03" E and No 21 arable land 44º44'02" N, 19º35’05" E, 126-133 m al) were in southern Mačva, lowland subtype, and those at Slatina (No 9 forest 44º 38'26" N, 19º 38'05" E; No 18 meadow 44º38'37" N, 19º37'58" E; and No 27 arable land 44º38'35" N, 19º 38'01" E, 205-230 m al) in Pocerina, slope subtype (Škorić et al., 1985).

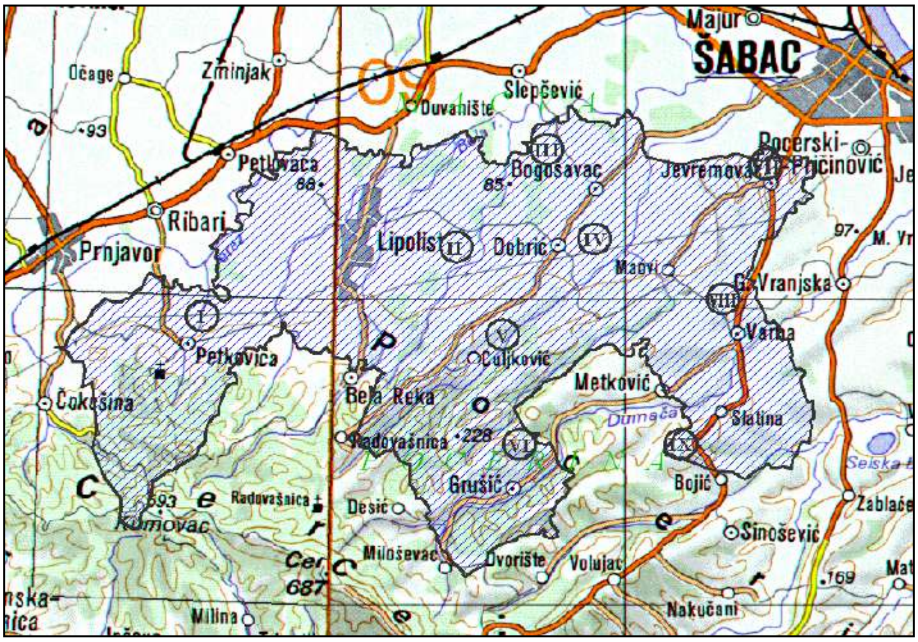

Figure 1. Study area

The soil texture and basic chemical properties were determined by standard methods (JDPZ, 1997; JDPZ, 1966), as follows: texture by the pipette method using samples prepared with sodium pyrophosphate; organic C by Turin’s method; pH by the electrometric method; and hydrolytic acidity and total absorbed alkaline cations by Kapen’s method. Total adsorption capacity and base saturation were calculated.

The aggregate composition and structural stability were determined by Savinov’s method (Korunović and Stojanović, 1989).Soil structure was assessed by calculating:(1) Revut’s coefficient of soil structure, K_S= a/b, where a = is the mesoaggregate content (10-0.25 mm), and b is the sum of macro- (>10 mm) and microaggregates (<0.25 mm), after dry sieving (Revut, 1972), and (2) Vershinin’s coefficient of soil aggregate structure, K_A= a/b, where a is the mesoaggregate content and b is the microaggregate content, after wet sieving (Vershinin,1958).

The results were statistically processed by correlation analysis and t-test using StatSoft, Inc. Statistica software for Windows, Version 8.

Results and Discussion

Table 1 below contains the results of soil sample analyses after dry sieving. They show large aggregate distribution differences between the various land uses and horizons of the studied Pseudogley profiles.

The structure of the forest Pseudogley in both surface and deeper horizons was more favorable than that of meadow and particularly arable land Pseudogleys.

The content of optimal-diameter (0.25–10 mm) aggregates in the three forest profiles that were studied, taking into account all four depth zones, was 65.8% on average. The largest proportion was found in the surface Ah horizon – 74.9–82.2% (78.8% on average), which constitutes 4/5 of all structural aggregate fractions. Among these aggregates, the most widespread was of the agronomically most favorable diameter, 1–5 mm, whose average content was 50.4%.

Table1. Aggregate distribution of forest, meadow and arable land Pseudogleys

			Aggregate diameter (mm)										
Pro file	Hori zon	Depth cm	Macro aggr. > 10	Mesoaggregates							Micro aggr. < 0.25	Total 1-5	K_S*
				10-5	5-3	3-2	2-1	1.0 - 0.5	0.5 - 0.25	10.0 - 0.25			
						Forest							
1	Ah	0-20	12.6	19.3	13.4	16.9	25.6	4.28	2.77	82.2	5.34	55.9	4.62
	Eg	20-37	19.7	24.1	16.1	14.4	19.1	2.49	1.24	77.4	2.91	49.6	3.43
	Btg	37-75	32.2	28.6	16.2	11.0	8.12	1.07	0.84	65.8	2.05	35.3	1.92
	BtgC	75-102	40.3	29.3	11.4	8.04	8.69	0.47	0.32	58.2	1.50	28.2	1.41
3	Ah	0-18	22.1	26.5	18.3	14.2	11.9	3.06	0.65	74.9	3.07	44.4	2.98
	Eg	18-36	31.4	22.7	12.3	18.0	11.5	0.76	0.52	65.8	2.84	41.8	1.92
	Btg	36-75	47.8	25.2	9.64	6.80	7.54	0.65	0.40	50.2	2.01	23.9	1.01
	BtgC	75-105	47.5	27.3	11.7	6.98	5.00	0.47	0.18	51.6	0.86	23.7	1.07
9	Ah	0-17	16.7	20.0	12.6	17.6	20.8	6.75	1.56	79.4	3.95	51.0	3.96
	Eg	17-33	28.2	23.6	18.6	14.1	11.0	1.34	0.74	69.4	2.36	43.7	2.27
	Btg	33-75	40.2	27.4	15.7	8.06	5.28	1.02	0.51	58.0	1.81	29.1	1.38
	BtgC	75-102	44.8	26.7	13.8	5.68	7.01	0.40	0.26	53.9	1.35	26.5	1.17
						Meadow							
10	Ah	0-22	13.2	30.1	23.1	12.9	15.1	4.72	1.28	81.17	3.16	51.1	4.02
	Eg	22-42	32.7	25.7	14.3	13.6	9.37	1.69	0.79	65.47	1.88	37.3	1.90
	Btg	42-75	47.2	22.4	15.9	7.06	5.21	0.69	0.29	51.57	1.19	28.2	1.06
	BtgC	75-102	46.2	26.1	12.8	9.01	4.10	0.56	0.15	52.73	1.09	25.9	1.12
12	Ah	0-23	26.3	28.2	16.0	9.87	11.8	4.11	1.16	68.9	4.81	37.7	2.22
	Eg	23-43	46.0	20.6	11.7	9.03	8.06	1.87	0.90	52.2	1.79	28.8	1.09
	Btg	43-75	58.4	18.8	8.36	4.79	7.14	0.94	0.63	40.7	0.96	20.3	0.69
	BtgC	75-105	64.3	17.1	5.94	6.21	4.88	0.51	0.41	35.0	0.72	17.0	0.54
18	Ah	0-20	18.0	27.1	19.0	11.3	12.7	5.23	1.55	76.8	5.12	43.0	3.31
	Eg	20-35	38.7	20.4	15.2	8.76	10.2	3.02	1.39	59.0	2.27	34.2	1.44
	Btg	35-75	47.1	21.3	12.4	8.41	7.50	1.08	0.62	51.2	1.71	28.3	1.05
	BtgC	75-102	58.4	21.8	9.89	4.82	2.10	0.71	0.34	39.7	1.94	16.8	0.66
						Arable land							
19	Ahp	0-24	24.4	28.8	14.9	11.5	10.9	3.14	1.17	70.4	5.12	37.3	2.38
	Eg	24-42	34.1	23.1	16.4	8.60	12.1	2.05	1.08	63.4	2.27	37.1	1.73
	Btg	42-75	56.3	20.9	8.38	5.47	4.79	1.72	0.65	41.9	1.71	18.6	0.72
	BtgC	75-102	53.7	27.6	10.1	3.32	2.71	1.10	0.31	45.1	1.94	16.1	0.82
21	Ahp	0-24	39.0	31.7	10.3	4.06	7.14	3.78	0.47	57.6	3.39	21.5	1.36
	Eg	24-45	49.4	27.2	11.8	3.86	5.03	1.05	0.36	49.3	1.34	20.7	0.97
	Btg	45-75	66.0	20.7	7.83	2.80	1.58	0.50	0.28	33.7	0.27	12.2	0.51
	BtgC	75-105	64.3	20.2	8.71	3.75	2.20	0.47	0.24	35.6	0.18	14.7	0.55
27	Ahp	0-22	31.9	27.7	14.2	10.5	9.40	2.76	1.10	65.7	2.43	34.2	1.91
	Eg	22-38	39.9	24.7	14.5	8.37	10.8	0.56	0.31	59.3	0.79	33.7	1.45
	Btg	38-75	59.9	20.3	10.0	5.68	3.40	0.29	0.14	39.8	0.32	19.1	0.66
	BtgC	75-102	62.1	17.0	10.4	6.23	3.53	0.26	0.61	37.6	0.27	20.2	0.60

*K_S= a/b; K_S– coefficient of soil structure, a – mesoaggregate content, and b – sum of macro- and microaggregates.

Meadow Pseudogleys exhibited a slightly poorer structure than forest but better than arable land. In the surface Ah horizon, the 1–5 mm aggregate content of meadow Pseudogleys was 43.9% on average and that of arable land Pseudogleys 31.0%. The content of the agronomically most favorable medium-to-coarse crumbly aggregates (1–5 mm) and the finest aggregates (<0.25 mm), as well as those of 0.5–0.25 mm whose proportion was generally small, significantly decreased with depth.

The fraction of the largest-diameter (>10 mm) macroaggregates exhibited the highest values in the plow layer of the arable land Pseudogley, 31.7% on average, which was an 85% and 66% larger content than in the surface horizon of the forest and meadow Pseudogleys, respectively. The content of these aggregates increased substantially with depth, especially in the arable land profiles, compared to meadow and particularly forest Pseudogleys.

In addition to determining the content of the aggregates of various sizes, the aggregate composition was assessed using Revut's coefficient of soil structure (Ks). The value of this coefficient in the case of forest profiles was 2.26±1.21, of meadow profiles 1.59±1.09 and of arable land profiles 1.14±0.62. Large standard deviations suggest major differences in the Pseudogley aggregate compositions, depending on land use. Statistical data processing revealed that the values were much higher in the case of forest profiles, compared to meadow ($t=6.84$, $p=0.01$) and arable land ($t=6.21$, $p<0.01$), as well as higher of the meadow than arable land ($t=2.84$, $p<0.05$). The differences were the largest between the surface horizons (forest vs. meadow $t=14.18$, $p<0.01$; forest vs. arable land $t=10.74$, $p<0.01$; and meadow vs. arable land $t=5.64$, $p<0.05$), suggesting that the effect of land use on the aggregate distribution of this horizon was dominant, relative to the other horizons.

Table 2 shows the results of analyses of wet-sieved soil samples. They also indicate large differences in the water-stable aggregate content between the various land uses and Pseudogley horizons. The largest proportion of water-stable aggregates >0.25 mm was found in the forest Pseudogleys and it amounted to 41.1–81.0% (64.1% on average). The content of water-stable aggregates >0.25 mm in the Ah horizon was in the 51.7–73.9% interval (65.1% on average). Aggregates >1 mm, with an average content of 31.8%, exhibited the highest stability. Among these, the largest proportion was of the fraction >3 mm (15.1% on average).

The surface horizon of the meadow Pseudogley revealed 14.6% fewer water-stable aggregates >0.25 mm, compared to the same forest horizon. The largest proportion was of the aggregates >1 mm (35.8% on average).

The arable land profiles exhibited the smallest proportion of water-stable aggregates >025 mm, which ranged from 38.6 to 79.2% (60.1% on average). The water-stable aggregate content of the plow layer (Ahp) was 46.1% on average, which was 40.1% less than forest and 29.4% less than meadow. The stability of the agronomically most favorable structural aggregates (diameter 1–5 mm) was very low. Their content was 1.2–2.6 times smaller than in the Ah horizon of the forest and meadow Pseudogleys. Contrary to the forest and meadow Pseudogleys, finer aggregates (diameter 1-

0.5 mm, content 16.5.26-2%, or 22.3% on average) of the surface horizon exhibited the highest stability to water, as did 0.5–0.25 mm, whose proportion was 13.0–14.0% (13.4% on average). The lowest stability to water was found in the case of aggregates >1 mm, especially those >3 mm, 1.16–2.27%.

Table 2. Water-stable aggregates (%) of forest, meadow and arable land Pseudogleys

Pro file	Horizon	Depth cm	Aggregate diameter (mm)						Micro aggr. < 0.25	Total 1-5	K_A *
			> 3	3-2	2-1	1-0.5	0.5-0.25	> 0.25			
						Forest					
1	Ah	0-20	7.82	1.48	6.93	24.7	10.3	51.7	48.3	16.2	1.07
	Eg	20-37	2.72	0.50	3.40	21.3	13.2	41.1	58.9	6.62	0.70
	Btg	37-75	2.78	1.14	15.1	27.1	11.2	57.3	42.7	19.0	1.34
	BtgC	75-102	1.98	1.74	21.6	30.8	9.70	65.9	34.1	25.3	1.93
3	Ah	0-18	21.4	6.46	13.0	20.7	12.2	73.9	26.1	40.9	2.83
	Eg	18-36	5.37	2.01	18.3	29.5	9.35	64.6	35.4	25.7	1.82
	Btg	36-75	31.8	10.8	14.5	12.4	6.16	75.9	24.1	57.4	3.16
	BtgC	75-105	38.0	6.92	15.2	17.1	3.74	81.0	19.0	60.1	4.27
9	Ah	0-17	16.0	6.14	16.1	21.7	9.82	69.8	30.2	38.3	2.32
	Eg	17-33	4.32	2.46	12.2	20.3	8.76	48.0	52.0	19.0	0.92
	Btg	33-75	7.56	5.78	16.0	25.2	8.82	63.2	36.8	29.3	1.72
	BtgC	75-102	9.56	7.98	21.6	25.6	6.62	71.4	28.6	39.1	2.49
						Meadow					
10	Ah	0-22	10.7	2.08	9.28	12.9	7.52	42.5	57.5	22.1	0.74
	Eg	22-42	3.70	1.12	7.88	14.1	11.3	38.1	61.9	12.7	0.62
	Btg	42-75	8.24	5.34	14.8	23.8	14.6	66.8	33.2	28.4	2.01
	BtgC	75-102	10.8	8.00	13.1	21.0	11.5	64.5	35.5	32.0	1.82
12	Ah	0-23	29.1	5.20	10.0	14.2	7.72	66.3	33.7	44.3	1.96
	Eg	23-43	6.91	4.47	18.8	17.2	10.0	57.8	42.2	30.2	1.37
	Btg	43-75	35.0	9.02	21.3	11.3	2.60	79.1	20.9	65.3	3.79
	BtgC	75-105	30.4	6.10	23.8	13.8	3.82	77.9	22.1	60.3	3.53
18	Ah	0-20	24.0	4.64	12.5	14.0	6.70	61.8	38.2	41.1	1.62
	Eg	20-35	10.1	6.90	14.4	15.2	7.36	53.9	46.1	31.4	1.17
	Btg	35-75	15.6	8.16	19.5	20.9	6.16	70.3	29.7	43.3	2.37
	BtgC	75-102	12.6	7.74	26.1	19.8	6.12	72.4	27.6	46.5	2.62
						Arable land					
19	Ahp	0-24	1.06	1.26	5.72	16.5	14.0	38.6	61.4	8.04	0.63
	Eg	24-42	0.58	1.04	9.66	14.9	9.76	35.7	64.3	11.3	0.56
	Btg	42-75	0.88	1.84	19.2	23.3	16.6	61.8	38.2	21.9	1.62
	BtgC	75-102	0.86	3.97	27.8	25.2	8.54	66.4	33.6	32.7	1.98
21	Ahp	0-24	2.72	2.04	8.16	26.2	13.3	52.4	47.6	12.9	1.10
	Eg	24-45	3.76	4.71	18.9	25.1	9.59	62.0	38.0	27.3	1.63
	Btg	45-75	31.8	7.56	20.5	11.5	6.42	77.8	22.2	59.9	3.50
	BtgC	75-105	35.7	6.29	18.9	10.8	8.38	79.2	20.8	60.8	3.81
27	Ahp	0-22	1.56	1.72	6.96	24.0	13.0	47.3	52.7	10.2	0.90
	Eg	22-38	0.80	1.96	10.2	21.5	10.7	45.2	54.8	13.0	0.82
	Btg	38-75	2.42	7.52	22.5	28.3	15.1	75.8	24.2	32.4	3.13
	BtgC	75-102	4.78	7.62	25,9	29.3	10.0	77.7	22.3	38.3	3.48

***** K_A= a/b; K_A– coefficient of soil aggregate structure, a – mesoaggregate content, and b – microaggregate content

A much smaller humus content (Table 3), intensive land use, cultivation often beyond the interval of physical maturity, use of mineral fertilizers (primarily nitrogen-based), and a poorer effect of roots and soil fauna on aggregation all result in a considerably smaller proportion of coarse water-stable aggregates >1mm, particularly >3mm, in the surface horizon of arable land Pseudogley, compared with the same meadow and especially forest horizons. The results are consistent with the theory of hierarchical aggregation, according to which microaggregates unite using relatively biodegradable organic matter and create macroaggregates (Tisdall and Oades, 1982). Consequently, a change in land use has a major effect on macroaggregates, compared to microaggregates (Ashagrie et al., 2007; Bouajila et al., 2021; Puget et al., 2000; Spohn and Giani, 2011). Many researchers have associated deterioration of structural properties with reduced content of organic matter in the soil (Six et al., 2000; Spohn and Giani, 2011), which was corroborated by the present research. Namely, compared to the forest Pseudogley, the humus content was much smaller in the meadow (t=-3.60, $p<0.1$) and arable land Pseudogleys (t=-3.11, p=<0.01).

In the eluvial (Eg) horizon, the content of water-stable aggregates in the meadow and especially forest profiles rapidly decreased due to a sudden decrease in humus content. There was slightly more humus in the arable land profiles.

In the illuvial Pseudogley (Btg and BtgC) horizons, due to a considerable increase in clay content, there were more water-stable aggregates >0.25 mm, especially in the case of arable land Pseudogley, by as much as 60%, compared to the Ahp horizon. Among them, aggregates >1 mm were the most stable. The largest content of microaggregates <0.25 mm in the surface horizon was found in the arable land profiles, followed by meadow and forest. The content of these aggregates gradually decreased with depth of all the profiles.

Based on the results of dry and wet sieving of soil samples, it follows that the destruction of primary forest vegetation and conversion to meadow and especially arable land in the study area (Mačva and Pocerina) has led to considerable structural deterioration, particularly of the Ahp horizon. It is the most important horizon for farming and contains fewer agronomically stable structural aggregates (diameter 1–5 mm) by a factor of 1.2-2.6, compared to the Ah horizon of the forest and meadow Pseudogleys.

Vershinin's coefficient of soil aggregate structure (K_A) was used to assess the stability to water. Based on this coefficient, the values of forest Pseudogley profiles were the highest (2.05±1.03 on average), followed by meadow (av. 1.96±0.99) and arable land (av. 1.93±1.22). Taking into account the overall depth of the soil profiles, statistical analysis showed small or insignificant differences (forest vs. meadow t=0.49, p=0.63; forest vs. arable land t=0.46, p=0.66; and meadow vs. arable land t=0.23, p=0.81). The differences were larger in the case of the A horizons (forest vs. meadow t=3.97, p=0.63; forest vs. arable land t=3.08, p=0.09; and meadow vs. arable land t=2.45, p=0.13). Similar to Revut's coefficient of soil structure (Ks), standard deviation indicated that

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Vershinin's coefficients (K_A) also varied among the forest, meadow and arable land profiles, but the differences were smaller compared with those based on Ks.

Table 3. Texture and basic chemical properties of forest, meadow and arable land Pseudogleys

Pro file	Depth	Sand	Silt	Clay	Humus	pH in H_2O	T - S	S	T	V
	cm	%	%	%	%		mEq/100 g			%
					Forest					
1	0-20	35.8	43.0	21.2	3.10	4.64	17.6	3.18	20.7	14.9
	20-37	33.2	42.3	24.5	1.44	4.75	13.8	3.48	17.3	20.1
	37-75	28.6	38.2	33.2	0.91	5.20	10.1	10.0	20.1	49.9
	75-102	28.3	37.4	34.3	0.81	5.27	8.49	13.5	22.0	61.4
3	0-18	22.9	41.3	35.8	3.92	4.91	20.1	13.9	34.0	40.9
	18-36	22.8	37.7	39.5	1.84	5.41	11.0	19.7	30.7	64.2
	36-75	20.1	35.5	44.4	0.98	6.03	4.71	26.3	31.0	84.8
	75-105	20.8	35.0	44.2	0.96	7.05	1.89	30.2	32.0	94.2
9	0-17	30.3	42.8	26.9	3.04	4.67	24.8	5.80	30.6	18.9
	17-33	29.6	42.0	28.4	1.45	4.84	20.4	6.60	27.0	24.4
	33-75	24.3	41.9	33.8	0.93	5.50	9.79	15.1	24.8	60.6
	75-102	23.7	37.8	38.5	0.81	5.69	6.29	18.2	24.4	74.3
					Meadow					
10	0-22	34.1	42.7	23.2	1.82	4.97	11.0	4.24	15.2	27.8
	22-42	31.3	40.2	28.5	0.95	5.42	6.92	7.32	14.2	51.4
	42-75	29.8	37.5	32.7	0.90	5.63	6.60	12.0	18.6	64.5
	75-102	29.5	37.2	33.3	0.83	5.72	5.97	13.2	19.1	68.8
12	0-23	27.9	40.2	31.9	2.17	5.28	9.66	12.9	22.5	57.1
	23-43	26.9	38.0	35.1	1.03	5.47	7.23	14.1	21.3	66.1
	43-75	24.3	33.5	42.2	0.80	5.97	6.29	17.6	23.8	73.6
	75-105	24.3	33.1	42.6	0.72	6.39	4.21	21.1	25.3	83.3
18	0-20	29.8	45.5	24.7	2.09	5.94	6.29	12.0	18.3	65.6
	20-35	27.1	42.0	30.9	0.83	5.70	5.97	12.4	18.3	67.4
	35-75	22.7	37.8	39.5	0.64	5.78	5.95	15.5	21.4	72.2
	75-102	22.1	37.0	40.9	0.61	5.81	5.90	16.2	22.1	73.3
					Arable land					
19	0-24	33.1	43.2	23.7	2.04	4.86	13.8	4.08	18.0	23.1
	24-42	32.1	41.7	26.2	0.98	5.06	10.1	5.00	15.1	33.2
	42-75	29.6	37.0	33.4	0.83	5.27	8.80	9.68	18.5	52.4
	75-102	28.8	36.2	34.0	0.79	5.44	7.23	12.8	20.0	63.8
21	0-24	27.6	40.0	32.4	1.99	5.23	13.5	10.4	23.9	43.6
	24-45	27.1	39.7	33.3	1.12	5.78	5.66	13.2	18.8	69.9
	45-75	26.7	32.3	41.0	1.00	6.23	4.71	21.6	26.3	82.1
	75-105	27.0	33.3	39.7	0.73	6.57	3.15	24.0	27.1	88.4
27	0-22	29.0	45.6	25.4	1.75	5.53	11.3	10.0	21.4	47.0
	22-38	27.8	39.5	32.7	0.84	6.16	5.19	15.5	20.7	74.9
	38-75	23.3	39.2	37.5	0.81	6.19	5.03	17.4	22.4	77.6
	75-102	23.7	38.2	38.1	0.74	5.90	5.97	18.8	24.8	75.9

Soil aggregation involves the formation and stabilization of structural aggregates. These two processes essentially take place at the same time (Amezketa, 1999). Stabilization is aided by stabilizing substances, organic or inorganic such as clay, bivalent and trivalent cations, carbonates and gypsum (Cornu et al., 2006). Consequently, the correlation analysis indicated a connection between the aggregate composition and stability of structural aggregates of the studied Pseudogleys and their texture and chemical properties. Ks negatively correlated with clay, pH and base saturation, and positively correlated with humus (r=-0.77, -0.70, -0.81 and 0.79, respectively, $p<0.01$). Conversely, K_A negatively correlated with humus and positively correlated with clay, pH and base saturation (r=-0.21, 0.82, 0.69 and 0.69, respectively, $p<0.01$). Conversion of forest into meadow and arable land has caused significant variations in the aggregate distribution and stability, which are attributable to changes in soil texture and basic chemical properties. According to Six and Paustian (2014), soil cultivation disrupts aggregate formation and stability because soil aggregates cannot be physically protected from microbial decomposition, causing an increase in humus mineralization. Humic substances are considered to be persistent cementing agents related to the formation and stabilization of soil aggregates, where their molecular composition plays a predictive role in the soil aggregation process (Fei et al., 2021). According to He et al. (2021), free and occluded light soil organic carbon (SOC) play major roles in macroaggregate stability, probably because the positive effect of SOC on van der Waals attractive force between soil particles can limit the release of microaggregate. However, an increase in SOC does not always result in a decrease in microagglomeration or re-flocculation of small soil particles. Small particles of some types of soils with high SOC were difficult to re-flocculate when they were released from the mechanical breakdown of macroaggreates. Many other soil properties can limit SOC's roles and induce repulsive forces, which are stronger than attractive forces between soil particles. Thus, apart from a considerable decrease in humus content, compared to the forest Pseudogley, the meadow and arable land profiles showed a substantial increase in pH levels (2.47 and 2.79, respectively, $p<0.5$) and base saturation (t=2.49 and 2.27, respectively, $p<0.5$). Contrary to the chemical properties, the clay content of the arable land Pseudogley decreased, compared to forest and meadow, but the differences were not statistically significant. It follows from the above that the action of certain stabilizing substances improved in arable land Pseudogleys, and decreased in others. This has likely caused a considerably poorer aggregate composition, but also less pronounced differences in aggregate stability, compared to forest and meadow.

Numerous researchers report similar results, attesting to structural deterioration of plow and subplow layers of Pseudogley and other soils, after conversion of forest and meadow into arable land (Dugonjić, 2001; Dugonjić and Đorđević, 2007; Dugonjić et al., 2008, Dugalić, 1998; Dugalić et al., 2019; Vojinović, 1973; Cupać et al., 2006; Gajić, 1998; Gajić and Živković, 2006; Gajić et al., 2010; Marković, 2000; Kretinin and Lenov, 1978; Dilkova and Kerchev, 1986; Beare et al., 1994).

Conclusions

The studied Pseudogley soils of southern Mačva and Pocerina (Serbia) demonstrated rather unfavorable aggregate distributions and water-unstable structures. Land use appears to have had a considerable effect, particularly on surface horizons.

Compared to meadow and arable land, forest Pseudogley profiles were found to have the best structure and the largest content of optimal-diameter (0.25–10 mm) aggregates, dominated by the agronomically most favorable diameter 1–5 mm, in both surface and deeper horizons.

Arable land Pseudogley profiles showed the smallest content of water-stable aggregates >0.25 mm, which was 40% less in the forest and 29% less in the meadow surface horizons. Among the water-stable aggregates, the least stable were the agronomically most favorable aggregates (diameter 1–5 mm), whose content in the plow layer was smaller than in the surface horizons of the forest and meadow Pseudogleys by a factor of 1.2–2.6.

Statistical analysis showed that Revut's coefficient of soil structure (Ks) was much higher in the case of forest profiles than meadow or arable land. Vershinin's coefficient of soil aggregate structure (K_A), which is used to assess the stability to water of structural aggregates, was higher in the case of forest and meadow profiles, compared to arable land, but the differences were not statistically significant. These differences were found to be larger between the A horizons.

Destruction of primary forest vegetation and conversion into meadows and arable land have caused considerable structural deterioration of the soil, especially of the arable land Pseudogley plow layer, which is one of the main reasons for the low Pseudogley productivity in southern Mačva and Pocerina.

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Uticaj načina korišćenja na strukturu pseudogleja južne Mačve i Pocerine, Srbija

Mladen Dugonjić*[1], Aleksandar Đorđević[2], Slađana Golubović[3], Svjetlana Radmanović[2]

[1]Akademija strukovnih studija Šabac,Odsek za poljoprivredno-poslovne studije i turizam, Vojvode Putnika 56, 15000 Šabac, Srbija
[2]Univerzitet u Beogradu, Poljoprivredni fakultet, Nemanjina 6, 11080 Beograd, Srbija
[3]Akademija strukovnih studija Južna Srbija,Odsek za poljoprivredno-prehrambene studije, Ćirila i Metodija 1, 18400 Prokuplje, Serbia

* *Corresponding author*: Mladen Dugonjić, dugonjic015@gmail.com

Izvod

Istraživan je uticaj načina korišćenja pseudogleja južne Mačve i Pocerine na agregatni sastav i stabilnost strukturnih agregata na zemljišnim uzorcima uzetim iz profila pod šumskom, livadskom i njivskom vegetacijom, sa 3 lokaliteta. Agregatni sastav i stabilnost strukturnih agregata određeni su metodom Savinov-a. Za ocenu strukture zemljišta korišćeni su Revut-ov koeficijent strukturnosti i Vershinin-ov koeficijent agregatnosti zemljišta. Rezultati istraživanja pokazali su da se istraživana pseudoglejna zemljišta karakterišu nepovoljnom strukturom, a da način korišćenja ima veliki uticaja na agregatni sastav i stabilnost strukturnih agregata, naročito u površinskim Ah i Ahp horizontima, gde su te razlike najizraženije. Najpovoljniji agregatni sastav i najveću otpornost agregata prema rasplinjavajućem dejstvu vode pokazali su profili pseudogleja pod šumskom, zatim pod livadskom, dok su profili pod njivskom vegetacijom pokazali najlošiji agregatni sastav. Statistička obrada podataka pokazala je da su vrednosti Revut-ovog koeficijenta strukturnosti (Ks), dobijenog suvim prosejavanjem, u profilima pod šumskom vegetacijom najveće, i u proseku iznose 2.26±1.21, pod livadskom 1.59±1.09, a pod njivskom 1.14±0,62. Vrednosti Vershinin-ovog koeficijenta agregatnosti (K_A), za ocenu stabilnosti strukturnih agregata,dobijenog mokrim prosejavanjem, takođe su pokazale da profili pseudogleja pod šumskom vegetacijom pokazuju u proseku najveće vrednosti (2.05±1.03), potom pod livadskom (1.96±0.99), dok su profili pod njivskom pokazali najmanje vrednosti (1.93±1.22). Rezultati korelacijone analize pokazali su da je Ks u negativnoj korelaciji sa glinom, pH i stepenom zasićenosti zemljišta baznim katjonima, a u pozitivnoj korelaciji sa humusom (r=-0.77, -0.70, -0.81 i 0.79, redom, p<0.01), dok je K_A u negativnoj korelaciji sa humusom, a u pozitivnoj sa glinom, pH i stepenom zasićenosti zemljišta baznim katjonima (r=-0.21, 0.82, 0.69 i 0.69, redom, p<0.01).

Ključne reči: pseudoglej, agregatni sastav, stabilnost strukturnih agregata, šuma, livada, njiva

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