THE MAIN TYPES AND SUB-TYPES OF SOIL FROM THE FOREST ZONE OF THE PLAINS OF BANAT (TIMIŞOARA AND LUNCA TIMIŞULUI FOREST DISTRICTS) CORRELATED WITH THE STUDY OF THE FOREST SITES AND VEGETATION

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Abstract: *In the present paper, an analisys is made on the main soils found in the forest area of the plains of the Banat region, respectively within the range of Timişoara and Lunca Timişului forest districts. Onwards, some correlations were made between the soils and the forest sites, the natural fundamental forest types and finally the optimal forest compositions (aim compositions) from the forestry point of view. Geomorphology, geological conditions, soil and climate, generally determined by the geographical and altitudinal location of the study district, favored the development of a varied and valuable forest vegetation, corresponding to the existing vegetation floors. The lithological substrates have led to the formation, in the vast majority of the surface, of luvisols. The soils determined the existence of resorts of superior and medium quality. In some situations, as productivity limiting factors appear: the deficiency in useful mineral substances, the active acidity of the soil, the shortage of accessible water, the low temperatures in and around the soil, etc. Particularly important are the destabilizing factors that affect the trees as well as the limiting ones. In the vast majority of the territorial area under study, the natural regeneration of the main forest species in the area is done well and very well. In the studied territory are the forest species characteristic of the phytoclimatic floors in which it is located. The predominant oaks are found in the plain and low hills, on soils of the luvisol class, they are better adapted to these heavier seasonal conditions determined by the presence of relatively compact (high clay content) soils and poor rainfall regime. In the higher meadow areas the oak, ash and lime tree vegetate. First, some data was presented regarding the location of the territory, the study of the forest site, the methods of work. All these used as base the data from the forest management plans of the two forest districts.*

Keywords: *forest soils, forest sites, fundamental forest types, forest site mapping, forest management plan.*

INTRODUCTION

From the geographic point of view, the studied territory is located in the Western part of Romania, respectively in the Plains of Timiș, Plain of Vinga, Plain of Bârzava, the Hills of Lipova and the Hills of Doclin.

The identification of the types and sub-types of soil from the forest fund which is public property of the State, adminitrated by the Timişoara and Lunca Timișului Forest Districts, was carried out with the occasion of the forest management planning works, within the field study stage.

The criteria for grouping stationary units into types of resort are indicated by the name of the type of resort. These criteria are of a physical-geographical, ecological and forestry nature. As the type of resort is characterized, in general result, by a certain ecological specificity and a certain physico-geographical framework, the equivalent ecological results (climatic, trophic, hydric equivalence) were taken into consideration for establishing the type of resort.

The climatic, geological, geomorphological and vegetation conditions from the Timişoara and Lunca Timişului Forest Districts favour the formation of a relatively varied range of soils.

MATERIAL AND METHOD

They were used existing data from the forest management plans of the eight production units (U.P.) belonging to the forest district Timişoara (U.P. I Pişchia, U.P. III Foradea, U.P. IV Şarlota, U.P. V Honoş, U.P. VI Herneacova, U.P. VII Hodoş, U.P. VIII Pădurea Verde, U.P. X Paniova), respectively from the nine U.P. from Lunca Timişului forest district (U.P. I Dumbrava, U.P. II Silagiu, U.P. III Bazoş-Hitiaş, U.P. IV Chevereş, U.P. V Bacova, U.P. VI Giroc, U.P. VII Lighed, U.P. VIII Banloc-Mănăstire, U.P. IX Clopodia).

Also, they were used observations and measurements from the field, collected within the re-issuing of the forest management plan during 2017 by the Forest Manegement Planning Team from the Timişoara Research-Development Station.

In this paper an analysis will be carried out, from the forest management planning point of view, regarding the situation of the types and sub-types of soil present in the forest area of the plains of the Banat region, respectively present within the Timişoara and Lunca Timişului forest districts.

They were used the data collected during the forest sites mapping at medium scale, during which they were made principal soil profiles in characteristic situations, together with control soil profiles. The pedological data were deepened by soil analyses, which were carrieed out within the Soil Laboratory of the Braşov Station of I.N.C.D.S..

The placement of the principal soil profiles' network, the description of these profiles, together with the placement and description of the control soil profiles in each forest management unit were carried out simultaneously with the collection of data such as: form of relief, terrain configuration, exposition, slope, altitude, type of forest site, litter and flora type.

The field data were filled in the dataforms of the forest management units and in the datasheets of the soil profiles, using codes and oficialized denominations, those forms being the primary documents of the information system of the forest management planning.

Within the analysis of the soils' distribution, they were made also general assessments regarding their favourability for certain species according to some data from the forest management plans.

The processed data reffer to a surface of forest fund – public property of the State of 20064.29 ha, administrated by the Timiş County Forestry Directorate through the two forest districts.

RESULTS AND DISSCUSIONS

The forming of the soils

The main factors which influence the forming of the soils are the following:

- The geological factor
- The climatic factor
- The biologic factor
- The relief

- The geological factor is important by the meneralogical composition on which the soil is formed
- The climatic factor determines the intesity and nature of the pedo-genesis processes (temperature, precipitations)

- The biologic factor (flora and fauna) is represented by the quantity of organic matter which enters in the composition of the soil
- The relief infleunces the ntensity of the pedo-genesis processes especially due to the slope and the exposition

The soils’ classification is a complex process because for the soils forming many pedo-genesis processes act and they have as consequence the forming of a large number of types, respectively sub-types of soil. The soil is a consequence of the environmental factors of where it is formed. The nature and intesity of the facters of soil forming determine the type and sub-type of soil. (Puiu ȘT., 1983)

The pedo-genesis processes

In order to corectly evaluate the diagnosis horizons of the soils and to not misidentify the type and sub-type of the soil (a tranzitory horizon not to be misidentified as a dignostic horizon), the pedo-genesis processes which act on the soil must be known, as it follows :

- The accumulation of organic matter
- Eluviation
- Illuviation
- In situ argilisation
- Iron-humus podzolization
- Andisolization
- Gleysation and pseudogleysation
- Salinisation and alkalization
- Vertic processes

The accumulation of organic matter determines the formation of the soil horizons Am (A molic), Au (A umbric), Ao (A ocric), O and T. It represents a process of migration and concentration of the organic matter in the soil’s complex.

The eluviation (the washing of the argillaceous minerals) determines the formation of the soil horizons El (E luvic) and Ea (E albic). In the case of the Ea soil horizon, the washing is more intense and only the more coarse minerals remain (quartz) which give a whitish aspect to the soil horizon.

The illuviation represents the migration of the clay and its deposit in amore deep horizon, which leads to the formation of the soil horizon Bt (B argic). This soil horizon is enreached with clay by the migration from the upper horizon, therefore resulting a fine texture and a high dimensions structure.

The in situ argilisation represents the forming of argillaceous minerals in situ and determines the formation of the soil horizon Bv (B cambic).

The Iron-humus podzolization (the total washing of the soluble salts from the colloidal complex and the migration of the resulted products, especially the Fe and Al oxids under the action of the fulvic acids in a lower horizon) which determines the formation of the soil horizons Es (E spodic), Bs (B spodic), Bhs (B humico-spodic) and Bcp (B cripto-spodic).

The andisolization (disagregation and alteration of the vulcanic rocks) has as effect the enrichment in allofanic minerals (oxides and hydroxides of Al and Fe) which determines the formation of an association soil horizon - An (andic).

Gleysation and pseudogleysation are chemical processes of reduction and oxidation of the Fe compounds in the conditions of excess water in the soil, which determines the formation of the Go (G oxidation), Gr (G reduction), W (pseudogleysated) and W (pseudogleic).

Salinisation and alkalization represent the processes of excessive enrichment of the soil with soluble salts, which determine the formation of the association horizons (salinic), Ac (alkalic) and Btna (B argic - natric).

The veric processes represent the enrichment of the soils with gonflable clay (soils wick have cracks within the dry climate periods) by disagreagation of the parental material which is rich in clay and determines the formation of an association soil horizon vertic y which will associate with other soil horizons (Ay, Bty, Cy).

The study of the soils was carried out together with the works of forest site mapping, 106soil profiles being respectively executed. The delimitation/separation of the soil horizons was made mainly by the following criteria: colour, texture and structure.

Table 1

The distribution of soil types and sub-types

Class	Soil type	Soil sub-type	Code	Horizons' succesion	Total	
					ha	%
Protisoluri	Aluviosol	molic	403	Am – C	31,60	-
		coluvic molic	412	Amco-Cco	12,77	-
		gleic	414	Ao-Go-Gr	19,92	-
	Total aluviosol				64,29	-
Total protisoluri					64,29	-
Cernisoluri	Cernoziom	tipic	1201	Amca - ACca - Cca	39,07	-
	Total cernoziom				39,07	-
Total cernisoluri					39,07	-
Luvisoluri	Preluvosol	tipic	2101	Ao - Bt - C(Cca)	1005,61	5
		molic	2102	Am – Bt – C	863,85	4
		vertic	2107	Ao-Bty-C	49,17	-
		stagnic	2108	Ao - Btw - C	3232,82	16
		gleic	2109	Ao-BtGr-CGr	322,19	2
		erodat	2124	Ao-Btw-C	11,15	-
		molic-gleic	2119	Am – BtGr - C	208,58	1
	Total preluvosol				5693,37	28
	Luvosol	tipic	2201	Ao-El-Bt-C	8063,90	40
		stagnic	2212	Ao-El-Btw-C	5264,00	26
		vertic	2208	Ao-El-Bty-C	15,43	-
		gleic	2213	Ao-El-Bt-CGr	31,35	-
	Total luvosol				13374,68	67
	Alosol	stagnic	2305	Ao-Elw-Btw	609,10	3
	Total alosol				609,10	3
Total luvisoluri					19677,15	98
Hidrisoluri	Gleiosol	eutric	7202	Aoeu – AGoeu - Gr	69,11	1
		molic	7204	Am-AGo-Gr	13,59	-
		aluvic	7210	Aoel – Agoel - Gral	201,08	1
	Total gleiosol				283,78	2
Total hidrisoluri					283,78	2
T O T A L					20064,29	100

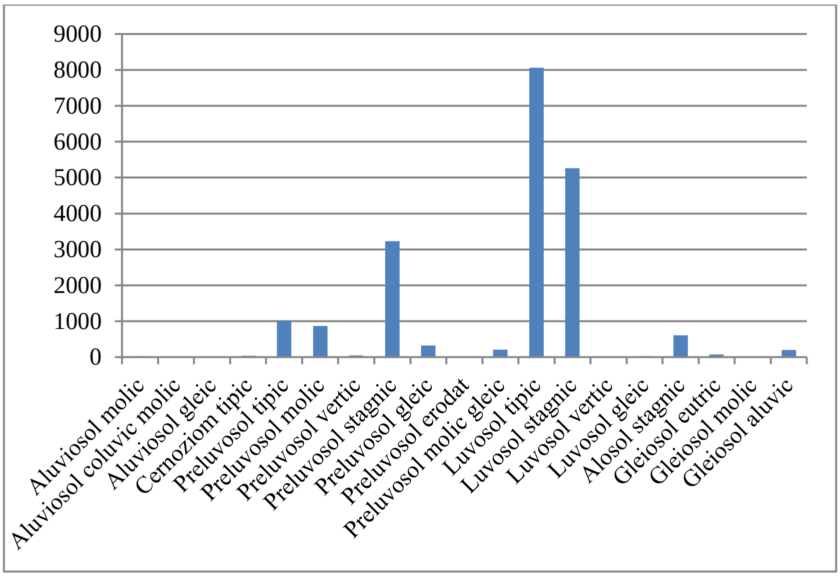

Figure 1 Distribution of soil types and sub-types

Soil types and sub-types

The most frequent soil types are the luvosol with its two sub-types (67%), the preluvosol with its 3 sub-types (28%) and the alosol with only one sub-type (3%) from the surface of the forests and terrains designated to be forested, as it follows:

Luvosol (LV) - soils having an A ocric (Ao) horizon, followed by an elluvial horizon E (El or Ea) and B argic (Bt) horizons having a degree of base saturation V >53% at least in one sub-horizon in the upper part; they don't have an abrupt textural change (between E and Bt <7,5 cm).

Luvosol tipic (″2201″ Ao-El-Bt-C), having the horizons Ao, El and Bt in one of the sub-horizons, at least as stains (with more than 50% proportion), colours with shades of 7,5 and 10YR, sometimes even more yellow with values and chromes ≥3,5 (wet), on the surfaces and inside the structural elements (with the exception of the soils which present an abrupt texture change on maximum 7,5 cm); they have a differentiated texture along the profile, loam-sand in Ao, sand-loam in El and loam-clay or even clay in the Bt horizon. The clay and the oxids of Fe migrate together on the soil profile, being the case of a mechanical migration and not a podolization process. The structure of the soil is grainy, poorly developed in the Ao horizon, lamellar or small polyhedric in El and prismatic in Bt;

Luvosol stagnic (″2212″ Ao-El-Btw-C), alike with the typical sub-type, but having stagnic properties betewwn 50-100 cm, with purple reduction stains on less than <50% of the surface of the structural aggregates and inside them. The precipitation water easily penetrates the upper horizons and stagnates above the Bt horizon, therefore in the moist periods, the soil presents water excess, and in the dry periods, the soil presents water deficit.

Preluvosol (EL) – soils having an A ocric or molic (Ao, Am) horizon, followed by the argic (Bt) horizon having colours with values above 3,5 (wet) and degree of base saturation V>53%.

Preluvosol tipic (″2101″ Ao-Bt-C or Cca), appears on the slopes with diverse expositions and slopes, having horizons Ao and Bt in the lower part with shades of 7,5 YR or >3,5 for the wet material at least inside the structural elements; the limitative factor for the forest vegetation formed on this soil is represented by its compactness determined by the high content of clay.

Preluvosol molic (″2102″ Am-Bt-C), alike with the typical sub-type, but having an Am horizon, is specific for the plateau and ridge zones;

Preluvosol stagnic (″2108″ Ao-Btw-C), alike with the typical sub-type, but with hipostagnic properties between 50-100 cm. These soils are of average and high fertility for common oak, sessile oak, Turkey oak and Hungarian oak. The average fertility is determined by the average edaphic volume, due to the apparition of the Btw horizon, loamy and compact during the vegetation season, also due to the humidity regime with water deficit during the vegetation season, especially on the sunny slopes

Alsol (AL) – soils having an A ocric or umbric (Ao, Au) horizon followed directly or after an elluvial horizon € by a B argic (Bt) horizon, having alic properties (V>53%) on at least 50 cm between 25-125 cm in depth or at least half of the horizon if R or C horizons appear at lower depth. It could present an organic horizon pr moderated stagnic properties (w) or intense stagnic properties (W) below 50 cm in depth.

Alsol stagnic (″2305″ Ao-Elw-Btw) horizons Ao with or without El with Bt, Bt with V<53% with hipostagnic properties w (pseudogleysated) between 50-100 cm, with purple reduction stains on <50% of the surface of the structural aggregates and inside them.

These soils are found on loams and have a differentiated structure along the profile, loam-sand in Ao, sand-loam in Elw and loam-clay or even clay in the Btw horizon. The clay and the oxids of Fe migrate together on the soil profile, being the case of a mechanical migration and not a podolization process. The structure of the soil is grainy, poorly developed in the Ao horizon, lamellar or small polyhedric in Elw and prismatic in Btw.

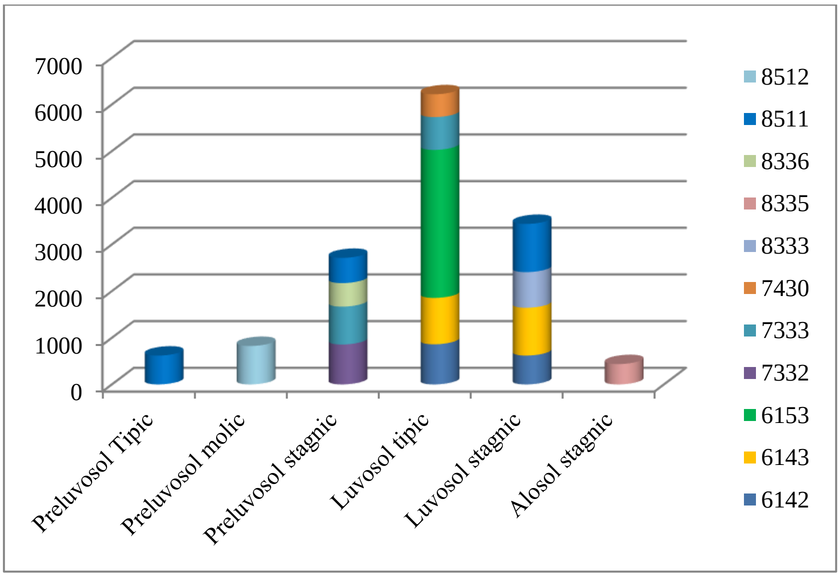

Figure 2.- Distribution of soil types and sub-types correlated with the forest site type

Correlation between the soil and the forest site type

Within the paradigm of the forest as a terrestrial ecosystem, the forest site or the biotope represent the component or the sub-system of inorganic nature, the living place og the biocenosis or the physical environment of the ecosystem. The forest site or the biotope consists of elements of releif, rock or parental material, soil and climate and represents the climatic and edaphic fund of substance and energy of the biocenosis (C.D. Chiriță, 1977).

At the base of the establisment of the existing forest site types on the studied territory layed the works of forest site mapping at medium scale executed, with this occasion being collected pedological, ecological, climatological and geomorphological informations.

In the following table is presented the distribution of the forest site types correlated with the main types and sub-types of soils from the studied territory.

Table 2

Correlation between the soil and the forest site type

Soil type	Soil sub-type	Code	Forest site type	Total	
				ha	%
	tipic	2101	8511	617,88	4
Preluvosol	molic	2102	8512	823,80	6
	stagnic	2108	7332	855,53	6
			7333	811,74	6
			8336	504,29	4
			8511	540,01	4
Total preluvosol				4153,25	29
Luvosol	tipic	2201	6142	860,00	6
			6143	993,70	7
			6153	3172,00	22
			7430	488,00	3
			7333	703,44	5
	stagnic	2212	6142	618,80	4
			6143	1024,00	7
			8333	763,11	5
			8511	1033,30	7
Total luvosol				9656,35	68
Alosol	stagnic	2305	8335	435,22	3
Total alosol				435,22	3
TOTAL				14244,82	

6153- Hilly, oaks forests (Turkey oak and Hungarian oak/sessile oak) Ps, brown +/- mildly pozdolizated-pseudogleysated, large edephic volume – 22%
8511- Forested plain, river meadow with mixed forests, Pm, brown, wet, gleyzated or semigleic, average or large edaphic volume -15%
6143- Hilly with oak forests (sessile oak) and mixed hilly forests, Ps, pozdolizated-pseudogleysated, large edephic volume, with Carex pilosa-14%

Correlation between the soil and the forest type

The forest type reunites the forest patches which are uniform by the composition of tree species, by the other layers of vegetation and fauna, by the site conditions complex (climatic, edaphic and hidrological), by the relationships between the plants and the environment, by the processes of regenerarion and by the direction of succesions within them, asking as a consequence, within similar economical condition, for similar forestry measures (S.Pașcovschi, 1955).

In the following table it will be presented the distribution of the forest types correlated by the main types and sub-types of soil from the studied territory.

Table 3

Correlation between the soil and the forest type

Soil type	Soil sub-type	Code	Forest type	Total	
				ha	%
Preluvosol	tipic	2101	6324	558,96	4
	molic	2102	6321	334,10	3
	stagnic	2108	7311	784,42	6
			7121	504,29	4
			7312	789,36	6
Total preluvosol				2971,13	22
Luvosol	tipic	2201	7311	3716,45	28
			7312	1866,13	14
			7431	973,79	8
	stagnic	2212	6324	578,50	4
			7311	1493,63	11
			7312	629,82	5
			7421	574,02	4
Total luvosol				9832,34	75
Alosol	stagnic	2305	6223	435,22	3
Total alosol				435,22	3
TOTAL				13238,69	100

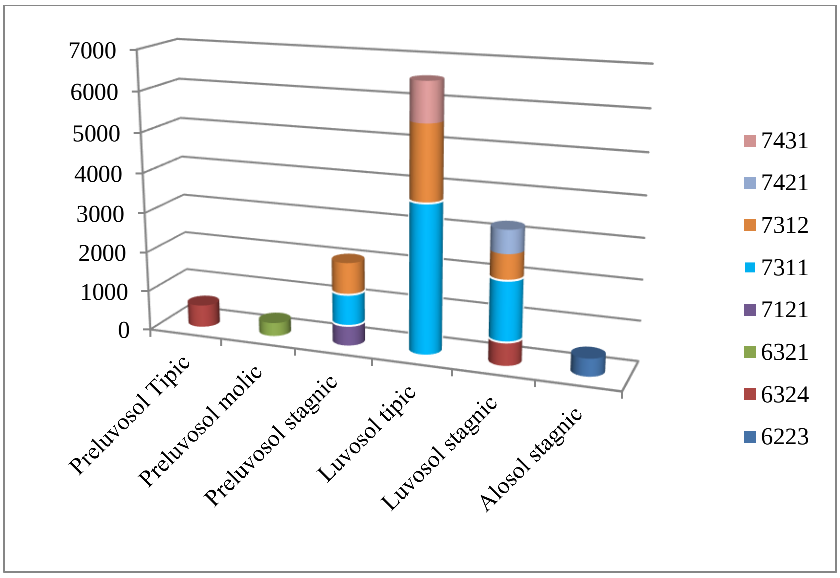

Figure 3.- Distribuion of the types and sub-types of soil correlated with teh forest type

7311-Turkey oak-Hungarian oak hilly forest of high productivity -45%
7312- Turkey oak-Hungarian oak hilly forest of average productivity -25%

The correlation between soil, natural fundamental forest type and the optimal composition of the forest

The reference optimal aim-composition represents the association and proportion of tree species within a stand which aggregates in the most favourable way the ecological requirements of the species from the most valuable provenances, with the social-economical requirements, at the and of the stand's existence. (Rucăreanu N., Leahu I, 1980)

In the following table it is evidentiated the optimal composition from the forestry point of view for the natural forest types corresponding to the main types and sub-types of soil.

Table 4

Correlation between soil and the optimal composition

Soil type	Soil sub-type	Code	Forest type	Optimal composition
Preluvosol	tipic	2101	632.4.	7ST 3(FR,TEA,CI,JU,CA,UL)
	molic	2102	632.1.	7ST 3(FR,TEA,CI,JU,CA,UL)
	stagnic	2108	731.1.	5CE 3GI 2(TE,CI,CA,AR,JU,PĂ)
			712.1.	8CE 2(TEA,FR,CI,JU,PĂ)
			731.2.	5CE 3GI 2(TE,CI,CA,JU,PĂ)
Luvosol	tipic	2201	731.1.	5CE 3GI 2(TE,CI,CA,AR,JU,PĂ)
			731.2.	5CE 3GI 2(TE,CI,CA,JU,PĂ)
			743.1.	3ST 2GO 2CE 1GI 2(TE,CI,PĂ,JU,CA)
	stagnic	2212	632.4.	7ST 3(FR,TEA,CI,JU,CA,UL)
			731.1.	5CE 3GI 2(TE,CI,CA,AR,JU,PĂ)
			731.2.	5CE 3GI 2(TE,CI,CA,JU,PĂ)
			742.1.	4ST 2CE 2GI 2(FR,TEA,CA,JU,PĂ)
Alosol	stagnic	2305	622.3.	7ST 3(FR,TE,PA,CI,CA)

CONCLUSIONS

In conclusion, for the studied territory, we can appreciate that everything representing site conditions, including the correlations between the types and sub-types of soil, forest site types and fundamental forest types, the optimal compositions from the forestry point of view are based on oak forests, especially Turkey oak (*Quercus cerris*), but also common oak (*Quercus robur*), sessile oak (*Quercus petrea*), respectively Hungarian oak (*Quercus frainetto*).

Besides, the existing compositions are mainly based on the same forest tree species, therefore the existing forest site conditions are valorized at maximum potential.

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