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MAKING A DIGIDAL DATABASE REGARDING LAND ANTIEROSION ORGANIZATION WORKS AND ITS DISSEMINATION THROUGH THE CARRY MAP EXTENSION

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Abstract

The purpose of this study is to make an inventory of works regarding antierosion organization and land improvements that have been designed in the body known as Feleac Farm, in Cluj-Napoca, Romania. After consulting execution projects, estimates for various categories of works and documents from the archive of S.C.H. Cluj-Napoca, an inventory was made of works fighting surface soil erosion (canals that intercept runoff, outlets, chutes, collector and absorbent drain pipes in view of collecting groundwater, leveling) and works fighting deep soil erosion. The existing cartographic material was first scanned in order to be used in the GIS platform, then georeferenced. The digital database was created starting from vector database structures, based on the graphic primitive's dot, line, polygon, and from tabular database structures, attribute. In order to visualize and access data for information and field orientation for the evaluation of the current state of works, data has been disseminated through the Carry Map ArcGIS extension.

Key words: *databases, dissemination, fighting erosion, GIS, works.*

INTRODUCTION

In order to establish the proper measures and works needed to eliminate the excess moisture from the slopes, several factors have to be considered such as: factors which enhance the excess water, soil permeability, the terrain configuration, territorial organization, anti-erosion works (Dirja & Budiu, 2006).

The area in the country covered with works necessary for preventing soil erosion is around 2.226.469 ha, the main constructions being coastal, marginal and leading drainage channels, organizing valleys and ravines, anti-erosion roads, dams and thresholds, chutes, culverts, anti-erosion forestry plantations, support walls and shore consolidation works, outlets, collector and absorbent drain pipes. Land improvement works, such as drainage works, from A.N.I.F. administration, foretell a surface of 3.085.895 ha spread throughout Romania, the main constructions being represented by evacuation channels, main and collector channels respectively secondary and tertiary channels, evacuation pumping stations, bridges and culverts, weirs and chutes. The underground drainage network consists of 40.660 km of collector drains and absorbent drains. When slopping lands are concerned, the issue regarding eliminating the excess moisture and the soil erosion must be taken into consideration, as well as landslides control and prevention works if it is needed.

According to Dirja (2000), improving the surface water runoff regime and improving the soils natural drainage must be ensured by landscaping works regarding slopping lands with excess moisture.

Horizontal drainage is the most efficient work for lands with a permanent water excess. For lands with lower water permeability, besides leveling works, a network of coastal channels and sloped land waves must be built. These works ensure to intercept water leaks from the slopes, leading them towards the outlets, which lead the collected water into a natural emissary or evacuation collector channel.

For good water runoff regularization from the slopes, within the study area certain works have been designed within the complex consisting of channels, outlets, chutes, leveling works.

The considered study area, marked by the red outline (Figure 1), is located at the southern extremity of the cadastral limit of the city Cluj-

Napoca, Cluj County. This zone contains the spatial extension of the frame known as Feleac Farm, which was under the property of S.C.H. Cluj-Napoca (S.C.H. – Horticultural Research Station Cluj-Napoca).

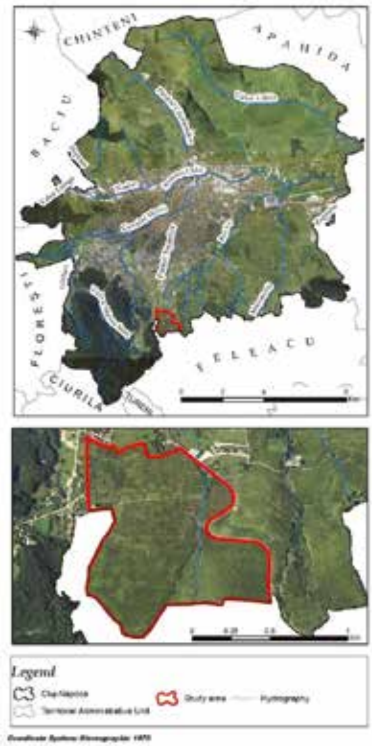

Figure 1. The geographical location of the study area, Cluj-Napoca

MATERIALS AND METHODS

After consulting the existing documents from the S.C.H. Cluj-Napoca archive, an inventory regarding design works, water runoff regularization works, anti-erosion landscaping works, which are grouped into surface anti-erosion landscaping works and depth anti-erosion landscaping works was created. For an improved data access and analysis, the existing plans within the S.C.H Cluj-Napoca archive, which were created from 1966 to 1971, were converted from an analog format to a digital one, thus results a database as well as a digital archive. The first step into creating the digital database is scanning the documents, followed afterwards by georeferencing the cartographic materials for a better territorial identification of the entities which are to be represented. For an improved management over the database and due to the spatial entities, that needed to be represented, a File Geodatabase file was created along with Feature dataset as well as Feature Classes, each specific to the type of vector entities they were to contain. The coordinate system used for representing the database was Stereographic 1970 and the program used to create the database was ArcGIS 10.2. The dissemination was done based on the drawings, as well as on the Carry Map plug-in for ArcGIS. The Carry Map application allows visualizing spatial databases and interrogating them, by using a mobile device with an Android operating system and the Carry Map Observer application installed on it.

RESULTS AND DISCUSSIONS

For the Feleac Farm frame, the soil nature, slope and the pluviometric regime have favored the surface and depth erosion process. After conducting some studies, the soil degradation process was presented as follows:

Table 1. The situation regarding the soil degradation process

Dregradation process	Area ha
Surface erosion	
Second degree	56.33
Third degree	30.91
Forth degree	7.59
Trenches and ravines which have to be levelout	0.52
Active trenches and ravines	1.09
Active landslides	4.13
Stabilized landslides	30.91

The torrential formations are represented by trenches and ravines. Depending on the direction in which the water drains, the shores for these formations are alternately partially consolidated. The transported solid material is represented in big part by sand and bolders, due to the fact that it is disloged from the upper third part of the slope, where the soils have a slight sandy texture.

When the landslides from the within the study frame are concerned, these are of two types as follows. In the lower and upper thirds there are old landslides, geologycal, with a sliding bed at great depth, where the petrographyc sublayer is represented by marl and clay. These kind of landslides are reactivated in isolated points, small areas, where the groundwater appears every day. In the ravines area, due to the depth of their bottom, the soils slide towards the ravines thread because they have no support.

All the works were dimensioned to the evacuation flow rate corresponding to the study and design year,

$Q_{10\%}$ = 0.049 m^3/s/ha, determined with the following formula:

$$Q = 0.167 \times i \times K \times F \quad (1)$$

where:

i - rain intensity having a 10% insurance [mm/min];

K - drainage coefficient;

F - collecting surface [ha].

Upstream, besides roads, there were designed marginal slopped channels. They serve, on one hand to protect the roads and on the other they are a part of the controlled slope water evacuation network, in order to collect pelicular leaks and to direct the water towards outlets and streams. The slope for the marginal channels was calculated taking into account the flow rate and speed, so that the water speed will be between the limits of non-erosion and non-clogging, according to the consolidation type for every channel. According to the dimensioning calculus based on the hydrological studies and the 10% insurance, there were designed the following types of channels: 5 types of slopped marginal channels consolidated with grass furrows, a type of slopped coastal channels, a small pier downstream and a type of marginal slopped channel consolidated with concrete tiles (Figure 2).

In the areas where the channel slope exceeds the maximum allowed non erosion speed some drops were designed in order to reduce the slope and to ensure that the drainage speed is below the non-erosion speed.

The collected and transported water by the channels are directly evacuated in an emissary or will be evacuated through a series of outlets to the nearest emissary. These were located on the thread of the natural water drainage concentration zones on the line with the highest grade. Depending on the flow rate, speed and location the following were designed: 3 types of outlets consolidated with grass furrows, having a shore with a slope of 1: 3; one type of outlet consolidated with grass furrows having a shore slope of 1: 1.5; 1 type of outlet having a shore slope of 1: 1; 1 type of outlet consolidated with concrete tiles having a shore slope of 1: 1.5 (Figure 3).

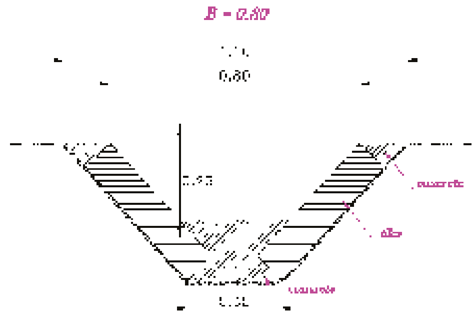

Figure 2. Slopped channel consolidated with concrete tiles, trapezoidal section:
B = 0.80 m, b = 0.30 m, H = 0.25, h = 0.20 m, 1/m = 1/1

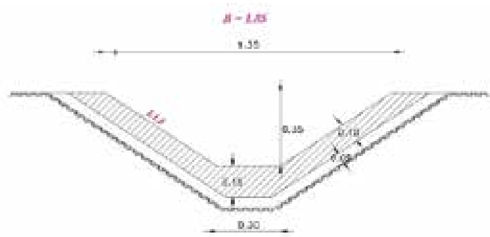

Figure 3. Outlet consolidated with concrete tiles, trapezoidal section:
B = 1.35 m, b = 0.30 m, H = 0.35, 1/m = 1/1.5

In order to capture the water coming from the groundwater, 2 types of drains were designed: collector drains and absorbent drains.

The collector drains are located on the line with the highest grade, in the depression areas, collecting the water transported by the absorbent drains (Figure 4).

The absorbent drains were designed both for water stagnation zones, at the base of the slope break lines, as well as in the inside of the excess groundwater zones.

The absorbent drains are designed to be build out of perforate concrete tubes having a longitudinal slope between 2 and 3 percent. They are located around 50 centimeters below the impervious layer, having on the downstream wall a screen of clay to prevent

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water passing downstream of the drain (Figure 5).

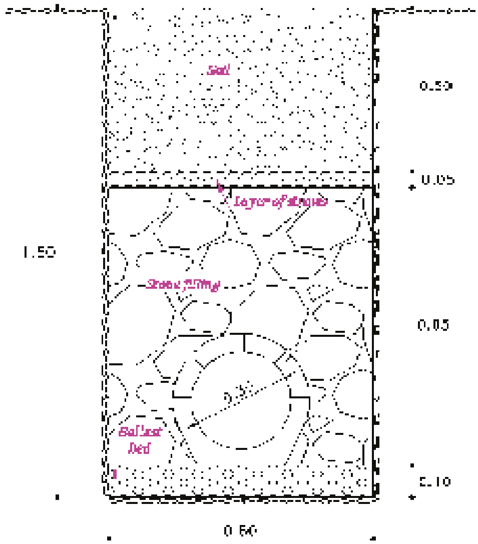

Figure 4. Collector drain

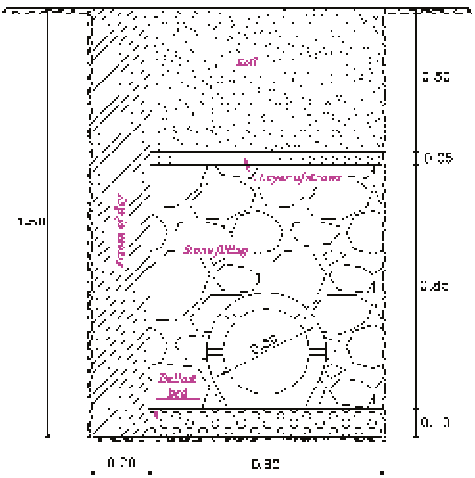

Figure 5. Absorbent drain

In order to equalize the slope, several leveling works have been designed, abolishing water stagnation on the slopes, an essential factor to producing landslides.
Reducing the parcel grade where necessary is done using terraces, which contribute to adjust the slope drainage through a higher infiltration capacity and reducing the water drainage speed.

Combating depth erosion is resolved in the project depending on the nature of trenches and ravines. On the great ravine, concrete steps and a dam made out of a stone wall were designed. The concrete steps are located on the active sectors of the ravine and on the sectors where a reactivation tendency is noted.
Thus, an inventory of all the works, including data regarding their number but also the dimensioning elements, was created.
In order to have a good data management, when the drawings are concerned, the existing analog material from the S.C.H. archive was scanned, resulting a TIFF image with 100025 x 9450 pixels dimensions and a 300 dpi horizontal and vertical resolution. This image was subjected to the georeferencing process to the Stereographic Projection 1970 (Figure 6).
During the georeferencing process several control points, common points, which are easily identifiable both in the field and on the scanned drawing, represented by elements stable in time, such as road intersections, were identified.


Figure 6. Georeferenced situation plan

Elements regarding the land use, parcels, contour lines, limit, roads, lakes, streams,

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culverts, outlets and drains were vectorized and had their principle attributes attached, which include name, type, length and surface.
The symbols used are in conformity with the map legend and for a better visualization and identification of the elements, the Label feature has been activated (Figure 7).

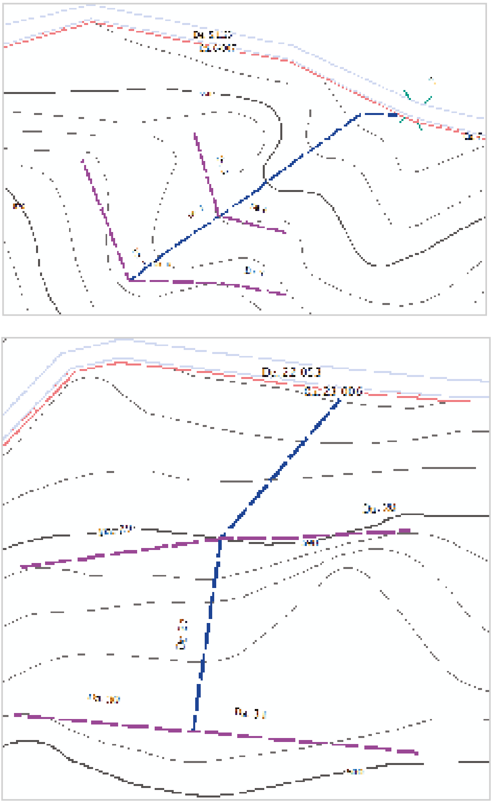

Figure 7. Sections of the designed works plan

The visualization, interpretation and analysis of the databases materialized in drawings; thematic maps are facilitated by integrating them as stand-alone applications.
The applications integrate both the symbolized databases as well as their related attributes.
During the present paper the dissemination was done based on the drawings, but also on the Carry Map plug-in for ArcGIS.
The Carry Map plug-in is available for free for 14 days and it can run multiple operating systems such as: Windows 2000/XP/7/10 - the *Create Desktop Win 32 version* option; Windows Mobile - the *Create Windows Mobile version* option; Android and iOS - the *Create Map file* option (Bilasco et al., 2017).
The file which runs on the Windows operating system (Figure 8) allows visualizing and interrogating databases, the possibility to measure on the map, the printing option, etc.

Figure 8. The Carry Map Interface

Once the cmf file type was accessed on a mobile device (Figure 9) it allows consulting, identifying and analyzing on the field without having to use analog maps, thus facilitating the users work because in most cases the drawings have big dimensions, such as A0 format or custom.
Furthermore, the application's importance consists in the ability to localize the user on the map if the mobile device has a GPS sensor.

Figure 9. Carry Map Observer

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CONCLUSIONS

Creating a digital database in the field of land improvements has a major importance because it facilitates the access to spatial and non-spatial data, converting plans from an analog format to a digital one thus leading to creating a complex database for this field.

The works inventory with related attributes is necessary because it represents the founding stone for the studies being conducted in the area.

Disseminating databases through the Carry Map application allows for an easier field identification of all the represented entities, for the established purposes: evaluating the condition of the works, proposals and recommendations for anti-erosion landscaping and eliminating excess humidity.

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***http://www.anif.ro/patrimoniu/