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Changes in soils used for agriculture and wastelands in the Gałęzowo-Niepoględzie Catena (in Bytów region – NW Poland)

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Abstract: Both intensive agricultural use and leaving the soil uncultivated result in changes of soil properties. The present research was aimed at determining the influence of cessation of agriculture on arable area on selected soil properties. The Gałęzowo-Niepoględzie Catena is located in the North-West Poland, in the Bytów Lake District. Both agricultural grounds and wastelands of the Gałęzowo-Niepoględzie Catena reflect similar properties within the scope of: soil compaction of the horizon at the depth of 25-35 cm and thickness of the humus horizon, both arable and diluvial. Also the soil reaction of the humus horizon and of the plough soles at the depth of 25-35 cm is similar. Wasteland soils show greater humus content and greater dehydration of the sorption complex by acid cations than arable soils.

Key words: wastelands, Colluvic Umbrisols, soil compaction horizon, humus, soil reaction

Introduction

Agricultural use results in changes in properties of soils. The changes may cover both physical and chemical properties. Leaving arable soil uncultivated at the final stage may bring back the soil properties similar to the primary ones. In the initial period of leaving the soil uncultivated, the soil reaction decreases and the number of acid cations in the sorption complex increases (Strączyńska, Strączyński, 2000). On the other hand, introducing of green plants into the wasteland leads to an increase in organic substance content (Lal et al., 1999). The use of agricultural machines may result in forming a plough pan, and in the case of sculpture area this results in the occurrence of thicker diluvial deposits (Hryńczuk, Weber, 2005, Sinkiewicz, 1998, Włodek et al., 1998).

Research area and methodology

The Gałęzowo-Niepoględzie Catena is located in the Bytów Lake District, at the border of the Bytów and Słupsk powiat, in the western part of the Pomorskie province (NW Poland). The area of the Gałęzowo-Niepoględzie Catena is characterized by a strong surface thickness. The area can be classified as wavy, partly hilly, which results in the occurrence of thicker anthropogenic diluvial deposits in the case of arable use of this land. The area of research was dominated by Dystric Luvisols. The said Dystric Luvisols were formed from loamy sands, sometimes with higher silit content. The bedrock of these soils may include sandy loam. The area of research covered approx. 10 ha, which has been the wasteland for about 7-10 years. Earlier, the area was used for agriculture and was a part of a large-area farm. The wasteland is covered with grass plants, where some birches, pines and oaks appear.

During the field research, 10 soil test pits and 2 bores were made (9 pits were made in the wasteland and 1 pit with bores in the arable ground) (fig. 1). Samples for laboratory analysis were taken from the soil horizon. The samples were subject of the following laboratory analysis: soil reaction using potentiometric method, organic carbon ratio by the Tiurin method, hydrolytic acidity and the total exchangeable alkaline and acid cations by the Kappen method, bulk density and thickness of the humus horizon. Also the absorbing capacity was calculated (T=Hh+S).

Results and discussion

Bulk density

Bulk density in wastelands and arable grounds ranges from 1.35 Mg·m-3 at the depth of 10-15 cm up to 1.8 Mg·m-3 at the depth of 100-125 cm (fig. 2, 3). The values of bulk density up to approx. 50 cm are of the biggest importance to the growth of plant roots and capacity to absorb mineral substances. In agricultural soils at the depth of 25-35 cm, an increase in bulk density is often marked in relation to horizons situated above and below that depth. This is the result of the use of agricultural machinery. In the Gałęzowo-Niepoględzie Catena the increase in bulk density in the horizon of 25-35 cm is similar for arable grounds and wastelands and ranges from 0.03 to 0.30 Mg·m-3 (tab. 1, fig. 2, 3). Lack of soil cultivation in the period of 7-10 years is too short to degrade the creation of a plough sole at the depth of 25-35 cm. In sculpture areas, the soil compaction may also cause an increase in water erosion (Sinkiewicz, 1998).

Thickness of the humus horizon

Thickness of the humus horizon in the Gałęzowo-Niepoględzie Catena ranged from 25-30 cm in plateaux and levelled lands up to 80-100 cm in depressions, at the bases (fig. 4, 5). Within the wastelands, the biggest thickness of diluvial humus horizon (up to 80 cm) is present at the bottom of depressions, surrounded by several slopes. The diluvial horizon reaching even 100 cm was observed in arable grounds (fig. 5). It may be assumed that both turfing of soil and lack of agricultural machinery use have significantly slowed down both water erosion and anthropological erosion (Sinkiewicz, 1998). On agricultural land, the soil coming from the slope may still relocate, in particular in the period of intensive precipitation and when the soil is not covered with arable crops (Stasik, Szafrański, 2001). The smallest thickness of the humus horizon is present at the section of the convex slope in arable grounds and slightly concave slope in wastelands (25-30 cm).

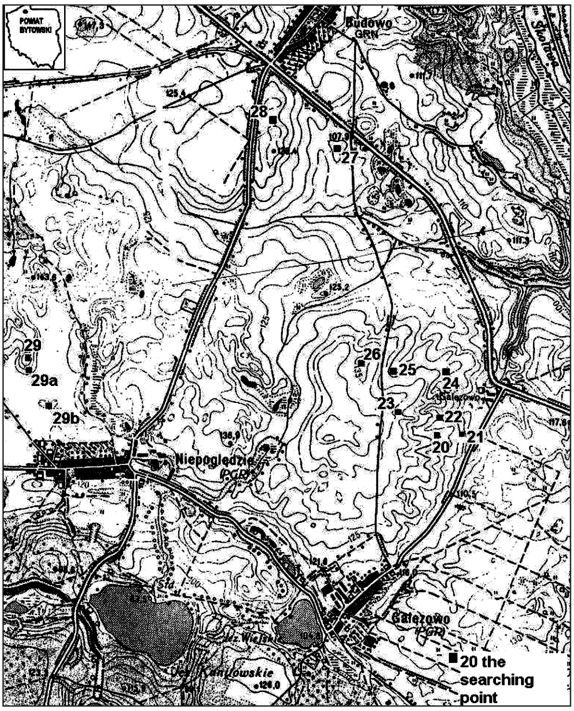

Fig. 1. The study area

Humus content

Humus content in soils was assessed on the basis of percentage content of organic carbon. The organic carbon content in wastelands ranged from approx. 1% in flattenings and concave slopes up to almost 1.9% in depressions, in diluvial horizons (tab. 1). In arable grounds, the carbon content amounted to approx. 1% in plateaux, up to 1.6% in land depressions. The increase in the thickness of the humus horizon is also often reflected by the increase in humus resources. The biggest humus content is reported in grounds left uncultivated. The surface turfing has an impact on the increase in the amount of humus in soils. A significant increase in the humus content is observed in slopes of wastelands.

Table 1. Scope of selected soil properties in the Gałęzowo-Niepoględzie Catena

	Depth (cm)	Bulk density $Mg \cdot m^{-3}$	Humus (%)	Soil reaction (pH)	Dehydration of the sorption complex by cations		
					alkaline (%)	acid (%)	sorption capacity (cmol·100g-1)
Wasteland	0-15	1.33-1.60	1.76-3.24	3.93-5.14	16.5-29.8	70.3-83.8	4.78-9.46
	15-30	1.47-1.63	1.24-3.03	3.93-5.10	16.5-29.8	70.3-83.8	4.78-9.46
	30	1.47-1.78					
	30-50	1.36-1.78	1.59-2.19	4.10-4.84	15.08-25.5	74.5-85.0	3.21-7.36
Arable ground	0-15	1.47	1.64-2.81	5.00-5.55	22.8-45.8	54.2-77.2	6.1-10.2
	15-30	1.66	1.22-2.27	4.78-5.00	23.7-36.2	55.8-76.3	6.1-10.2
	30	1.67					
	30-50	1.74	2.19-2.36	4.78-5.04	23.7-38.5	63.8-76.3	4.3-6.1

Soil reaction and dehydration of the sorption complex by cations

The soil reaction in the Gałęzowo-Niepoględzie Catena ranges from 3.93 to 5.15 pH in the humus horizon (tab. 1). At the depth of below 30 cm, the soil reaction does not exceed 5 pH (tab. 1). The reaction is slightly bigger in agricultural soils. The pH values oscillate around 5, both in the humus horizon and in plough soles at the depth of 25-35 cm (tab. 1). This is the result of mineral and organic fertilization and liming. The acid soil reaction is

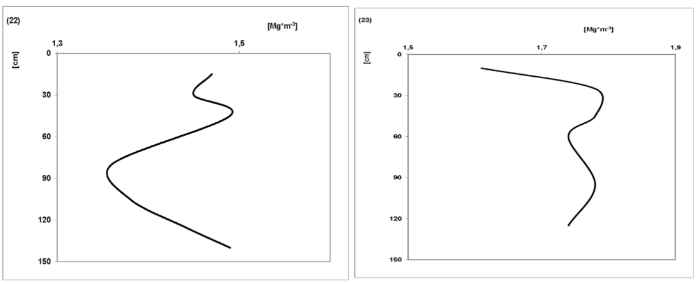

Fig. 2. Wasteland bulk density in the Gałęzowo-Niepoględzie Catena

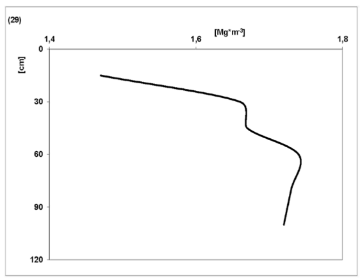

Fig. 3. Arable ground bulk density in the Gałęzowo-Niepoględzie Catena

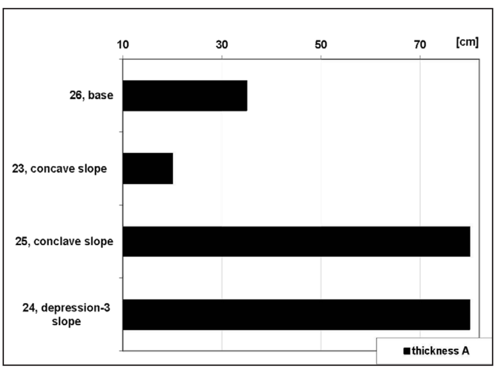

Fig. 4. Thickness of the humus horizon in wastelands

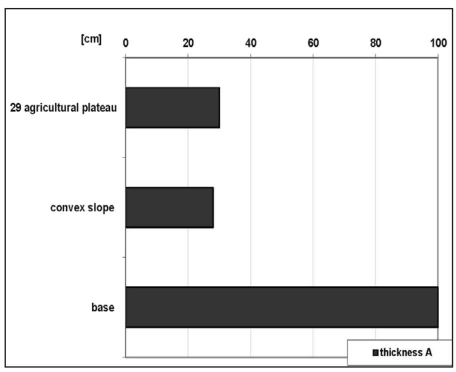

Fig. 5. Thickness of the humus horizon in arable grounds

influenced by dehydration of the sorption complex by acid cations of at least 70% (tab. 1).
A greater dehydration of the sorption complex by acid cations (above 80%) is present in plateaux and depression areas. At the sections of concave slopes, the dehydration of the sorption complex is slightly bigger by alkaline cations (approx. 25-50%). In arable grounds, the dehydration of the sorption complex by alkaline cations is slightly bigger and amounts to approx. 23% in plateaux, 36-38% in depressions, up to 46% in convex slopes. Such a relation of acid and alkaline cations in the sorption complex in arable grounds explicitly shows liming and fertilization of these soils. The soils of the Gałęzowo-Niepoględzie Catena are acid and regular liming does not have a significant influence on the soil reaction change.

Summary

Despite 7-10 years of non-cultivation, the grounds still have a lot of properties of agricultural soils. Among the properties shared by agricultural soils and wastelands the following should be mentioned: soil compaction of the horizon at the depth of 25-35 cm and thickness of the humus horizon, both arable and diluvial. Also the soil reaction of the humus horizon and of the plough soles at the depth of 25-35 cm is similar.
Wasteland soils show greater humus content and greater dehydration of the sorption complex by acid cations than arable grounds. The greater amount of humus in the wasteland soils is related to the delivery of debris of herbaceous plants which is not removed beyond the ecosystem. The biggest content of acid cations in the sorption complex results from the acidification of the soil profile and lack of fertilization, in particular liming.
In many cases, a cessation of agricultural use may lead to the agricultural soil degradation. A future reintroduction of agricultural fertility to these soils may be related to significant financial expenditure.

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