DATABASE OF AGRICULTURAL LAND QUALITY INDEX IN MĂDÂRJAC VILLAGE, IA□I COUNTY

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ABSTRACT

Land quality index is based not only on soil fertility, which is undoubtedly the most important factor, but also on climatic factors, landscape and hydrology.

The administrative unit considered in this study falls in terms of climate under the temperate zone, with an annual average temperature of 8.3° C and the average annual rainfall of 531 mm. The landscape is typically hilly with the highest altitude of 415 m and the lowest of 171 m. The hydrographic network is relatively dense, characterized by the presence of intermittent watercourses and temporary ponds in depression areas, and the ground water is located at 2-4 m in Sacovățul meadow and at 0.8-1.5m in micro-depressions. The productive capacity of the soil on the mapped agricultural land is affected by gleyzation, stagnogleyzation, surface erosion, landslides and gully-related features, the soils falling under the classes of Luvisols, Protisols, Antrisols, Hydrisols and Cernisols.

This paper deals on one hand with the connection between genetic types and landforms and distribution of soils, and on the other hand attempts to delineate the main evaluation indicators as a database regarding the establishment of their responsibility in the assessment of the evaluation coefficients depending on the intensity level of the limiting pedo-geomorphological factors in question.

Keywords: *agricultural land evaluation, gleying, stagnogleying, luvisols*

1. Introduction

Soil fertility is affected more or less by one or more restrictions caused by natural factors and/or anthropogenic agricultural and industrial activities, which may often act synergically in a negative way. Their harmful influences are reflected in the deterioration of soil characteristics and functions, i.e. their bioproductive ability, with consequences on the quality of agricultural products and food security.

Teaci D. and colab. (1985) defines agricultural land evaluation marks as being the "complex operation of thorough knowledge of growth and fruiting conditions of plants and of determining the favourability degree of these conditions for each use and crop (because a land may be unfavourable for certain uses and crops but favourable for others) through a system of technical coefficients of evaluation notes."

2. Material and method

From an administrative point of view, the Mădârjac commune belongs to Iasi county, being located about 50-60 km South-West of the city of Iasi. From a geographical point of view, Mădârjac is located in the North side of the Central Moldavian Plateau (Fig. 1).

Mădârjac is located in an area of hills and plateaus in the middle of a massive forest of over 15000 ha, the settlement being actually a larger meadow surrounded by forest.

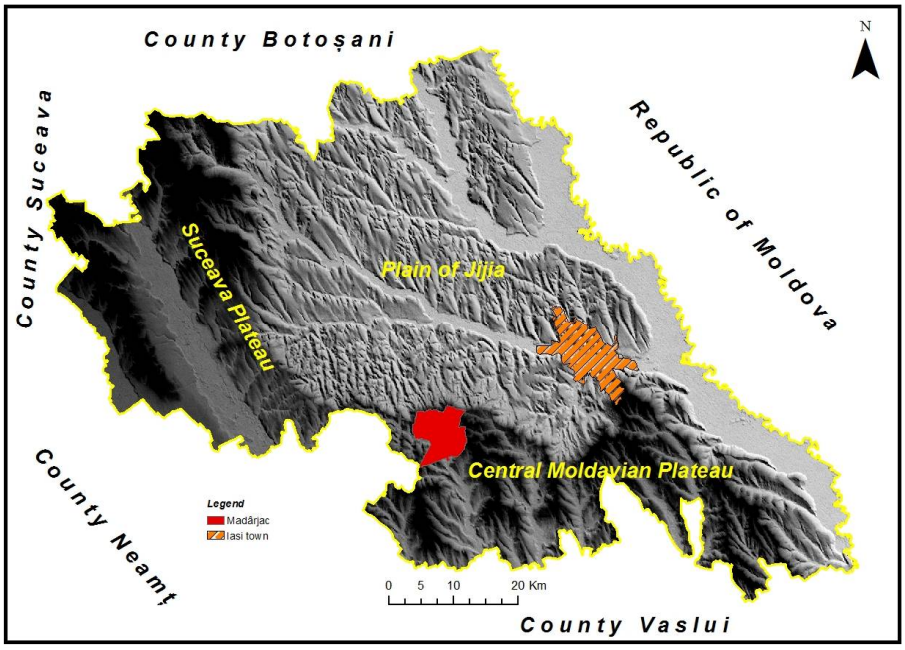

Figure 1 Physical-geographical positioning of Mădârjac commune

The total area of Mădârjac territorial administrative unit (Office of Pedological-Agrochemical Studies Iasi, 2003) is 5263 ha of which 1329 ha is agricultural land and 3934 ha non-agricultural land. Structure of uses: 559 ha arable land, 434 ha pasture, 304 ha grassland, 27 ha vineyards, 5 ha orchards, 3736 ha forests, 18 ha waters, 62 ha roads, 111 ha constructions and 7 ha unproductive land.

The geomorphological features and processes of Mădârjac commune were identified both through traditional research methods (observations and field measurements, geomorphological mapping, statistical and mathematical processing, analysis, synthesis) and modern methods based on GIS software. So, the Digital Terrain Model (DTM) based on the contour vectorisation according to topographic maps scale 1:25,000, 20/20 m pixel size, was the basis for obtaining thematic maps.

The characterization of the soils cover and evaluation ecopedological indicators was performed based both on the soil units map developed by the Office of Pedological-Agrochemical Studies Iasi, scale 1:10,000 in 2003 and by addressing the physical and chemical analyses of the main pedological profiles from the territory in question. After scanning and georeferencing respectively the said map, the digital processing was performed by vectorization of the soil units (SU) and the other uses with the help of the TNTmips v.6.9 program, corrected and supplemented with new data, as well as equivalence of soil types, from the Romanian Soil Classification System of 1980, in to the Romanian Soil Taxonomy System published in 2012.

3. Results and discussions

The pedo-climatic and geomorphological constraint in use of the Mădârjac commune lands requires thorough research of the soil fertility status and identification of the main limiting factors of the agricultural production in order to establish necessary agropedoameliorative measures for the proper implementation of the Code of Good Agricultural Practice.

As within the Mădârjac commune's territory there are no improvement land works, the evaluation of the agricultural land is established based on natural conditions. Of the many environmental conditions, the evaluation of the agricultural lands considers the most important factors, namely: climate, relief, hydrology and soil.

a) Climate

The climate is temperate, but more severe, specific to the forest area with an annual average air temperature of 8.3°C (Fig. 2), which varies between the value of 8.0°C recorded mainly on the northern and eastern interfluvial sculptural peaks of the researched territory, at altitudes of 334-415 m and the value of 9.1°C registered at the lowest altitudes of the researched area, at 171-176 m in the Sacovă□ plain and valleys of the tributaries' lower courses (Robert J. Hijmans et. al., 2005).

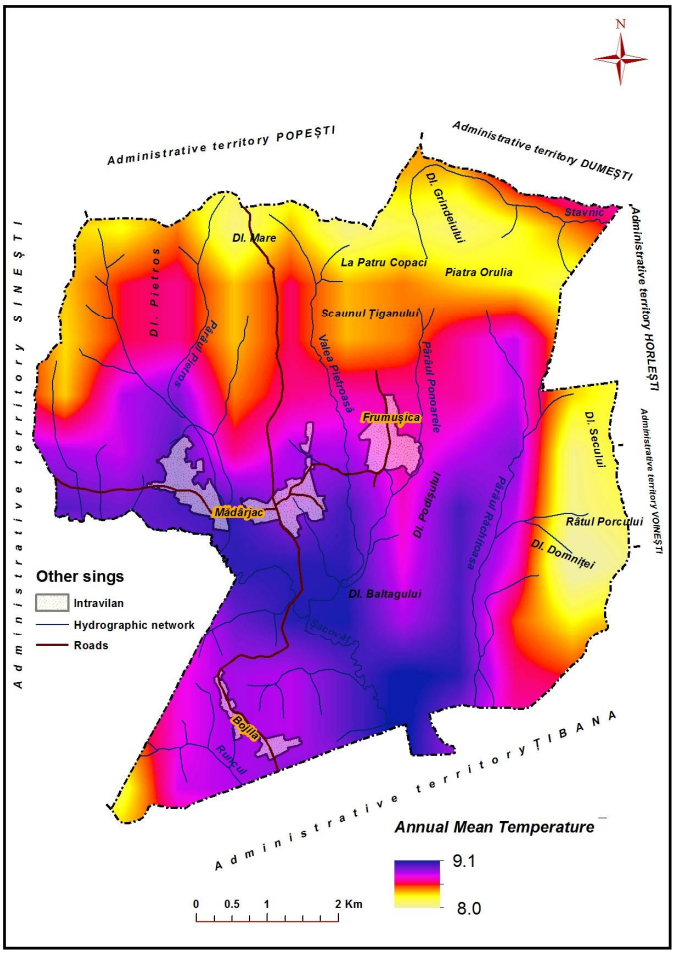

Figure 2 Average annual temperature map

The average annual rainfall is 531 mm, the highest rainfall being recorded in June (Fig. 3). The rainfall distribution is uneven with periods when crops suffer from drought and periods of excess moisture. The average annual rainfall spatial distribution follows closely the relief configuration with maximum intensity in the north-eastern part of the territory (597 mm), with a slight decrease in intensity (548 mm) on Sacovăț plain and its tributaries' lower courses (Robert J. Hijmans et . al., 2005).

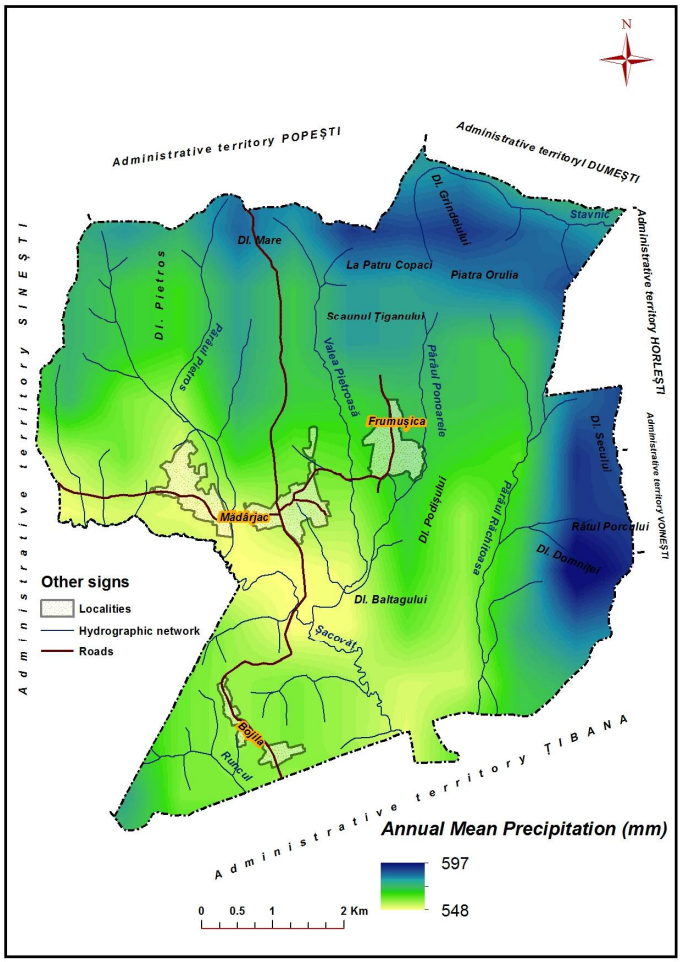

Figure 3 Average annual rainfall map

b) Relief

The geomorphological overall appearance is given, mostly, by the evolution of the hydrographic network and slope processes substantially favoured by climatic conditions which, on a soft sedimentary rock complex, have individualized the relief of Mădârjac commune under the form of interfluvial sculptural peak, with a N-S orientation, drawn from small structural plateaus separated by non-sequential valleys, with structural asymmetry of level 2.

Obviously this overall relief physiognomy is closely linked to the presence of the largest cuesta of the Moldavian Plateau with relief energy of 200-300 m, strongly affected by the current geomorphological processes, also called Coasta Ia□ilor (M. David, 1941) and the subsequent evolution of Sacovăț and Stavnic highlighting, this time, the structural asymmetry of level 1.

Associated to the river-denudational relief in a general monoclinal structure, along the main valley of Sacovăț and its tributaries, a relief formed by accumulation was born composed of plains made of alluvial-colluvial deposits, which are relatively thin, often filled with small cones of dejection.

The main genetic types of relief in the researched area are those specific to the Central Moldavian Plateau, namely: structural relief, sculptural relief (fluvial-denudational) in a general monoclinal structure and relief of accumulation (Fig. 4).

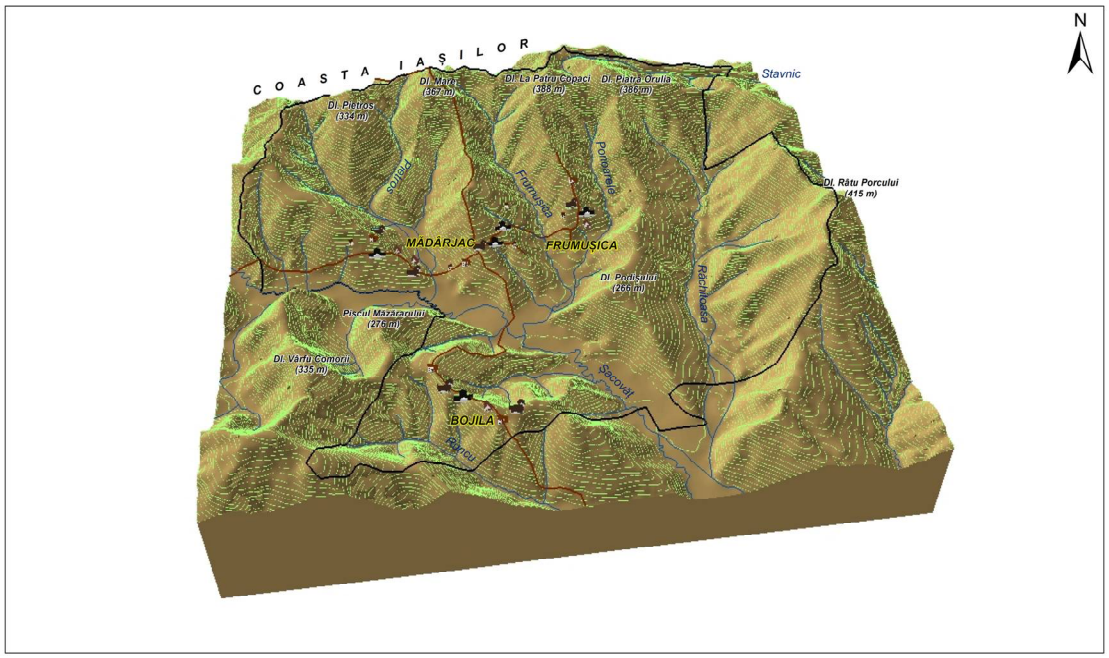

Figure 4 3D representation of Mădârjac commune relief

The structural relief is represented by structural-lithological small plateaus maintained in relief on the interfluvial peak of the northern end of the communal territory as stacks compartmentalized by small saddles of the Basarabian sandstone and limestone plate at altitudes between 334-388 m (The Pietros Hill, the Big Hill, the La Patru Copaci Hill, the Orulia Hill).

The river-denudational sculptural relief in the general monoclinal structure, the largest morphological structure of the entire researched area, is highlighted by two specific forms, namely sculptural interfluvial peaks and deluvial slopes. In the researched area, the presence of an interfluvial peak is highlighted in the northest end of the territory, in the West-East side, protected by the Basarabian sandstone and limestone oolite, from which a series of rounded, lateral undeveloped sculptural interfluvial peaks are separated and wind down to Sacovăț valley. In addition, in the eastern part of the territory, on the border with Horlesti, Voineşti and Tibana communes, the presence of an interfluvial peak in the North-South and then NE-SW is highlighted on whose crest the highest point of the village is located, Râtu Porcului Hill (415 m).

The differentiation of the deluvial slopes is closely related to the way in which the local hydrography highlights the two structural asymmetries specific to the cuesta landscape of the Central Moldavian Plateau. From this point of view, the level 1 structural asymmetry is evidenced by the subsequent slightly diagonal (sideways) character of the Sacovăț valley, in which the right slope plays the role of cuesta front with a NE general direction, fragmented by

subsequent dells, degraded by current geomorphological processes, and the left side is a large reverse cuesta fragmented by a network of sequential/non-sequential valleys.

The second level structural asymmetry is prominent on the left side of Sacovăț with a role of reverse cuesta emphasized by the typical subsequent evolution and slightly diagonal subsequent evolution (sideways) of the valley. So, the non-sequential valleys on the N-S direction (Pietros, Ponoarele, Frumu□ica, Răchitoasa) according to the general inclination of the geological layers, show a generally simetrical cross section, in which the left side plays the role of cuesta front with a West general exposure, and the right side as a reverse cuesta with an East general exposure.

We can conclude that this dual structural asymmetry present in the subsequent and sequential/non-sequential valleys of the researched area, is due to both the general inclination in the NS direction of the geological layers, of 6-7 m/km, responsible for the first level of structural asymmetry and the secondary inclination of the geological layers on the W-E direction, of 3m/km, responsible for second level structural asymmetry; from the vector combination of the two directions results a general inclination on the N-NW / S-SE direction, which gives the monoclinal character of the Moldavian Plateau (Ionita I., 2000).

For all uses and most favourable crops the flat or relatively flat lands are better.

Within Mădârjac village the land is highly uneven with variable slopes. Lands with a slope greater than 15%, occupy 29.13% spread mostly on the versants with exposure on the west side, which play the role of cuesta fronts specific to the level II asymmetry of Pietros, Pietroasa, Ponoarele and Răchitoasa valleys.

On the reserve cuesta, and also on the sculptural interfluvial peaks and on softer steps of the cuesta front, with a general E and SE inclination (straight versants of the said valleys), the slopes are softer with values of 5-15%, representing 39.74% of the Mădârjac commune.

Figure 5 shows that, from the pedological mapped area of 1369 ha, plus the urban area (196 ha), an area of 331.04 ha (21.14%) has slopes of less than 5%, distributed dominantly on the Sacovăț plain and its tributaries, as well as on some small interfluvial peaks of the plateau. The lower sector of interfluves on the left side versant of Sacovăț has mainly slopes of 5-15% representing 651.64 ha (41.62%). The most pronounced slopes of 15-25% and over 25% are located on the right versant of Sacovăț with the role of cuesta front highly degraded by the current geomorphological processes, covering 582.94 ha (37.24%).

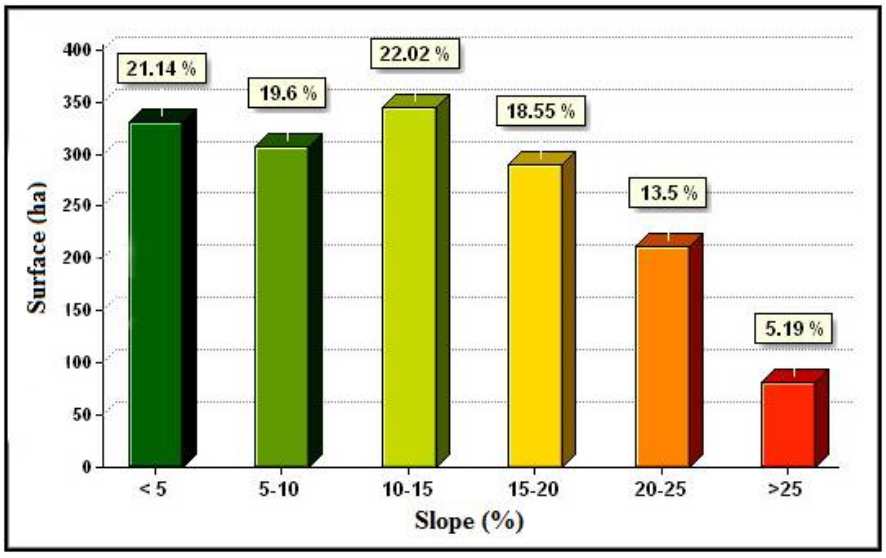

Figure 5 Share of land slope categories

The Basarabian lithological structure specific to the Central Moldavian Plateau, the relief consisting of a series of hills and elevations separated by deep valleys and a cooler climate and richer in rainfall, and the human activity are a part of the natural and anthropogenic factors that determined an area of 613 ha, namely 45% of the pedological mapped area to be affected by landslides and ravines (Fig. 6). Of this area, stabilized landslides occupy 374 ha (27%), semi-active and active landslides 149 ha (11%) and the ravines occupy 90 ha (7%).

Active landslides are common mainly in the south part of the administrative territory of Mădârjac, on lands with slopes greater than 15% on the right versant of Sacovăț with the role of cuesta front, with general NE exposure (Fig. 7).

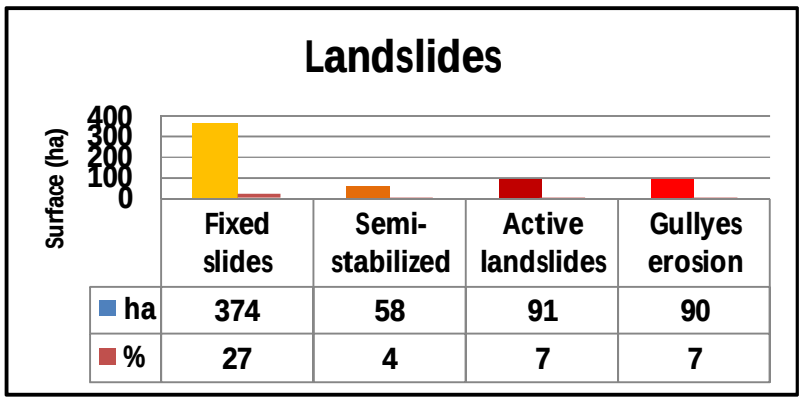

Figure 6 Share of landslides and ravenes

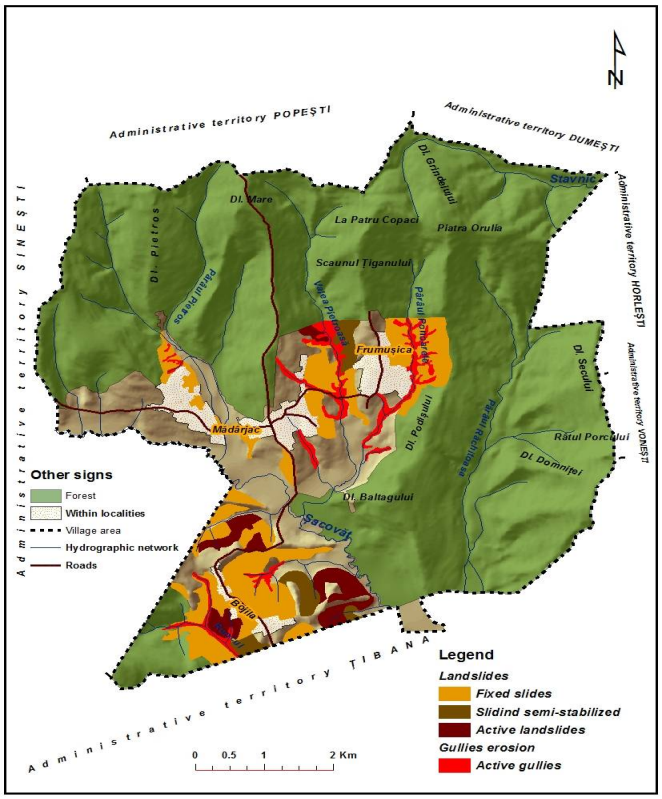

Figure 7 Territorial distribution of landslides and ravenes

a) Hydrology

In terms of hydrology, the Mădârjac territory belongs 93% to the Sacovat drainage basin, namely 4895 ha and only 7%, from the N-NE side of the territory belongs to the Stavnic drainage basin, representing 368 ha.

The main rivers that drain the area are the upper course of Sacovă□, the origin of Stavnic and the intermittent Sacovăț tributaries namely, Pârâul Pietros, Pietroasa, Ponoarele and Răchitoasa on the north side of Sacovăț creek. South of Sacovăț, the territory is drained by the Runcu creek.

A feature of the hydrographic system is the intermittence of watercourses and presence of temporary ponds installed in the lowland areas of the main water beds.

Plant growth and development can be influenced by the presence of groundwater at certain depths. Groundwater can have positive effects when it constitutes an additional source of soil water supply, or negative influences when they are confined in the superficial layers of the soil, causing excess moisture on the surface.

In the highlands, on the upper part of the versants, the ground water is found at depths exceeding 10 m. In the Sacovăț meadow, the groundwater is found in some areas at depths of 2-4 m, the soils being gleyed at the base determining moderate overall drainage. In the narrow valleys and small lowlands, the groundwater is at 0.8-1.5 m causing imperfect drainage.

b) Soil

The key limiting factors of the soil fertility in the Mădârjac commune are gleying, stagnogleying and surface erosion.

In the Sacovăț plain and its tributaries, the main pedogenetic factor in the formation of alluvisols is the groundwater which is located at a critical depth, and given a weak deepened minor bed and a not very permeable lithologic substrate, determined that in the highest and drained areas of the plain, an area of 238 ha (17%) of the mapped area has poor gleying. The lower areas of the plain, shallow ground water caused strong gleying on 93 ha (7%) and in the small lowlands with deep ground water less than 1 m, 43 ha (3%) have excessive gleying (Fig. 8).

In addition, the water excess in the soil coming from rainfalls, due to a hard permeable horizon, determined that 43% (584 ha) of the pedological mapped surface to present a poor stagnogleying and 22% (302 ha) a moderately strong stagnogleying (Fig.9).

A specific feature of the researched area is the surface erosion affecting approx. 70% of the pedogenetic fund. Poor erosion is recorded on 210 ha, moderate erosion on 458 ha and strong and excessive erosion can be found on 304 ha of the area. In this context the more or less typical regional soils can be found only on some cvasiorizontal surfaces such as interfluvial plateaus and on less inclined slopes.

On the slopes with moderate and steep declivities, the soils are under various stages of erosion until the genetic type cannot be recognised or even with rock fragments. Regarding this aspect geomorphological characteristic to the slopes the Central Moldavian Plateau, 63% of the pedological mapped area is occupied by preluvisols and luvisols and 9% of anthrosols, most of them eroded-preluvice subtypes. The plains and narrow valleys are occupied by alluvisols and gleys which represent 24% and 3% of the mapped area. The faeozioms occupy a small area of 7 ha, which represents less than 1% of the 1369 ha pedologic mapped area.

Alluvisols occupy an area of 331 ha and have a glomerular, grained or polyhedral structure, low to moderately developed. The used water capacity, permeability, aeration porosity etc. vary in wide limits depending on the texture and structure. They have a humus content of 2-3%, are alkali saturated and have weak alkaline or neutral reaction.

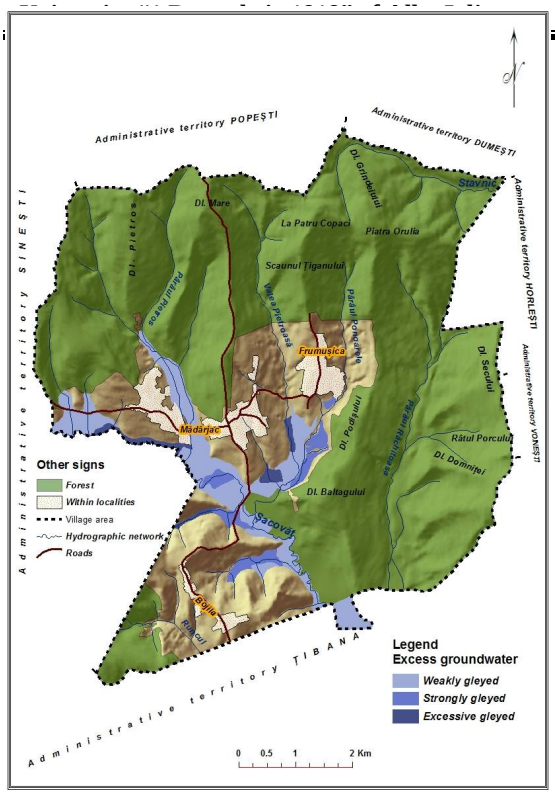

Figure 8 Map of gleying soils

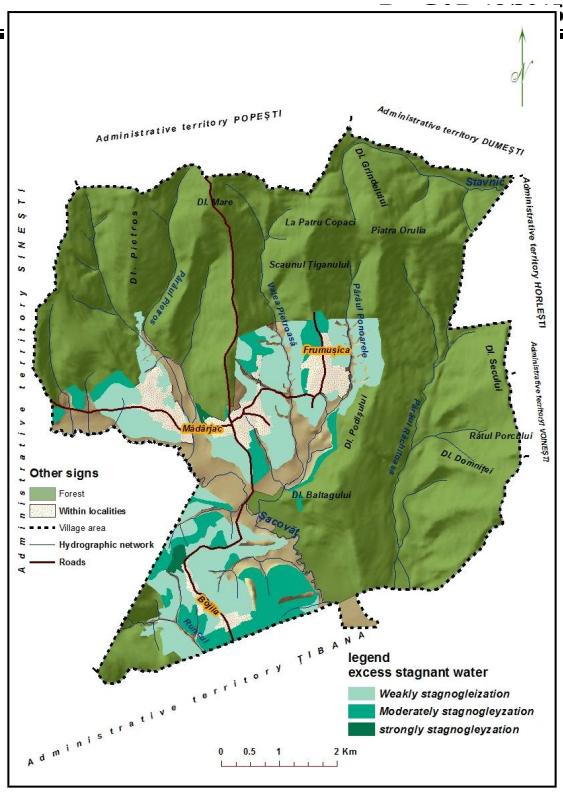

Figure 9 Map of soil stagnogleying

Marnic ***faeozioms*** (Romanian Soil Taxonomy System 2012) or Pseudorendzinas (Romanian Soil Classification System 1980) are spread over a small area of only 7 ha, featuring clay or loamy textures, a low permeability for water and air and are hard to work on. They are well supplied with humus (4-8%) and nutrients, and the degree of alkali saturation exceeds 80%.

Stagnogleying ***preluvosoils and luvisoils*** mainly occupy the largest area of 869 ha being compact, heavy and cold soils, with a loamy texture, poorly supplied with humus (1.2-2%) and nutrients, with moderately or weakly acidic reaction (pH 5.5-7), with values of the alkali saturation degree between 60 and 80%, with poor aerohidric regime. In rainy periods excess moisture is recorded, and in the dry periods, water is shortly lost through evapotranspiration.

Gleyosols (Romanian Soil Taxonomy System 2012) or marshy grounds (Romanian Soil Classification System 1980) occupy 43 ha. Air and water permeability is low because of the fine texture and polyhedral structure. Gleysols are well supplied with humus (4-8%) and have a neutral reaction (pH = 6.8-7.2) or slightly alkaline (pH = 7.2-8.3) if calcium carbonate is present. The adsorbtive complex is predominantly saturated with alkaline cations and their contents increases with the increase of humus and clay content. The high potential fertility of marshy grounds cannot be valued due to defective aerohidric regime and therefore they are used only for meadows.

Erode ***anthrosols*** which are mostly preluvic (Romanian Soil Taxonomy System 2012) or Erodisols (Romanian Soil Classification System 1980) occupy 119 ha with different textures according to the texture of the parental material which has reached the surface. They are underdeveloped, with a small or inexistent content of humus, poorly supplied with nutrients, without alkalines and acidic, with extremely low microbiological activity.

4. Conclusions

The climate is temperate, but more severe, specific to the forest area, with an average annual temperature of 8.3°C and annual average precipitation of 531 mm, distributed unevenly.

The local terrain is hilly, the typical maximum altitude recorded is 415 m and the minimum is 171 m. The largest area of the commune, namely 76%, has altitudes between 200-350 m. Slopes of less than 5% are recorded on 21% of the 1369 ha mapped area, slopes between 5-15% on 42% and slopes ranging from 15-25% and larger than 25% on 37% of the pedologic mapped area.

The landslides and ravines were recorded over an area of 613 hectares, i.e. 45% of the mapped area, thus the stabilized landslides occupy 374 ha (27%), active and semi-active landslides 149 ha (11%), while the ravines occupy 90 ha (7%).

The hydrographic network is relatively dense, over 90% of the area of the commune belonging to the Sacovă□ drainage basin. A feature of the hydrographic system is the intermittence of watercourses and presence of temporary ponds installed in the lowland areas of the main water beds. The groundwater is located at depths greater than 10 m in high areas, 2-4 m in Sacovă□ meadow and 0.8-1.5 m in lowlands.

The identified soils belong to the following categories: Protisols, Cernisols, Luvisols, Hydrosols and Anthrosols. Preluvosols and luvisols occupy 63% of the pedologic mapped area, the alluviosols 24% anthrosols 9%, gleysols 3% and 1% faezioms.

The pedo-climatic and geomorphologic conditions resulted in the manifestation of poor gleying on 17% (238 ha), strong gleying on 7% (93 ha), excessive gleying on 3% (43 ha), poor stagnogleying on 43% (584 ha) and moderate-strong stagnogleying on 22% (302 ha), of the pedologic mapped surface.

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