Using Modern Technologies to Complement the Classic Ones in Soil Survey

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Abstract

Soil is a complex and dynamic factor that, needs to be studied, analyzed, known and understood. The spreading of soils in the territory is conditioned by the microrelief, lithology characteristics and the hydrographic network. This paper aims to establish the soil survey characteristics and soil evaluation of an agricultural land to be introduced into the national forest fund for afforestation.

In order to achieve the proposed goals, in addition to the classical works, orthophotomaps were used. To establish an afforestation solution, the main site characteristics were determined on the field: altitude, exposure, slope, functional category. These characteristics have been associated with laboratory analyzes to determine soil type, with orthophotomaps measurements and weather data. Analyzing the collected data, the land was enclosed in the bioclimatic hilly region of Turkey oak stand (FD2), where the main species best suited is the Turkey oak, mixed with flowering ash, field maple and pear-tree.

Keywords: afforestation, orthophotomaps, soil, soil survey

Introduction

Soil, a major component of the ecosystem, along with climate and vegetation, is a complex and dynamic factor that, in order to use rationally, needs to be studied, analyzed, known and understood. Within it, a series of biochemical processes are carried out, which help to support life, especially of plants (Keesstra, 2016).

These processes have suffered disturbances due to human activities, since the beginning of the practice of agriculture, being intensified with the increasing need for food. In 2015, the United Nations adopted Sustainable Development Goals (SDGs), which contain 17 objectives, and objective 15 refers to the sustainable use of terrestrial ecosystems. This objective proposes the implementation of measures to stop soil erosion and restore the already eroded ones (Keesstra, 2018).

Worldwide, degraded land is about 75% of the land area, with a degradation rate of 4.18 million km^2 per year. Based on the current degradation rate, it is estimated that by 2050, degraded land could reach 90% (europa.eu/rapid/press-release_IP-18-4202_en.pdf). The natural geographical conditions of Romania, where the sloping land represents up to 67% of the national territory, amplified by a complex number of natural factors and the need to expand the agricultural areas from the end of the 19th and the beginning of the 20th

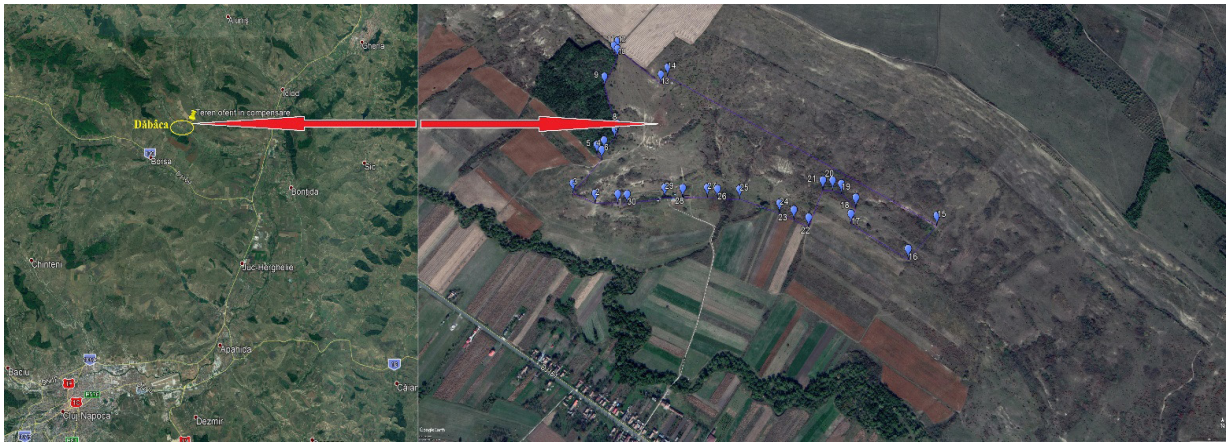

Figure 1. Location of the land

Figure 2. The apparatus used

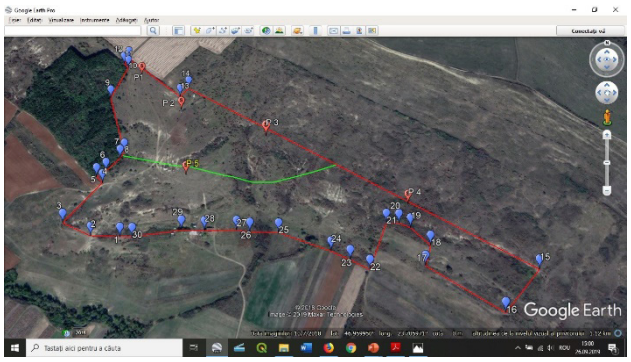

Figure 3. Upload GIS data to Google Earth

century, the vegetation and the soils are facing with serious ecological imbalances (Constandache, 2010).

In order to prevent these imbalances from being irreversible, on many grounds ecological reconstruction through forests has been used. For the accomplishment of afforestation it is necessary to know the environmental factors of the planting area.

Ecological reconstruction is essential for the rehabilitation of degraded areas and for the protection of biodiversity, ecosystem services and human welfare. The use of functional features for planning improvement strategies has been suggested, as they represent the main ecological qualities that underpin ecosystem processes and services (Gianni, 2017).

Material and methods

The land that is the subject of the present study, is located near Dăbâca, a village in Cluj County, with a total area of 25 ha, in the surrounding area of the forest fund administered by the Gherla Forest District, Management Unit IV Panticeu, compartement 136, with the destination of the land being grassland (Fig. 1).

For establishing the afforestation solutions, the type of site and type of forest, respectively the production class were determined. To do this, bibliographic studies and field trips were made, in order to make observations on the natural environment (relief, hydrography and hydrology, pedological and climatic conditions).

Also, to determine the afforestation composition, soil samples were taken from four profiles, which were sent and analyzed in the laboratory.

Equipment used for field observations and determinations includes Trimble Yuma 2 field computer, digital pH meter, Google Earth and Qgis applications were used for data analysis.

The surface studied is situated in the Transylvanian Plain, according to "Geography of Romania" volume I, the area is characterized by

Table 1. Monthly thermal regime

Temperature	Month											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Medium temperature (°C)	-3.2	-0.6	4.8	9.8	14.8	17.5	19	18.7	15	9.6	3.6	-0.9
Minimum temperature (°C)	-6.8	-4.6	-0.3	4.2	8.8	11.7	13	12.5	9	4	-0.1	-3.9
Maximum temperature (°C)	0.5	3.4	10	15.5	20.8	23.3	25	24.9	21.1	15.2	7.3	2.2

Table 2. The average temperature per season

Average temp. on seasons and vegetation period (°)	Winter	Spring	Summer	Autumn	Vegetation period
	-3,2	+9,1	+17,1	+13,9	+14,9

Table 3. Average monthly precipitation

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Precipitation (mm)	34	30	28	47	75	87	80	68	39	37	37	41

Table 4. Seasonal average rainfall

Average rainfall during seasons and vegetation period (mm)	Winter	Spring	Summer	Autumn	Vegetation period
	111	163	239	143	417

fragmentation of land, narrow and wide valleys as it approaches the spillway, slopes with variable inclinations, but usually short, with frequent landslides, having altitudes between 200 and 400 meters.

The lithological substrate is made up of deluvial deposits composed of marls, clays, sandy loams with rich content of skeleton, of tuffs and dacites.

From a hydrographic point of view, the territory in which the land is found, is located in the basin of the Lona stream, the main tributary of the Someşul Mic river on its left side.

The hydrographic network is represented by the following valleys: Ungurului, Cacova, Calăcii, Sotelic, Recea, Elciu, Cubleş, Cristur, Cărbunişteа and Toaderii. The water supply of this hydrographic network is mixed, both pluvial and nival.

From a climatic point of view, the land is found in the climatic province Df, continental climate of hills, forest climate of the substrate 2.I. According to the Köppen-Geiger classification it belongs to the province D.f.k, characterized by a hill topoclimate with a moderate continental climate, the average annual temperature being 9°C.

The average annual amplitude is 22.2°C, the warmest month being July with an average of 19°C, and the coldest is January with an average of -3.2°C. The average annual temperature is 8.2°C.

After the Koppen classification, the territory is in the type of climate Dfk and Df.b.k., where:

- D - rainy, boreal climate, with cold winters, the temperature of the coldest month is below 3°C, and in the hottest month it is higher than 10°C;
- f - sufficient rainfall throughout the year - permanently humid area;
- B - the temperature in the hottest month is less than 22°C and in at least 4 months it is over 10°C;
- K - cold winter, the average annual temperature is below 8°C, the warmest temperature, less than 22°C and higher than 18°C.

The average monthly precipitation is very varied, it records a maximum in May, June, July and a minimum in January and February (Tab. 3). The driest season is winter, when 16% of annual precipitation falls, and the rainiest is summer, with 30% of precipitation (Tab. 4).

During the vegetation period, the amount of precipitation reaches more than half of the annual total (66%). The total of mean precipitations is 603 mm.

The potential annual evapotranspiration varies between relatively close limits: 604-629 mm. The excess water in the soil is until the beginning of the vegetation season – April and the

Table 5. Synthetic indicators of humidity and aridity

Synthetic indicators	Annual	Spring	Summer	Autumn	Vegetation period
Humidity index R=P/T	73.5	72	56	41	56
Aridity index I=P/(T+10)	33.13	34	35	24	33

soil water deficit is relatively small and occurs at the end of the vegetation period - September.

The annual average of the De Martonne aridity index is 33.13 which confirms that these values indicate a surplus of water from rainfall compared to the potential evapotranspiration.

Results

The determination of the soil type was made initially on the field (Fig. 4) and subsequently, based on the laboratory results, two soil types were identified: Typical pelosol, having the succession of the Aoka–A/Cka–Cka horizons and the Marly phaeozem with the Aope–Btpe–Bt/Cca–Cca. These soil types have a high clay content, clay-dusty texture, and humus content is moderate (Tab. 6).

For pedo-stationary classification correlating the results obtained from the observations made on the environmental conditions, the main site characteristics were established:

a. Shape of relief: Corrugated slope;
b. Altitude: 325-400 m;
c. Exposition: Southwest;
d. Inclination: 20 g;
e. Functional category: grassland.

Figure 4. Soil profile

According to the above characteristics, the land taken in the study can fit into the type of site, according to the Romanian forest classification:

6.1.5.1 - Hilly of oaks (Turkey oak and Hungarian oak) Bi, brown, small edaphic (Tarziu, 1997) and the type of forest 7.1.1.3 - Hilly Turkey oak stand of inferior productivity (i).

The species corresponding to the site is Turkey oak, mixed with various typical species of hill mixed hardwood forest: flowering ash, field maple and pear-tree.

After identifying the types of site and forest, the ecological group was established on the basis of which the afforestation formula is established, according to the technical norms in use.

Thus in the studied area it was identified the Ecological Group 59, which established the afforestation formula 6 Ce (Go, Gî) 4 Ul.t, Mj, Ju, Pă, and the future forest is estimated to realize the fourth class of production.

The number of seedlings to be planted in the studied area is 75000 for Turkey oak (Sessile oak, Hungarian oak) and 50000 for Siberian elm, flowering ash, field maple and pear-tree.

Conclusion

The land that is the subject of the present study, is located the Dăbâca village, Cluj County, in a continental climate of hills.

The afforestation solution was established following bibliographic studies on the elements of the general natural environment in the area, associated with the microclimate and soil studies carried out in the planting area. They were also correlated with the technical norms in use regarding the establishment of plantations.

The main site characteristics obtained are: shape of relief corrugated slope, altitude between 325-400 m, exposition Southwest, inclination 20 g, functional category grassland. The main climatic characteristics identified are average annual temperature 8.2^{o}C and the annual average precipitation is 603 mm.

The soil types identified are Ttypical pelosol, having the succession of the Aoka–A/Cka– Cka

Table 6. Results of chemical and physical soil analyzes

Crt no	Location	Horizon	Level	Humidity	pH	Humus	Total nitrogen	Carbonates	The sum of the cation exchange bases	Hydrogen exchange	Total exchange capacity	Degree of saturation in bases	Mobile Ca	Mobile K	Granulometric analysis			TDS
						H	N	CO3Ca	SB	SH	T	V8.3			Sand	Dust	Clay	
			(cm)	%		%	%	%	me %	me %	me %	%	mg/kg	mg/kg	%	%	%	mg/L
1	P 1	Am1	0-34	4.8007	6.363	3.762	0.193	-	28.500	5.550	34.050	83.700	2906.12	117.69	1.561	41.359	57.080	-
2		Am2	34-60	5.6091	6.488	2.602	0.133	-	33.100	5.700	38.800	85.309	3289.72	96.86	-	-	-	-
3		A/C1	60-90	5.8673	6.720	2.105	0.108	-	37.900	6.150	44.050	86.039	3350.70	105.21	2.235	35.324	62.441	-
4		A/C2	>90	5.7905	6.933	1.574	0.081	-	33.300	5.775	39.075	85.221	3359.91	100.51	2.354	36.018	61.628	-
5	P 3	Am1	0-20	5.0473	7.733	2.817	0.144	0.624	-	-	-	-	3747.04	140.55	1.258	46.316	52.427	49.60
6		Am2	20-60	5.0718	7.805	2.535	0.130	0.333	-	-	-	-	3551.43	125.25	-	-	-	40.40
7		A/C1	60-70	5.3698	7.907	1.442	0.074	0.187	-	-	-	-	3667.92	107.58	1.376	42.283	56.341	37.60
8		A/C2	75-95	5.3816	8.024	1.591	0.082	0.208	-	-	-	-	3670.44	111.28	1.152	42.809	56.039	36.60
9	P 4	Ao	0-18	4.8729	7.898	3.066	0.157	12.686	-	-	-	-	3707.26	135.50	6.064	45.114	48.822	68.40
10		A/C1	19-40	3.8927	8.146	1.226	0.063	21.317	-	-	-	-	2545.37	64.88	4.749	49.557	45.695	51.70
11		A/C2	41-65	3.257	8.218	0.514	0.026	19.965	-	-	-	-	1731.62	59.78	3.352	56.658	39.990	50.40
12	P 5	Ao	0-24	4.8593	7.927	2.999	0.154	7.383	-	-	-	-	3924.88	151.31	3.339	45.636	51.025	65.60
13		A/C1	24-45	4.4776	8.146	1.392	0.071	17.678	-	-	-	-	3361.04	83.78	2.387	50.061	47.552	59.90
14		A/C2	45-75	4.2535	8.216	0.530	0.027	18.510	-	-	-	-	2504.17	64.84	2.588	52.174	45.238	52.40

horizons and the Marly phaeozem with the Aope–Btpe–Bt/Cca-Cca.

Combining the physico-climatic data with the soil types identified, the studied area was framed in the hilly region of oaks (Sessile oak, Turkey oak and Hungarian oak and mixtures between them) and hill mixed hardwood forest (FD2), the type of site being 6.1.5.1 - Hilly of oaks (Turkey oak and Hungarian oak) Bi, brown, small edaphic and the type of forest 7.1.1.3 - Hilly Turkey oak stand of inferior productivity (i). The species corresponding to the site is Turkey oak, mixed with various typical species of hill mixed hardwood forest: flowering ash, field maple and pear-tree.

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