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GULLY SURVEYING USED FOR IMPACT ASSESEMENT

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Abstract

Soil erosion is one of the greatest problem in agriculture, forestry and town-planning. Due to the continuous population growth towns are in a complex process of expansion, but when town expansion meets extreme deep soil erosion phenomena, this impediment is not only economical but also a social one and that is why gullies must be studied and monitored. This study is based on finding the technical data which defines the gully located in Cluj-Napoca in the La Cariera area and giving the solutions in order to stop the erosion, stabilize the gully and forecast its future behavior. The gully studied in this article is situated in the vicinity of the city of Cluj-Napoca and it is particularly important because in 10 years the city boundaries will overpass it and so these soil erosion phenomena must be integrated in the anthropic landscape.

Key words: *erosion, gully, landscape.*

INTRODUCTION

The deep soil erosion represents an important study domain, for many specialists. Gullies are formations of deep soil erosion which are intense studied because they occcupy great surfaces (Sevastel, 2014a). The studies of such formations involе the analysis of the factors that led to its formation (Sevastel, 2014b): [a] current state of erosion; [b] risk factors; [c] analysis of the natural landscape; [d] time monitoring of the ravine; [e] suggestions to stop evolution in time. The subject of this study is the ravine situated in Cluj County, in the area of the Cluj-Napoca City. Monitoring gullies is a topographical formation study, using GPS technology, classical measurements method and terrestrial laser scanning (Sevastel, 2002). In this study was used the classical method of lifting the three-dimensional detail. Because the gully is near the inhabited area of the city, is expected that in the near future it will be included in the intravillan. The study refers to the possibility of improvement and integration of erosion formations in the XXI century urban landscape.

MATERIALS AND METHODS

The gully is located in Cluj County, in the Cluj Napoca City (Figure 1).

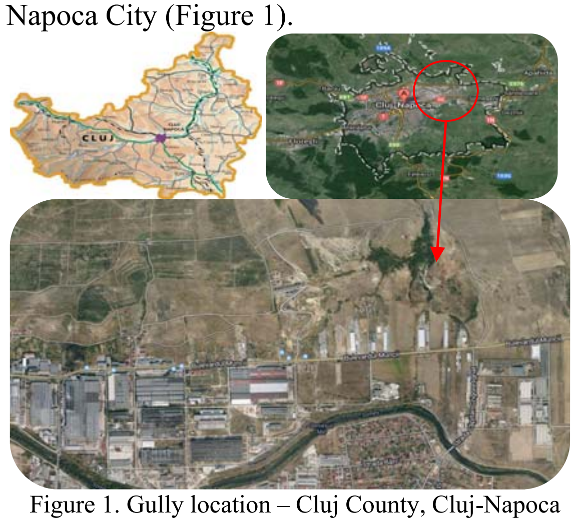

Figure 1. Gully location – Cluj County, Cluj-Napoca City

In Table 1 are presented the aspects regarding the specific climate habitat:

Table 1. Climate parameters

Data reported by the weather station: **151200 (LRCL)** Latitude: **46.78** | Longitude: **23.56** | Altitude: **410**		
Data	**Valor**	**Computed days**
Annual average temperature:	**10.2°C**	365
Annual average maximum temperature:	**17.0°C**	365
Annual average minimum temperature:	**4.9°C**	365
Annual average humidity:	**75.4%**	363
Annual total precipitation:	**596.57 mm**	365
Annual average visibility:	**9 Km**	365
Annual average wind speed:	**8.6 km/h**	365
Total days with rain:		**159**
Total days with snow:		**45**
Total days with thunderstorm:		**35**
Total days with fog:		**60**
Total days with tornado or funnel cloud:		**0**
Total days with hail:		**2**

Source: http://www.tutiempo.net/en/Climate/

In this study we used, as we said classical methods in order to measure the gully's details with the total station Leica TCR 805. In order to study the current urban situation of the city of Cluj Napoca and to perform a series of maps and charts, there were used the General Urban Plan (*PUG*), Detailed Urban Plan (*PUD*), cadastral and ortophotomap of the area. Thus using the measurements made in the field phase of the project we obtained the topographical plan, longitudinal and transverse profiles (ProfLT application) (Figure 2), and model of the formation studied in Surfer 9 program (Figure 3) and AutoCAD extension TopoLT (Figure 4).
For the studied gully were calculated the status and risk factors in order to have a complete characterization and the possibility to highlight in detail the physical, morphological, hydrological properties, as follows:

- A relevant parameter in the gully forming is the hydroclimate coefficient (HTK), defined by Zachar D. (1982) quoted by Sevastel (2012; 2014b), so:

$$HTK = \frac{\sum P}{\sum T} * 10$$

ΣP - annual rainfall amount→ in the studied area is 596.57 mm

Σt – sum of the temperatures exceeding 10°C on a year duration → in the studied area is 3,293.3°C

- status indicators on deep erosion

1. State of the terrain damage = $\frac{s}{S}$*100[%]

Where: s = surface occupied by deep erosion formations [ha]; S = total area of land located in slope [ha]

2. State of fragmentation=$\frac{L`}{S}$ [km/km^2]

Where: L'= gully's total length [km]; S= total area of land located in slope [ha]

- Risk indicators on deep soil erosion – length growth [m/an]

R = 0.15 · A^0.49 · S^0.14 · P^0.74 · E^1.02
R – with drawl rate of gully [feet/year]
A – reception area of the gully's peak [acre]
S – gully's peak upstream hill slope[%]
P – the amount of rainfall in 24 hours greater than 12.7 mm
E – soil factor (clay content of the soil) [%]

- rate of fragmentation and hazard for upstream targets by the gully's peak advancing=$\frac{R_{ar}}{S_{fv}}$ [m/an·ha],

  R_{ar} = advancing rhythm of the gully's peak [m/an]; S_{vf} = reception surface of the peak [ha]
- factors which determine gully evolution

- control factors of the gully evolution

$$E = 6.87 \cdot 10^{-3} \cdot P^{1.34} \cdot S1 \cdot H^{0.52}$$

P – annual volume of rainfall [mm]
S – reception surface [km^2]
H – gully's peak depth [m]

RESULTS AND DISCUSSIONS

Based on the obtained profiles we could calculate the volume of displaced by the soil-erosion formation. With the analytical method which considers the intersection between two transverse profiles and the longitudinal profile an irregular prism was obtained the volume's value of: 119686.128 m^3.
After the data interpretation on the studied estate from the Bulevardul Muncii – La Cariera zone, the terrain presents the most complex erosion formation, situated on a slope which faces southern part and it is partially wooded in the upstream part

The gully shows signs of that the erosion has stopped, as evidenced by installed vegetation on the thalweg and it is advancing only in width by the collapse of its banks in the median zone.
After literature classifications (Dîrja, 2000; Dîrja, 2006), the gully studied shows an average of 1-3 meters per year, is a slope one, in terms of development length, we deal with a short gully situated in 247.07 m a small basin with an area less than 10 ha. The gully shows a state of partial stabilization as evidenced above by installing both thalweg vegetation, mainly in the alluvial cone and on the steep banks of the gully. Loose rocks argillaceous nature present in the area affected by erosion in depth, made possible the development of intense deep ravine, which is very deep with an average depth of 19.5 m. Gully continue upstream with a rill that stretches from the top to the watershed. It was noted that technically the right bank shows a partial cessation the advance of the crumbling because this watershed was reached.

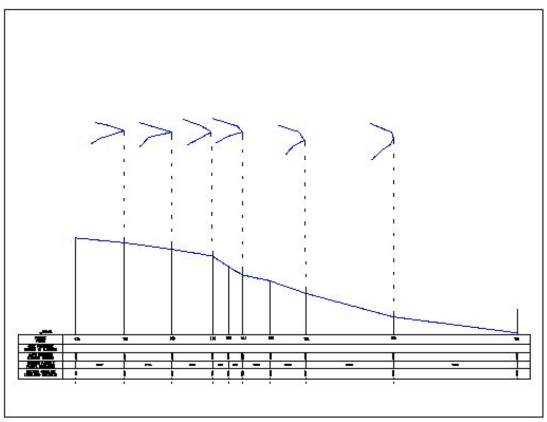

Figure 2. Longitudinal and transverse profiles

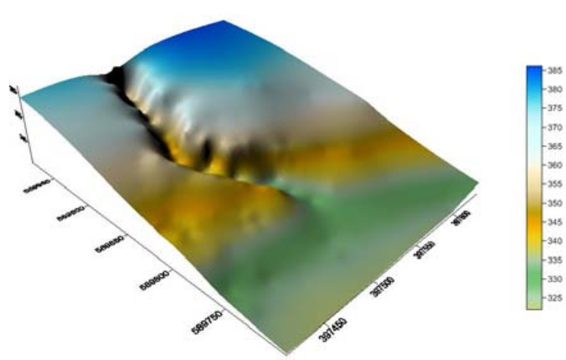

Figure 3. 3D model in the Surfer 9 application

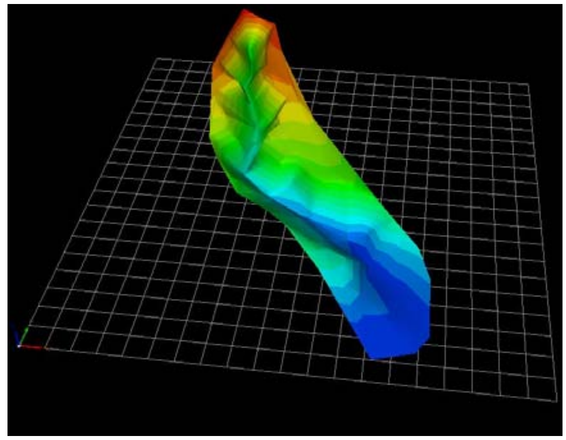

Figure 4. 3D model in the TopoLT extension

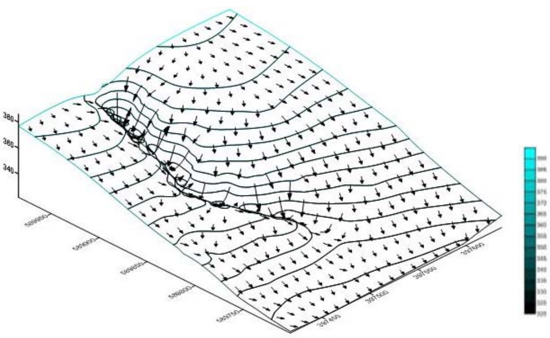

Figure 5. Direction of the water flow

The left technical bank continues developing and could be observed on the bank parallel cracks to the gully attesting to continuous erosion in the area. According thematic map (Figure 5) pointed direction drain water from precipitation on the slopes adjacent ravine on its banks. According to calculations based on the formulas presented above we concludes the following results:

Parameter	Value
Hydrothermally (HTK)	1.81
Status of surface damage	15.53%
Status fragmentation	0.044417[km/km^2]
Increase in length	13.499 [m/an]
Fragmentation rate	10.77 m/an pe ha
Controlling evolution of the gully	422.232 m^3

CONCLUSIONS AND RECOMANDATIONS

Due to massive growth in the constructed surfaces, we find that soon will become part of the intravillan, so it will be integrated into the urban landscape and is finding use as well-defined in terms economic, social, etc. Based on all measurements, of the data, parameters calculated consider that erosion can be stopped by a ravine afforestation both perimeter and improvement. Also the technical value of the location was estimated using the method of assessment evaluation notes for three different cases. Behind determinations carried out it was determined that land value increases from 12.39 $/m to 15.26 $/m in case of urban expansion, values determined after methodology quoted by Dîrja and Palamariu (2008). And if the application of specific measures of land improvements (silvicultural measures) the estimated value of the land may even reach 26.32$/m. Regarding the case study because the exhibition southern conditions of temperature and soil conditions, use a complex formula afforestation using three species: acacia (*Robina pseudacacia*) as the main species, oleaster (*Elaeagnus angustifolia*) as secondary species and Sea buckthorn (*Hippophae rhamnoides*) shrub species used successfully if eroded land amelioration, after the recommendations specified in Dirja (2000). Intimate mixture of species may be one form of pure alternate rows or grouped taking the form of bouquets of sizes between 10-25 m^2 and 50-100 m^2 or bands. Distances between saplings differs depending on the species, so if the main species used 2x1 scheme will apply other distance between rows is 2 meters and the distance between saplings of one meter row (Norme tehnice, 2000). Based on the formula of afforestation and afforestation scheme elected will result in the number of saplings of each species per unit area (hectare):

Robina pseudacacia......3000 saplings/ha
Elaeagnus angustifolia..1500 saplings /ha
Hippophae rhamnoides .500 sapplingsi/ha

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