THE MAIN FOREST SOILS FROM SATU MARE COUNTY AND THEIR CHARACTERISTICS

L. DINCĂ [1], I. BRATU [2]
[1] "Marin Drăcea" National Institute for Research and Development in Forestry, Braşov, Romania
[2] Lucian Blaga University of Sibiu, Sibiu, Romania
Corresponding author: dinka.lucian@gmail.com

Abstract. *The present paper analyses forest soils from Satu Mare County based on their main chemical properties and by using data from forest management plans. The study follows the distribution of the main soil types, their development conditions as well as their evolution during three decades, starting with the year 1990. The research methodology is specific to studying forest ecosystem within projects specialized in forest fund characterization, whose result is represented by forest management plans. As such, analysis were realized for pH, humus content, exchange base capacity(Sb), hydrogen exchange capacity (Sh), total cationic exchange capacity (T), base saturation degree(V) and total nitrogen. Luvisol is the most widespread forest soil in this area while the lowest pH values in the first horizon were found for dystric cambisol (4.36), while the highest ones were for eutric cambisol (4.96); pH values increase in the second horizon. The lowest values for the basis degree saturation were also found for dystric cambisol (oligomesobasic soils), while the highest values were for eutric cambisol (eubasic soils). The humus content is high for luvisol and dystric cambysol, while stagnosol, preluvisol and eutric cambisol are moderately humiferous. Nitrogen supply is very good for dystric cambisol, good for eutric cambisol, preluvisol and luvisol and weak for stagnosols. Dystric cambisol has a very large total cationic exchange capacity, while all the other soil types have a large exchange capacity. As such, we can conclude that the values of the main analysed parameters are situated within the appropriate variation limits for Romania's forest soils.*

Keywords*: eutric cambisol, luvisol, humus, nitrogen, base saturation degree, total cationic exchange capacity*

INTRODUCTION

Satu Mare is located in north Romania, at the border with Ukraine (figure 1). Part of Tisa Plain, the county has a surface of 441 989 ha, from which 72.600 ha are forest fund (DIRECŢIA JUDEŢEANĂ DE STATISTICĂ SATU MARE, 2019; EUROSTAT, 2004).

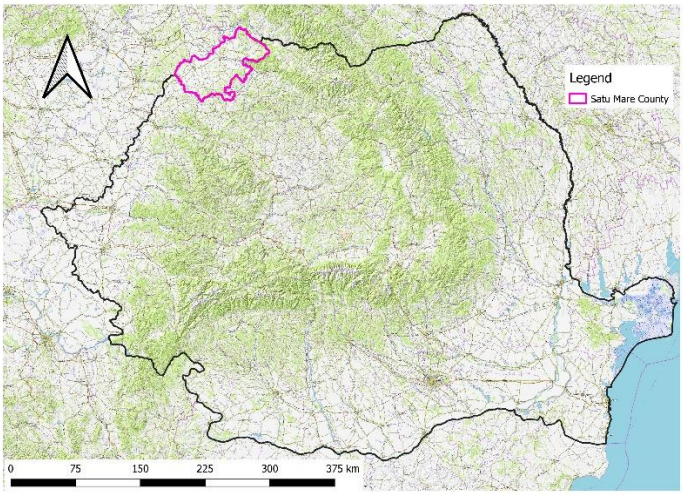

Figure 1. Study area.

Forests occupy a surface of 71.000 ha, with 3.000 ha occupied by resinous species and 68.000 ha by broad-leaved species. From an altitude perspective, the limits start at 120 m and go up to 1240 m, with a distribution of 63% fields, 20% hills and 17% mountains. Satu Mare County is situated within the continental temperate climate, having annual average temperatures between 8 and 9.8oC and annual average precipitations between 600 mm in the west part and 1200 mm in the mountain area (VELCEA, 1964). Someș, Tur and Crasna are the main rivers that collect waters. The main forest formations are represented by oak, common beech stands, different hard broad-leaved and resinous species (ȘOFLETEA AND CURTU, 2007). Forest management plans are updated every 10 years and they include soil studies. Luvisol call, with a share of 42% represents the main soils from Satu Mare, based on the vegetation, relief, climate and litology conditions present in this area.

MATERIAL AND METHODS

The data analysed for this article originate from forest management plans of state forest districts (6 forest districts) realized during 1990-2016 (FOREST MANAGEMENT PLANS, 1990-2016). These plans, which are realized every 10 years (which means that a forest district has 3 rows of soil data) include stand descriptions and environment characteristics for the so called "management units". These field areas are homogenous from the point of view of forest and environment characteristics. Soil profiles are gathered from certain management units (one at approximately 1000-3000 ha), namely from pedogenetic horizons (soil horizons with similar physical or chemical characteristics) whose chemical properties are then analysed.

The present study has analysed soil profiles and 738 pedo-genetical horizons. The soil's chemical properties that were analysed were: pH, humus content, exchange base capacity (Sb), hydrogen exchange capacity (Sh), total cationic exchange capacity (T), base saturation degree (V) and total nitrogen. The soil's pH was determined through the potentiometric method, while the readings were fulfilled with a Thermo Orion 3 pH-meter. The soil humus was established through the humid oxidation method and titrimetric dosage by Walkley-Black-Gogoasa method. The total nitrogen from the soil was established through the humid mineralization method and titrimetric dosage by Kjeldahl method with Gerhardt automatic analyser. The exchange base capacity and the hydrogen exchange capacity were determined through the repeated bleeders with ammonium acetate (DINCĂ, *ET AL.*, 2012).

RESULTS AND DISCUSSIONS

Type of soils from Satu Mare Forest County

The most widespread soil types are luvisol (42% from the total soils in the area), followed by preluvisol (26%), and eutric cambisol (15%). Lower percentages are present for stagnosol (5%) and dystric cambisol (2%), while other soil types (fluvisol, chernozem, phaeozem, gleysol, arenosol) occupy only 10% (figure 2).

At a national level, dystric cambisol occupies the first place (2.292.35 ha, meaning 35%), while luvisol occupies the 2nd place (1.440.052 ha, meaning 22%), eutric cambisol the 3d place (with a total surface of 869.909 ha, meaning 13%), and preluvisol the 5th place (335.050 ha, meaning 5%), (DINCĂ, *ET AL.*, 2014). Unlike the national average, stagnosol has a high presence in this county (being a representative soil for micro-depression areas – FILIPOV, 2005).

The soils characteristic for Oasului Mountains (that partially overlap with forest districts from Satu Mare county) are eutric cambisols (55%), luvisols (15%) and preluvisol (8%), (RUSU, *ET AL.*, 2005).

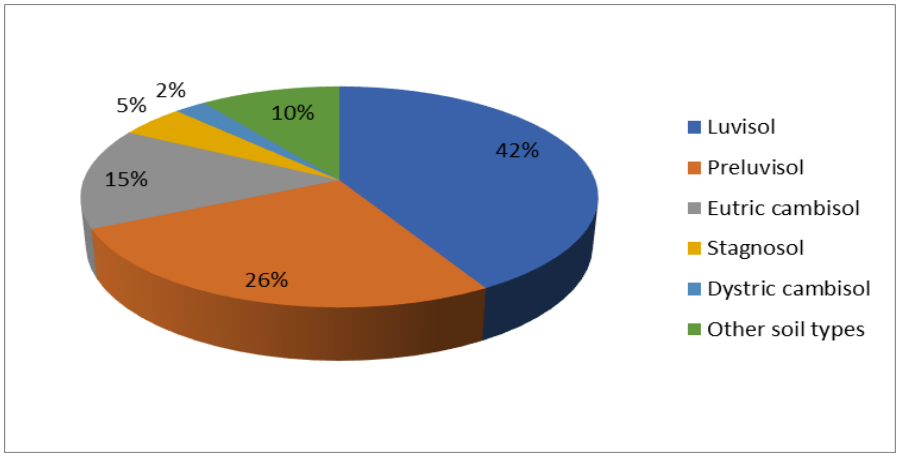

Figure 2. The percentage of forest soils identified in Satu Mare County

The soil solution reaction

Soil solution reaction increases from dystric cambisol, to stagnosol, luvisol, preluvisol and reaches a maximum at eutric cambisol (figure 3).

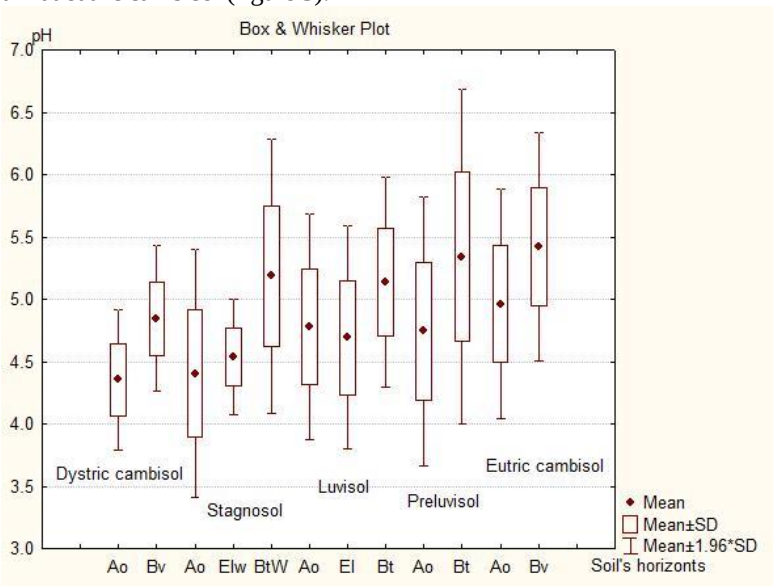

Figure 3. pH variation of genetic horizons for the most widespread forest soils from Satu Mare County

The lowest pH variability is found at dystric cambisol (a soil formed on acid rocks, TARZIU, *ET AL.*, 2002) and is the largest for preluvisol (a soil characteristic for the hill area-SPARCHEZ, *ET AL.*, 2011).

In the first horizon, the average pH is 4.36 for dystric cambisol, 4.40 for stagnosol, 4.74 for preluvisol, 4.78 for luvisol, and 4.96 for eutric cambisol.

The second horizon is more alkaline than the first one, having average values of 4.54 la stagnosol, 4.85 pentru dystric cambisol, 5.14 la luvisol, 5.34 la preluvisol, 5.42 la eutric cambisol.

Some authors identified the presence of acid soils represented by dystric cambisols in Bihor (DINCĂ, *ET AL.*, 2017), preluvisols in Arad County (CANTAR AND DINCĂ, 2018), or luvisols in Vrancea (ONET, *ET AL.*, 2019).

The base saturation degree

As in the case of pH, the base saturation degree (V) was analysed on soil types and on pedo-genetic horizons (figure 4).

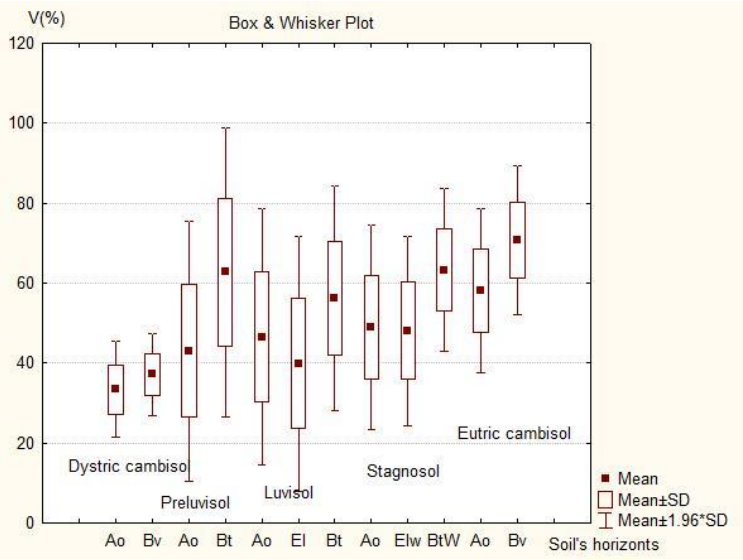

Figure 4. Base saturation degree variation for the most widespread soils from Satu Mare County

Forest soils from Satu Mare County are oligo-mesobasic (dystric cambisol), mesobasic (preluvisol in the Ao horizon), or eubasic (eutric cambisol, preluvisol in the Bt horizon)

A unique situation was presented by luvisols and stagnosols, soils characterised by the presence of a second eluviation horizon (TARZIU, *ET AL.*, 2004). In their case, the base saturation degree decreases in this horizon (El) in comparison with the soil's surface horizon (Ao), after which it increases in the last clay-alluvial horizon (Bt).

This parameter showcases the same situation of lower variability for dystric cambisols and higher for preluvisols and luvisols.

Dystric cambisols have the lowest base saturation degree (33.44% in Ao and 37.15% in Bv), while eutric cambisols records the highest values (58.12% in Ao and 70.53% in Bv). One of the main differences between these two soils is the dystric cambisol's 55% limit of the base saturation degree and higher values for eutric cambisols (BLASER, *ET AL.*, 2008).

Other authors have also obtained similar base saturation degree values for preluvisols in Calarasi (DINCA AND BRATU, 2020).

Humus

From the perspective of humus quantity, stagnosol, preluvisol and eutric cambisol are moderately humiferous, while luvisol and dystric cambisol are intensely humiferous (figure 5).

Dobrogea's Plateau records higher humus values for forest soils similar with those from Satu Mare (4.77 for eutric cambisols, 5.52 for preluvisols and 5.82 for luvisols) (CRISAN AND DINCĂ, 2020). This is caused by different climatic conditions. However, in the Getic

Plateau, the values (4.94 for eutric cambisols, 4.8 for preluvisols) are similar with the ones recorded in Satu Mare (ENESCU, *ET AL.*, 2019).

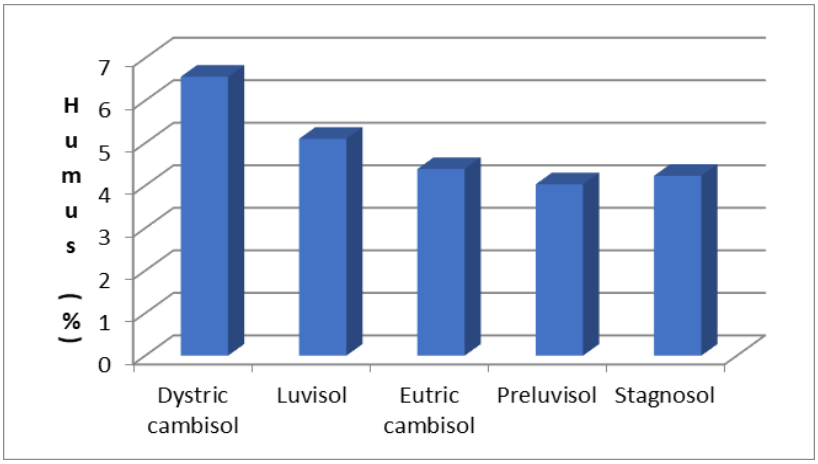

Figure 5. The variation of humus content for the most widespread forest soils from Satu Mare County

Nitrogen

The poorest soils in nitrogen from this area are stagnosoils. Their average value (0.14%) situates them in the category of soils that are medium supplied with this element. The other soils (eutric cambisol, preluvisol and luvisol) are well supplied with nitrogen (having almost equal percentages). Only dystric cambisol is very well supplied with nitrogen (Table 1).

Table 1

Average content of humus, nitrogen and total cationic exchange capacity for forest soils from Satu Mare County

Soil type/characteristics	Eutric cambisol	Dystric cambisol	Preluvisol	Luvisol	Stagnosol
Average humus content in the A horizon per soil type (H-%)	4.39	6.56	4.03	5.10	2.82
Average nitrogen content in the A horizon per soil types (%)	0.25	0.38	0.25	0.27	0.14
Total average cationic exchange capacity per soil type (T-me 100 g^{-1} sol)	23.07	25.74	21.83	19.81	17.33

Total cationic exchange capacity

In regard with the total cationic exchange capacity, an average was calculated per profile and was rendered in table form for each type of soil (Table 1).

Dystric cambisol has a very large total capacity of cationic exchange, while all the other types of soil have a large exchange capacity (figure 6).

However, in Bacau County, dystric cambisol is not the soil with the largest values, as it is outperformed by phaeozems and fluvisols (CRISAN, ET AL., 2020).

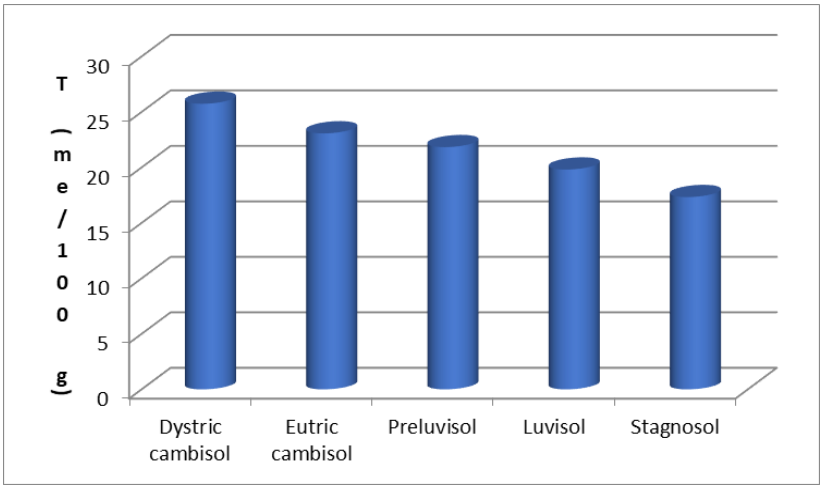

Figure 6. The variation of total cationic exchange capacity for the most widespread forest soils from Satu Mare County

CONCLUSIONS

The relatively even physical-geographical conditions that have led to the formation of soils are connected to litology, climate, hydrographic and vegetation conditions. The dominant soil types are luvisol (42% from the total soils in the area), followed by preluvisol (26%), and eutric cambisol (15%). A not so accidental presence is represented by stagnosol, which generally appears in basin areas (FILIPOV, 2005).

The lowest pH values in the first horizon were found for dystric cambisol (4.36), while the highest ones were for eutric cambisol (4.96); pH values increase in the second horizon. The lowest values for the basis degree saturation were also found for dystric cambisol (oligomesobasic soils), while the highest values were for eutric cambisol (eubasic soils) (DINCA AND BRATU, 2020). As such, a positive correlation exists between pH and the degree of saturation in basis.

The humus content is high for luvisol and dystric cambysol, while stagnosol, preluvisol and eutric cambisol are moderately humiferous. Nitrogen supply is very good for dystric cambisol, good for eutric cambisol, preluvisol and luvisol and weak for stagnosols. Dystric cambisol has a very large total cationic exchange capacity, while all the other soil types have a large exchange capacity.

As such, we can conclude that the values of the main analysed parameters are situated within the appropriate variation limits for Romania's forest soils.

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