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ASSESMENT OF DEGRADATION PROCESSES AND LIMITATIVE FACTORS CONCERNING THE ARENOSOLS FROM DĂBULENI – ROMANIA

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Abstract: Soil degradation can be described as a process by which one or more of the potential ecological functions of the soil are harmed and also like a process that lowers the current and/or future capacity of the soil to produce goods and services. The arenosols from Dăbuleni Plain, located in the SW of the Romanian Plain, have a large extension due the aeolian sand deposits which covers the Danubian loess terraces. The main degradation processes affecting the arenosols are the removing and deposition of soil material by wind forces. This type of degradation causes loss of topsoil and severe sand accumulation, which reflects in terrain deformation. The loss of topsoil induces a decrease in depth of the A horizon due to the removal of soil material by the wind because of their sandy texture and insufficient protection offered by vegetation. We should also mention that the forest shelter belts are being destroyed. An irregular removal and depositions of soil material by wind action causes deflation hollows, hummocks and dunes which lead to "terrain deformation" with severe consequences concerning land quality.
Key words: soil degradation, limitative factors, arenosols, Dăbuleni Plain

Rezumat: Evaluarea proceselor de degradare şi a factorilor limitativi privind arenosolurile din Dăbuleni - România. Degradarea solului poate fi descrisă ca un proces prin care una sau mai multe din potenţialele funcţii ecologice ale solului sunt afectate, dar şi ca un proces care diminuează prezenta sau/ şi viitoarea capacitate a solului de a produce bunuri şi servicii. Arenosolurile din Câmpia Dăbuleni, situată în sud- vestul Câmpiei Române, au o mare extindere datorită dunelor de nisip care acoperă terasele de loess danubian. Principalele procese de degradare care afectează arenosolurile sunt îndepărtarea şi sedimentarea materialului din sol de către vânt. Acest tip de degradare cauzează pierderea stratului de sol superior şi acumulări masive de nisip, care se reflectă în deformarea terenului. Pierderea stratului superior de sol determină o descreştere în adâncime orizontului A datorită îndepărtării materialului din sol de către vânt datorită texturii lor nisipoase şi protecţiei insuficiente oferită de vegetaţie. Ar trebui să menţionăm de asemenea că zonele de adăpost ale pădurii sunt distruse. O îndepărtare neuniformă şi sedimentările materialului din sol prin acţiunea vântului determină concavităţi prin deflaţie, movile şi dune care duc la "deformarea terenului" cu consecinţe grave asupra calităţii terenului.
Cuvinte cheie: degradarea solului, factori limitativi, arenosoluri, Câmpia Dăbuleni.

Introduction

Land degradation is defined as deterioration of soil and its environment below natural capacity to sustain in a durable manner the natural and/or man-made ecosystems (Dumitru and Munteanu, 2002).

In the context of current climate change, the regions with sandy soils are directly affected by drought and desertification. Regarding these, through the United Nation Convention to Combat Desertification, at which Romania adhered, a special interest has been given for controlling the effects of these processes since 1994. Also, the International Soil Reference and Information Centre (ISRIC) have coordinated a series of projects evaluating the current state of degraded lands. One important project is SOVEUR (Mapping of Soil and Terrain Vulnerability in Central and Eastern Europe), completed in 2000 by publishing a soil and terrain database and map at 1:2.5 million scale, on the status of soil degradation.

The processes of land degradation and limitative factors regarding the agricultural production have been studied with the aim of counteracting their negative effects on soil quality.

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The National Strategy and Actions Programme to Combating Desertification, Land Degradation and Drought (MWFEP, 2000) states that most of degradation process are to be found in the area with dry-subhumid climate, as well as in that affected by drought.

From these processes, in the study area, wind erosion occurs with higher intensity only on sandy and loamy sandy soils.

The sandy soils from Romania have been studied since the beginning of the 20th century. The study regarding the sands from the south of Oltenia by Chiriță and Bălănică in 1938 refers to the characterization of the main types of forest sites on the sands of Oltenia and the establishment of relationships between the properties of sands and sandy soils and the vegetation of different forest species, especially the acacia. A more comprehensive study on the Arenosols from Romania was performed by Florea et al. in 1988, where it is presented the distribution on various forms of relief, specific properties, development of sandy soils and also the origin of sand deposits. One important aspect refers to the capacity of sandy soils to sustain agricultural land use.

The present work focuses on clarifying some aspects of soil degradation, expansion of this phenomenon and assessment of limitative factors concerning the sandy soils from Dăbuleni Plain. In this area, with a predominantly agricultural land use, there were identified two main types of landscapes. One is the landscape of semi-stabilized dunes, with agricultural crops (mainly cereal crops), and forest shelterbelts partially destroyed, on the west side of the plain, near the Jiu River. The other one refers to mobile dunes landscape, with orchards, vineyards and cereal crops, in the central part of the territory. The loss of almost all the forest shelterbelts and the malfunction of the Sadova-Corabia irrigation system have led to the reactivation of sand dunes with direct impact on the land quality.

Dăbuleni Plain is located in the south of the Romanați Plain, subunit of the Oltenia Plain, which is part of the Romanian Plain. This unit comprises the terraces of the Danube and the Jiu Rivers, and has a great extension, with large surfaces of terraces, which are blurred by aeolian sands. Terrace deposits are covered by loess and aeolian sands. The relief microforms consist on fixed dunes disposed as continuum, large, and flat waves, elongated on few kilometers, and mobile dunes, easy to observe, with ridges aspect. The thickness of the sand deposits is larger near the Danube, on the lowest/youngest terraces, and on the west-side of the plain (about 20-25 m), and decreases northward and eastward, as the distance from the sand sources increases (the flood plains of the Danube and the Jiu) and the influence of the dominant winds diminishes (Geography of Romania, 2005). From the same causes, the highest dunes (about 15-20 m) and the largest mobile sand areas occupy the lowest terraces of the Danube and the Jiu Rivers, near to the localities Lişteava, Bechet and Dăbuleni.

The parent materials of which Arenosols were formed and developed have an aeolian origin. These consist of sand deposits (aeolian reshuffled) with coarse sand, sandy loam or loamy-sand texture, and loess and loess-like deposits with loamy or loamy-sand texture.

The climate is characterized by hot and dry summers with few precipitations, mainly showers, and moderate winters, with rare snowstorms and frequent warming periods due to the advection of warm air from the south and the south-west. The mean annual temperatures exceed 11°C (11.1°C at Corabia). Although the mean annual values of precipitation are between 525 and 550 mm (with 530 mm at Bechet), there still occur extensive dry spells and drought periods (30-60 consecutive days). These phenomena occur especially in the central part of the plain and correlates with the lack of the permanent hydrographic network and high depth of the groundwater. Dryness and drought justify the construction of Sadova-Corabia Irrigation System.

Natural vegetation has been restricted at less than 5% of the plain surface, the rest being occupied by arable lands. The forest shelterbelts consist of acacias and poplars (*Populus alba* and *Populus nigra*) and herbaceous species, such as *Bromus tectorium*, *Poa bulbosa*, and *Stellaria media*.

Material and methods

For the study, seven soil profiles (pits) were morphologically described, and disturbed and undisturbed soil samples were collected for physical and chemical determinations. Samples were taken at two depths per soil profile within differentiated horizons. The sampling locations were recorded using the Global Position System (GPS). The soil diagnostics were based on the concept of elementary pedogenetic processes reflected in the soil features and properties. The soil names were given in agreement with the World Reference Base for Soil Resources (IUSS-ISRIC-FAO, 2006).

The following analyses were made: texture, bulk density, hydraulic conductivity, penetration resistance, regarding the physical properties and pH, $CaCO_3$ content, organic matter – humus, total nitrogen content, C/N ratio and total phosphorus content concerning the chemical properties. Interpretation of the analytical data was made using the Soil Survey Methodology (in Romanian) – Part III, Ecopedological Indicators (ICPA Bucharest, 1987). Also, for establishing soil contamination a series of analyses were made: the content of pesticide residues (organochlorine insecticides like DDT and HCH), heavy metals, nitrates ($N\text{-}NO_3$) and ammonium nitrate ($N\text{-}NH_4$). Interpretation of pesticide residues and heavy metals content on soil samples was made according to the Order no. 756/1997 of Ministry of Waters, Forests and Environmental Protection for the approval of Regulation concerning the environment pollution assessment.

Results and discussion

Distribution of the Arenosols

The main characteristic of arenosols is the sandy texture of parent material (Grigoraş, 2003; Blaga et al., 2005; Grigoraş et al., 2006). In Dabuleni Plain the eutric and mollic subtypes are the most developed ones. Arenosols are widespread in the area, with sands and dunes, on the left side of the Jiu River (between the settlements Căciulăteşti, Sadova, Piscu Sadovei), where they are in association with Luvisols and shifting sands. One important area is in the southern and central of Dabuleni Plain (between Călăraşi, Dăbuleni and Ianca), where arenosols are associated with shifting sands, occupying a considerable area (Fig. 1). Mollic Arenosols, with the profile of: Am-AC-Cn or Am-Cn_l-Cn_2, occur in depressionary areas (interdunes) and the Eutric Arenosols (Ao-Cn_1-Cn_2 or Ap-Ao-AC-Cn) characterizes the relief with dunes and they are often associated with Eutric Regosols and shifting sands.

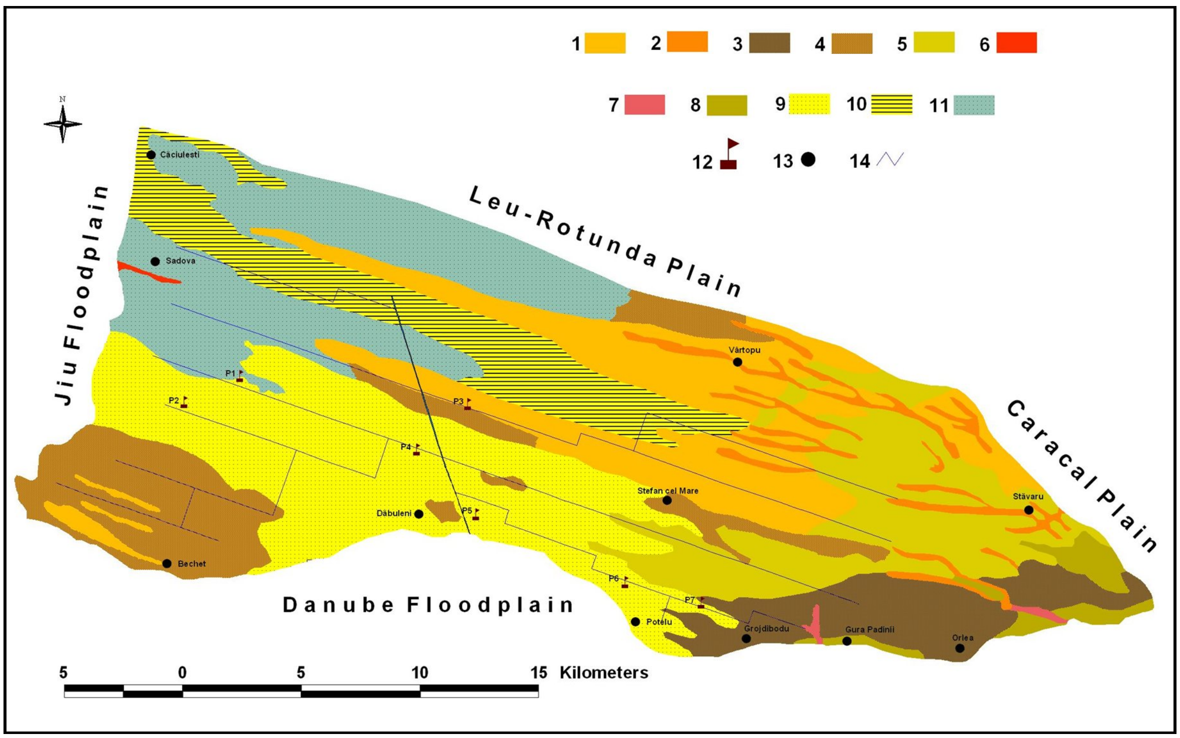

Fig. 1. Soil map of Dăbuleni Plain – classification according to WRB-SR 2006, FAO and SRTS 2003, Romania (after the Map of Romanian Soils, scale 1:200 000, 1969):

1, Haplic Chernozems / Cambic Chernozems; *2*, Haplic and Luvic Chernozems / Cambic and Argic Chernozems (in small-size depression on loess and loess-like deposits); *3*, Haplic and Luvic Chernozems / Cambic and Argic Chernozems, in depression (Aeolian rolling relief); *4*, Haplic Chernozems / Cambic Chernozems, on sand deposits (Aeolian rolling relief); *5*, Vermic Chernozems / Cambic Chernozems var. vermic; *6*, Haplic Chernozems, Haplic Chenozems (eroded phase) and strongly eroded soils / Cambic Chernozems, Eroded Cambic Chenozems and Erodisols (on slopes); *7*, Calcic Chernozems and strongly eroded soils / Typically Chernozems and Erodisols (on slopes); *8*, Vermic Calcaric Chernozems / Epicalcaric Chernozems var. vermic; *9*, Shifting Sands, Arenosols and Haplic Chernozems / Shifting Sands, Psamosols and Cambic Chernozems, on sand deposits (Aeolian rolling relief); *10*, Shifting Sands, Arenosols and Lamellic Luvisols / Shifting Sands, Psamosols and Psamic Preluvisols var. lamellic (Aeolian rolling relief); *11*, Lamellic Luvisols, Arenosols and locally strongly eroded soils / Psamic Preluvisols var. lamellic, Psamosols and locally Erodisols (Aeolian rolling relief); *12*, soil profiles; *13*, localities; *14*, irrigation channels.

Analytical Characteristics of the Arenosols

Physical Properties

In Dabuleni Plain, the arenosols have a loamy coarse sand or coarse sandy texture, regarding the two soil sampling levels, in the surface (Ao, Am, Ap) and subjacent horizons (AC, Cn_1). Clay content <0.002 mm varies between 0.9 and 12.1 percent. Particular to arenosols is the high content of coarse sand (44.2-71.9 percent) of aeolian origin (Fig. 2) compared with the fine sand (20.1-34.1 percent), which induces a characteristic single grain structure. Because of the extremely low content of clay and silt (2.3-9.6 percent) they are dusty, in terms of vulnerability to deflation, being devoid of any form of aggregation on depths of 1.5-2 m, with loose (non-coherent) consistence of soil mass (Table 1).

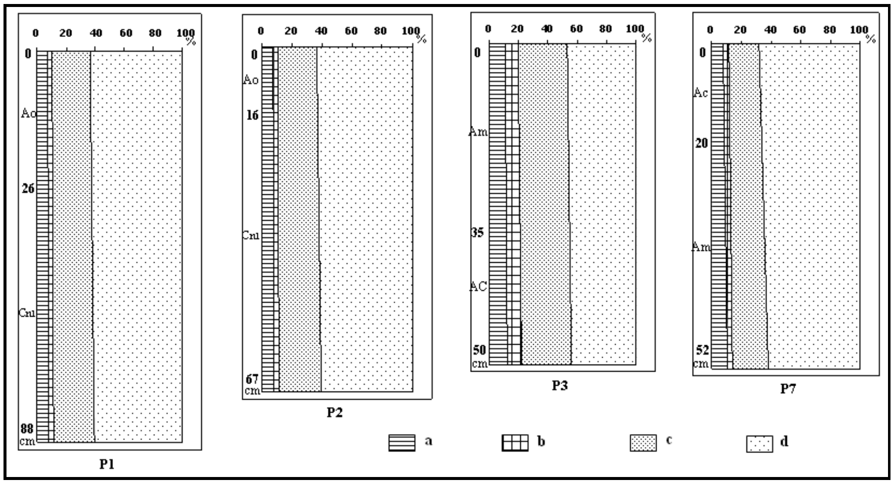

Fig. 2 Particle size distribution (%) of some selected soil profiles: a. clay; b. silt; c. fine sand; d. coarse sand.

Bulk density is low-medium (1.42-1.50 g/cm3) in surface horizons and medium to very high (1.48-1.76 g/cm3) in underlying horizons, which corresponds to a middle-high (44-47 percent) and small-medium (44-35 percent) total porosity. They have a very high permeability to water with high values of hydraulic conductivity (K) ranging between 42.06 and 189.4 mm/h in surface horizons and 57.22-201.24 mm/h in underlying horizons. P3 is the exception as its permeability is high in the horizon AC (18.60 mm/h) and very high (42.06 mm/h) in Am.

Arenosols resistance to penetration is very low with values of 2-9 kgf/cm^2 (range of values for the two levels of analysis). Moisture content at sampling moment varies between 3.0 and 7.6 percent 100g soil and, generally, it maintains within the same limits on both levels.

Chemical properties

The influence of relief microforms is noted in the accumulation of humus thickness, greater in depressions in comparison with dune ridges. The morphology of arenosols is characterized by the presence of a simple accumulation of humus with variable thickness, depending on relief microforms and age of stable dunes (Oancea et al., 1972). Eutric Arenosols are very poor in organic matter (humus), regardless the thickness of accumulation, with a very low content (0.51-0.60 percent) or extremely low (0.45 percent at P4) in the surface horizon and extremely low (0.03-0.29 percent) in the underlying horizon. The chemical data analysis indicates a weak acid reaction in the horizons Ao, Ap (pH 5.89-6.35) and in the parent material (Cn_1 horizon), with values of pH between 6.00 and 6.75. The total nitrogen (N) is very low in all samples analyzed, with values between 0.026 and 0.050 percent in Ao, Ap and 0.016 and 0.040 percent in Cn_1. The content of total phosphorus (P), is low-medium (0.016-0.072 percent) for soil profiles P1 and P6, low (0.017-0.022 percent) for P2 and low to high (0.014-0.091 percent) for P4.

Regarding the nitrate-N content (NO_3-N) with values of 5.4-16.0 ppm in surface horizon and 3.0-5.9 ppm in underlying horizon, Eutric Arenosols belong to the category of unfertilized arable soils (Lăcătuşu, 2006) with NO_3-N values below the 20 ppm (fertilized soils contain between 20 and 40 ppm). The ammonium nitrogen (NH_4-N) is low (2.40-4.80 ppm) for profiles P1 and P2 and medium (7.21-8.41 ppm) for P4 and P6.

Concerning the Mollic Arenosols, the soil reaction is weak acid with values of the pH between 5.90 and 6.40 in the horizon Am, Ac (A horizon covered with wind-borne sand) and AC (P3, P5) and neutral to weak alkaline for P7.

Table 1

Pedological data of the studied profiles (hyphen=no data)

Horizon	Depth (cm)	Colour (Munsell)	Structure	Texture	Granulometrical fractions (% g/g)			
					Clay <0.002 mm	Silt 0.002-0.02 mm	Fine sand 0.02-0.2 mm	Coarse sand 0.2-2.0 mm
P1, Lamellic Eutric Arenosol, cultivated land								
Ao	0-26	10YR4/3	SG	LCS	6.9	3.4	24.7	65.0
Cn_1	26-88	10YR 5/4-6	SG	CS	5.2	2.8	27.6	64.4
Cn_2l	88-140	10YR 5,5/4	SG	CS	-	-	-	-
P2, Eutric Arenosol, cultivated land								
Ap	0-16	10YR 3/4	SG	LCS	7.3	2.8	26.3	63.6
Ao	16-33	10YR 3.5/4	SG	LCS	7.7	3.8	27.7	60.8
Cn_1	33-67	10YR 5/4.5	SG	LCS	-	-	-	-
Cn_2	67-101	10YR 5/4	SG	LCS	-	-	-	-
P3, Mollic Arenosol, cultivated land								
Am	0-35	10YR 3/2	GL+SG	LCS	10.8	8.6	33.7	46.9
AC	35-50	10YR 3/3	SG	LCS	12.1	9.6	34.1	44.2
Cn	50-80	10YR 4/4	SG	LCS	-	-	-	-
P4, Eutric Arenosol, cultivated land								
Ap	0-27	10YR 3.5/4	SG	LCS	6.7	3.8	24.5	65.0
Ao	27-42	10YR 4/3	SG	CS	5.4	5.4	29.6	59.6
AC	42-53	10YR 4/4	SG	LCS	-	-	-	-
Cn	53-110	10YR 5/4	SG	CS	-	-	-	-
P5, Mollic Arenosol with severe sand accumulation, grassland								
Ac_{53}	0-23	10YR 4/4	SG	CS	4.5	4.1	30.9	60.5
Am	23-50	10YR 3/3	SG	LCS	7.8	3.2	32.0	57.0
Cn_1	50-89	10YR 3.5/4	SG	LCS	-	-	-	-
Cn_2	89-108	10YR 4/3	SG	LCS	-	-	-	-
P6, Eutric Arenosol, cultivated land								
Ao	0-37	10YR 4/4	SG	CS	0.9	7.1	20.1	71.9
Cn_1	37-60	10YR 5/4	SG	CS	5.2	2.3	21.3	71.2
Cn_2	60-81	10YR 4/4	SG	LFS	-	-	-	-
Cn_3	81-120	10YR 5/4-6	SG	CS	-	-	-	-
P7, Mollic Arenosol with moderate sand accumulation, grassland								
Ac_{52}	0-20	10YR 4/2	SG	LCS	7.9	3.7	20.1	68.3
Am	20-52	10YR 3/2	GL+SG	LCS	10.4	3.5	24.2	61.9
Cn_1	52-76	10YR 3/3	SG	CS	-	-	-	-
Cn_2	76-100	10YR 4/3	SG	CS	-	-	-	-

Structure: SG: single grain; GL: glomerular ;
Texture: CS: coarse sand; LCS: loamy coarse sand; LFS: loamy fine sand

Humus content (0.33-0.81 percent) and total N (0.022-0.050 percent) of the surface and underlying soil horizon is very low: mollic subtypes are slightly more humiferous compared with eutric ones. The Total P is very low-low (0.014-0.024 percent) in P3 and P7 and small-medium (0.029-0.060 percent) at P5. Generally, arenosols are very weak to moderate insured with total phosphorus. Regarding the content of nitrate nitrogen, Mollic Arenosols belong to the category of unfertilized arable soils with NO_3-N values below 20 ppm, between 5.3 and 6.3 ppm in upper horizon and 4.7-9.6 ppm in underlying horizon. Mollic Arenosols have a medium content of NH_4-N (6.00 ppm) in the surface horizon (Borlan and Hera, 1972) and low (3.60-4.80 ppm) in the underlying at P3 and P5.

Degradation Processes and Limitative Factors

Two categories of a soil degradation process are recognized, displacement of soil material (e.g., soil erosion by wind forces) and in situ soil deterioration covering chemical or physical soil degradation.

Displacement or coverage of soil material represents the main degradation processes, which affect the arenosols, in particular and the landscape, in general. Wind erosion or deflation is the process of displacement, transport and deposition of solid particles from the soil surface by wind. This process affects the upper soils horizon (usually A horizon) in which thickness is gradually reduced, with lost of soil material instead (Munteanu, 2000; Munteanu et al., 2004). Wind erosion was attenuated in Dăbuleni Plain by achieving shelterbelts forest, leveling the primarily aeolian relief and fitting irrigation systems. At present, the deforestation of shelterbelts and the malfunction of the Sadova-Corabia irrigation system have led to the reactivation of sand dunes with direct consequences regarding land quality. Nevertheless, the analyzed soil profiles are not affected by wind erosion, with all the surface horizons having thicknesses which do not include them into wind erodibility classes according to the Romanian System of Soil Taxonomy (2003) - the 20^{th} indicator on the degree erosion or soil striping.

Silting/colmatation defines a process of soil degradation resulting from the deposition on the soil surface of a layer of dispersed fine particles and development of a thin layer with dense and platy structure and low permeability (Canarache et al., 2006). In our case, silting or colmatation can refer to the coverage with infertile sediments, which concerns the deposition of sandy materials on the soils, derived from the process of wind erosion. In Dăbuleni Plain, there appear some areas covered with shifting sand that was blown by "outbreaks" of wind erosion from the neighbouring areas. These surfaces become virtually infertile and dry. Addition of sand by wind may also become a threat to agricultural crops (Fig. 3).

Thus, soil profiles P5 and P7 (Mollic Arenosols) are degraded as a result of sand accumulation. Soil profile P5 is covered by a coarse sandy layer of aeolian origin, and that compared with the thickness (23 cm), represents a severe sand accumulation on the upper soil layer (Am) (Fig. 4); the same situation is within the profile P7, with the difference that the sandy material has less thickness (20 cm) so that the soil is characterized by a moderate sand accumulation.

The effects of accumulated sand are insignificant regarding the permeability to water, which is still high due to coarse texture, but can

Fig. 3. Vineyard covered by shifting sands near Potelu

cause severe damages concerning the development and growth of plants, which depends on humus presence, even in small quantities. Of arenosols, only the mollic ones ensure a good plant development, the humus improving the trophic conditions of which sandy soils offer to the plants (Florea et al., 1988; Parichi, 1989).

Chemical deterioration can refer to the loss of nutrients or organic matter, acidification and pollution. Arenosols are very poor in organic matter (humus) and nutrients, having a weak acid reaction and critical moisture regime, especially on dunes, which represent limitative factors, not the results of chemical deterioration.

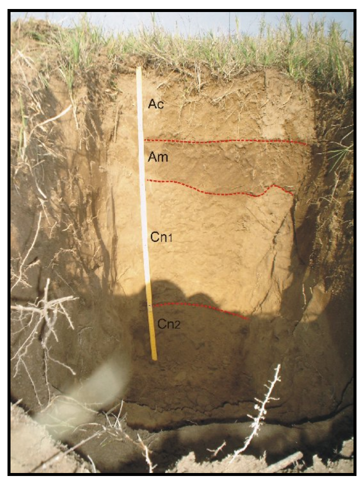

Fig. 4. Mollic Arenosol (P5) affected by coverage with infertile sediments of Aeolian origin

In order to prevent the acidification, it is necessary to promote a balanced fertilization, in case of chemical fertilizers, because the most vulnerable soils to acidification are the sandy soils, poor in humus and having an acid reaction (Florea, 2003).

Pesticide residue content is low, with some HCH values exceeding the maximum concentration limit (<0.005 mg/kg), but being lower than the alert threshold for a sensitive land use. The arenosols are not contaminated with pesticides, also due the fact that DDT contents are less than the maximum concentration limit (Table 3).

Analytical data of heavy metals content shows no contamination of the soils. All the values are below the AT - the alert threshold, which indicates that soils can sustain a sensitive land use. Some of the increased values of the elements can be attributed to previous historical contamination.

Table 3

Heavy metals and pesticide residue content (for a sensitive land use)

Profile no.	Soil type and subtype (WRB-SR 2006)	Horizon ; depth, cm	Sample depth, cm	Zn	Cu	Fe	Mn	Pb	Ni	Co	Cr	Cd	HCH tot.	DDT tot.
				mg/kg										
P1	Eutric Arenosol	Ao, 0-26	0-20	17.6	7.9	6274	165	29.8	17.8	28.8	5.0	*	0.012	0.015
		Cn_1, 26-88	30-50	11.9	3.8	5216	135	29.8	17.8	20.9	*	0.013	0.015	0.020
P2	Eutric Arenosol	Ap, 0-16	0-15	23.9	2.5	5745	165	29.8	29.4	13.0	5.0	0.044	0.013	0.015
		Cn_1, 33-67	35-50	22.8	3.8	4952	160	*	6.2	20.9	*	*	0.014	0.022
P3	Mollic Arenosol	Am, 0-35	0-20	19.3	3.2	8123	214	*	17.8	28.8	*	*	0.014	0.016
		AC, 35-50	35-50	15.3	3.8	8388	220	*	29.4	20.9	5.0	*	0.011	0.013
P4	Eutric Arenosol	Ap, 0-27	0-20	14.2	9.3	5216	152	*	29.4	13.0	13.9	*	0.015	0.023
		Ao, 27-42	27-42	21.1	2.5	6009	160	*	41.0	20.9	*	*	0.012	0.013
P5	Mollic Arenosol	Ac, 0-23	0-20	11.9	8.6	3102	84	*	6.2	*	*	*	0.011	0.015
		Am, 23-50	30-45	15.3	3.8	6802	176	45.3	6.2	13.0	5.0	*	0.008	0.005
P6	Eutric Arenosol	Ao, 0-37	0-20	24.5	20.8	4424	143	*	29.4	20.9	*	0.772	0.003	0.006
		Cn_1, 37-60	40-55	15.3	7.9	3895	106	*	17.8	13.0	*	0.066	0.001	0.005
P7	Mollic Arenosol	Ac, 0-20	0-15	17.6	42.5	7859	227	29.8	17.8	36.7	*	0.052	0.001	0.015
		Am, 20-52	30-50	28.0	21.1	8916	259	*	17.8	20.9	*	0.250	0.002	0.019
NV – normal values				**100**	**20**		**900**	**20**	**20**	**15**	**30**	**1**	**<0.005**	**<0.15**
AT – alert threshold				**300**	**100**		**1500**	**50**	**75**	**30**	**100**	**3**	**0.25**	**0.50**
IT – intervention threshold				**600**	**200**		**2500**	**100**	**150**	**50**	**300**	**5**	**0.50**	**1.00**

Conclusions

Soil environment quality in this area is in strong correlation with the humus content and the nature of parent material, which is relevant for the intensity of aridity processes, due to the strong heating and evaporation and few soil water accumulations. Also the reactivation of the sandy substrate and the formation of mobile sand dunes, with features of desert landscape increases drought severity, which will led in the end to desertification.

The specific pedogenetic processes of arenosols increase the water deficit affecting the development of grass vegetation cover and determine the sensitivity of the soils to deflation. The coarse texture determine a strong mineralization of organic matter and a more active mobilization of the various constituents of soil, with consequences regarding the migration of substances - including the nutrients – as the result of faster and deeper penetration of water into the soil. The loss in fine materials and organic matter by erosion and mineralization, together with climatic aridity, bring about specific landscapes characterized by soils with predominant ochric horizons that cannot support a sustainable agriculture without irrigation and protection against aeolian processes.

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