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GULLY'S MONITORING: MORFOMETRIC AND SEDIMENTS STUDY AT BRAZIL'S SAVANNA

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INTRODUCTION

The intense processes of the society development and the economy in the industrialist and agricultural scope had taken to an antropogenic raised in the environment having provoked a degradation sped up in exactly, factor this lot of due to form of disordered occupation in all the country and it was not different in the region of the Triângulo Mineiro in special in the region of the city of Uberlândia, which also felt the consequences of this occupation without planning. The place chosen for study is situated in a micro-basin, tributary of the Mogi Stream that is direct affluent of the Lagoinha Stream, which is tributary of the Uberabinha River, which is the main reserve of water of the city of Uberlândia MG. The erosive processes that occur inside the Lagoinha Basin were very interesting, in special those of bigger intensity, which is called gullies. The gully in question is situated at cartographic coordinates (UTM) 0788237 and 7903448 and the altitude is approximately 857m and was chosen by if dealing with an evolution unchained for Human kind action (Burnt, Tread of the cattle, etc) and sped up by the intemperic action (rains mainly). The area presents relief with little inclined form (hills), which are intercalated by shallow valleys. Moreover, the ground are sandy, acid and little cohesive, with presence of peat bogs, and exist in the high source one strong hydromorfic influence. It is necessary to mention that, to the long of the stream, a waterfall was formed that catalyzed the force of consuming of the water and facilitating the begin of the erosive process, that resulted in gully. When the relief is analyzed, cannot be forgotten the question of index declivity of one determined area, therefore this index contributes to determines the conditions of the superficial draining, influencing directly in the draining speed. In the area of the basin the declivities vary since low indices 2%, what contributes to determine a draining with speed low, until relatively high indices for the region between 12 and 16%. In the places where the declivity index is higher, associated to the Human kind occupation which causes a waterproofing of the ground, are where if perceives a bigger energy in the superficial draining, that in some intent rain hours can be responsible for

remodelling significant in the forms of the urban landscapes. Therefore, the intention of the study is to understand the main transformations that the relief comes suffering, from the intensification of the flow of antropics actions in the Cerrado (Savanna) and inside of all this context the intention is to guide quickly the degradation reorganization that the environment suffered and still it suffers, being searched indicating to understand the current problems there, in special those on to the degradation in the environment of the Cerrado, offering resources that can serve the recovery least or the of this environment.

Procedures and technical operations

The main questions were: where to install the stations, which methodology to adopt and which technical procedures for monitoring and measurement the gully in this area would be indicated. First, a recognition of the area by means of field work became and after comments, the best point was chosen to install the monitoring station. The place offered a gamma of questions that only from a monitoring for determined period (02/02/2002 to the 29/04/2004), that the evolution of the erosive process would be understood in part. At as a moment, the decided question was to install a measurement station at the place. After bibliographical revision, was opted to making an adaptation of experiments and the creation of proper instruments, that would offer easiness and would allow to reach the desired results. To the long one of the research it was necessary to make some adaptations to the equipment, however it was arrived the waited objective. To become to the measurements one established, three Cross-sections (Upstream; Intermediary; Dowsteam/estuary) a long to the gully's channel, which had been measured in a average of 15 in 15 days (Figure 1). The monitoring technique consists of the measurement of the width advance and depth of gully, by means of the stake in level in the two edges of the micro-basin. The measurements had been made, with a rope subdivided in intervals of 20cm, being thus subdivided to allow the displacement of a retractable ruler of metal (5m height) projected for the researchers (ALVES & ALVES), with a metrical scale of 5m fixed on ruler body (Figure 2).

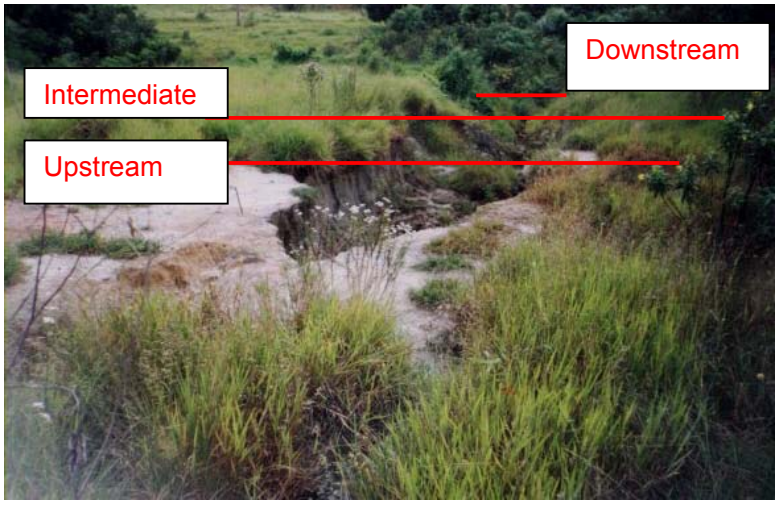

Figure 1 - It approximately illustrates the points of monitoring a long to the Gully-Author: ALVES – April 2003

The collected data had been placed in field note and later the information had been stored in a spread sheet (data base), and to leave of them it can be formed tables, graphs, to make future, average projections among others information. By means of the use of software Auto CAD R14 it was possible, the visualization of the advance of the erosive process, the calculation of the area, the perimeter and the volume and with this to understand the dynamics of the process.

Figure 2 - It shows to the use of the measurement equipment - Author: ALVES – June 2002

Physical Characterization

Geology

Almost all Triângulo Mineiro area is located inside of the Sedimentary Basin of the Paraná, and the local Rocks Formations are composed by formations of Mesozoic´s ages that are the arenitcs of the Bauru Group (Formation Marília and Adamantina), and this rocks represent the phase of deposition in the Paraná Sedimentary Basin in the Superior Cretaceo and still is formed by a basalt formation, which is included into the Serra Geral Formation. Into this basin it is possible to find the arenitcs of the Botucatu Formation.

Geomorfology

The Triângulo Mineiro is located in the Morpho-estructure of the Paraná Sedimentary Basin and in the Morpho-esculpture units of plateaus. The morphologic units, or either, the found standards of similar forms in the region are mainly the standards in hill form, being that they also appear the standards of tabular forms, constituting the main watershed enter the basins of the Rio Grande (to the south) and Paranaíba (the west and to the north), being that the same ones present in its surface, beyond a thick layer of soil which comes of the sandstone, material of the Tertiary one forming the calls Covering Conglomerate-iron Debris deposited on the Basalt coverings and this in turn are on rocks of the Araxá Group, presenting in some points inlayer of Botucatu sandstone in the basalt.

Soils

Soils in accordance with a soil survey made by the Embrapa (Brazilian Company of Farming Research), the city of Uberlândia presents a percentile greater in area of the type Red-dark soil and Red-yellow soil (Oxisoil) both dystrophic in the corresponding areas to the tabular forms ones. The soil of bigger fertility, as for example, the Purple soil appears in the watershed sources and near the rivers of bigger volume of the region. Already Red-yellow the Podzolic soil, are located next to deep to the Araguari River Valley and its tributaries. In the deep ones of relives softest generally it had occurrence of trails being point of extravasation of the freatic sheet occurring the springs of some streams of the region, presenting a great accumulation of organic material, what it gives the dark color to the soil, occurring, therefore, the called hydromorfics ground.

Climate

According to classification of Köpper, the predominant climate in the Triângulo Mineiro is the Cw, half-humid tropical type, with average temperature of 23°C, that it is characterized for presenting, six dry months and with mild temperatures (winter - April to September) and the others six months, hot and rainy (summer - October to March). And in

accordance with LIMA (1995), presents annual pluviometric average between 1300 and 1700mm.

RESULTED

The resultant products of this process are graphs that allow to visualize the advance in depth in such a way how much laterally, as they can be seen in the three figures to follow:

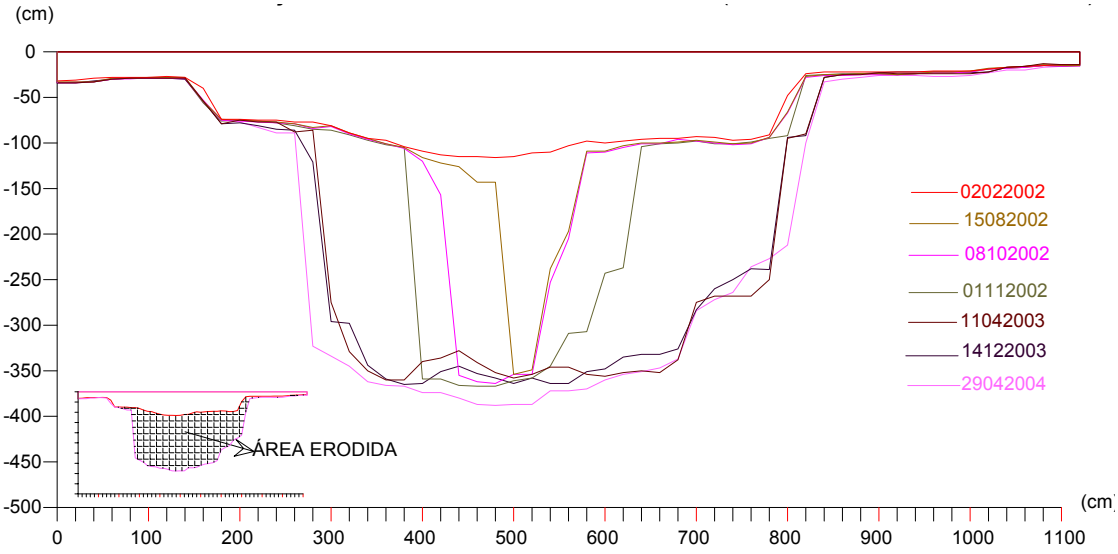

Figure 3 - Section of Sum - Depth x Width - Author: ALVES – January 2005.

The figure 3 presents the point of bigger kinetic energy, therefore in it had a small waterfall being, therefore the sector of bigger erosive activity. This point possess 11,20 meters of length and depths varying to long of the period, being the registers deepest around 3,78 meters. As it can be seen in the figure, the measured referring line the first one (of red color) in the legend, indicates the initial situation of the monitoring, with total duration of 2 years and 2 months. To the end of the period represented for the last measurement (line of pink color), it indicates that the form in the place was completely modified, increasing still more the depth and its lateral advance, which were increased mainly in the rainy period that goes October to March. For one better visualization of the erosive process evolution, it was used a colored representation in the graphs. The colors indicate the dates with more representative modifications. They also illustrate the advance in depth and the lateral modifications of the slope, as well as moments of accumulation of sediments.

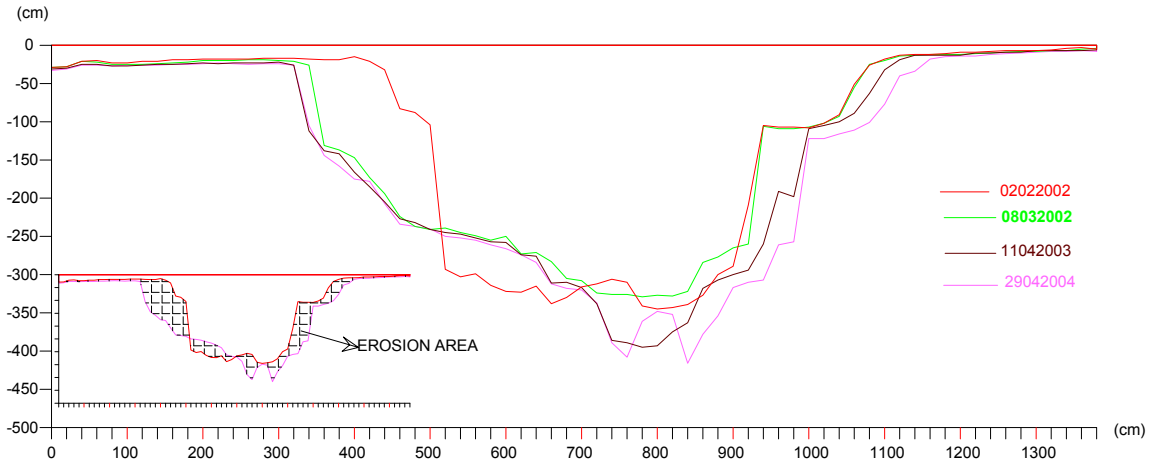

Figure 4 – Cross Section Intermediate - Depth x Width - Author: Alves – January 2005.

The figure 4, shows to the evolution the Intermediate Section process enters the props 13,80 meters of length. The first measurement, represented for the red color, sample that a great lateral jib in the slope of the left edge of the stream had. As it shows the green color, had a great deposition of sediments in the stream bed of the stream. This material deposited inside of the gully had cemented and remains in the last same place the rainy period in the region to the end of the 26 months good part of the material still was practically unchanged in its form, suffering only laminar erosion. To the end of the 26 months of monitoring represented for the line of pink color, a new phase in this section was observed, where it is having the deepening of the stream bed for the retaken one of the lateral erosive process what it will result in the magnifying of gully. In the line of pink color an anomaly is noticed of that the normal one would be represented for the other lines, therefore occurs an apparent accumulation of material in the part deepest, is about a concret block of 0,66m that it rolled and she was imprisoned consequently in the place influencing in the erosive dynamics and in the measurements.

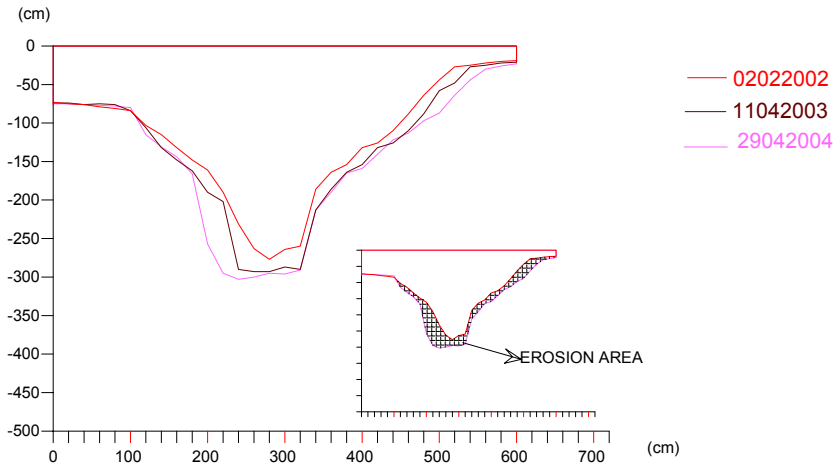

Figure 5 – Cross-section Dowstream - Depth x Width - Author: ALVES – January 2005.

Finally, there is a Donwstream tide Section, represented by the Figure 5. The deepening evolved thus, in the first measurement (red color) the point deepest was of 2,77 meters, in the last measurement (26 months) the point deepest reached the house of the 3,03 m. The brown color indicates 11/april/2003, in the end of the rainy period had evolution in such a way modifying the sidewalls how much deepening the canal. In the Section erosive process with exit of sediments without significant presences of material sedimented to the long one of the profile is only noticed, however at some moments it had fulfilling of the canal. In relation to the two first profiles this was what less it suffered alterations. Already in the pink color the deepening is perceived in such a way as the lateral advance. First a constant during the research as also, no meanwhile with bigger intensity na left edge where da occurred a small discouragement evolving the points following form: point 11 of 1,61m for 2,57m, point 12 of 1,90m in the beginning of the monitoramento for 2,95m in the end and point 13 of 2,31 for 3,03m.

Area, Perimeter and Volume

Another type of visualization can be made by means of the analysis of the area and perimeter of the Cross-section and the volume of gully. The calculations had been made from the placed graphs previously. The summarize results are show in Table 1. The biggest modification in the area was in the Section of Upstream with a variation of 13,42 m^2. The perimeter of bigger variation was of the Intermediate Section, enters the initial period in february of 2002 to April of 2004, the difference was of 13,17m for the perimeter, being that the explanation for reduction was to the fall of the slope inside of the body of gully, between

days 02/february/2002 and 12/february/2002, shown in the previous graphs. In the Downstream Section so significant modifications in the area and nor in the perimeter had not occurred, the modification of the area were of 1,46 m^2 and the perimeter 1,34m. Already the volume varied in the beginning of the measurements, of 245,96 m^3 for 257,59 m^3, in the period of 10 days. Few modifications had occurred in the dry station, with return of the erosive activity from the beginning of the rainy period, when the volume develop of 245,96 m^3 in February 2002 to 329,40 m^3 in April of 2004, had a total variation to the long one of the 26 months of 83,44 m^3.

Table 1 - Evolution of the Area and Perimeter of the Cross-sections and Volume of the Gully in the Period

	UPSTREAM		INTERMEDIATE		DOWNSTREAM		
PERIODS	AREA (m2)	PERIMETER (m)	AREA (m2)	PERIMETER (m)	AREA (m2)	PERIMETER (m)	VOLUME (m3)
2/2/2002	7,17	23,24	16,26	46,48	7,49	14,34	245,96
12/2/2002	7,39	23,31	17,06	31,34	7,52	14,34	257,59
24/2/2002	7,40	23,29	17,28	31,28	7,53	14,30	260,74
8/3/2002	7,45	23,30	17,56	31,39	7,53	14,27	264,77
23/4/2002	8,84	27,17	18,21	31,38	7,62	14,30	275,50
27/7/2002	9,00	27,14	18,10	31,23	7,64	14,36	274,11
27/8/2002	9,01	27,12	18,12	31,17	7,64	14,36	274,41
23/9/2002	10,49	27,20	18,12	31,15	7,65	14,40	275,90
8/10/2002	10,55	27,22	18,10	31,15	7,65	14,40	275,67
1/11/2002	12,87	27,55	18,14	31,15	7,82	14,66	278,73
27/12/2002	15,49	27,58	18,39	31,45	7,87	14,62	284,96
8/1/2003	16,42	27,61	18,60	31,39	8,02	14,82	289,03
30/1/2003	17,73	27,62	19,34	31,47	8,02	14,80	300,86
15/2/2003	17,83	27,65	19,32	31,73	8,14	14,93	300,80
10/3/2003	18,83	27,56	19,40	31,85	8,25	14,85	303,05
27/5/2003	18,91	27,94	19,80	32,08	8,33	15,56	308,90
26/8/2003	18,94	27,95	19,84	32,08	8,32	15,54	309,48
14/9/2003	19,04	27,86	20,01	32,10	8,32	15,51	312,00
9/10/2003	19,02	27,80	20,10	32,02	8,35	15,51	313,29
15/11/2003	18,99	27,74	20,23	31,82	8,43	15,55	315,19
14/12/2003	19,07	27,55	20,40	31,94	8,56	15,68	317,82
19/1/2004	19,39	27,40	20,61	32,78	8,67	15,73	321,24
14/2/2004	19,68	27,41	20,78	32,89	8,69	15,67	323,97
3/3/2004	19,92	27,52	20,94	33,06	8,83	15,66	326,62
18/3/2004	20,22	27,27	20,98	33,03	8,85	15,66	327,51
29/4/2004	20,59	27,58	21,08	33,31	8,95	15,68	329,40

Author: ALVES – January 2005

CONCLUSIONS

This research was done to understand the evolution behavior of the gully by means of the analysis of some accelerating elements of the process as: Human kind actions and the mechanical effect proceeding from the energy of precipitations and draining. By means of the monitoring the elaboration of a data base was possible, which allowed in accordance with it to arrive at some conclusions of the process the physical-ambient characteristics local and regional. The dynamics of the erosive process becomes much more aggressive in the rainy period, therefore the energy of waters attacks all internal surface and increases the depth of gully. No longer period of drought the erosive process is almost inert except for the exceptions of the Human actions in the place as burnt and treat of the cattle, this last one

occurs in function of the urban spot to have reached agricultural areas. In the dry period it is distinguished strong performance of the physical processes, provoking fictions throughout all the walls of gully, which is facilitated in the rainy period with the water performance. This type of dynamics in the open Cerrado (Savanna) region is very common, in function of a period of six months with rains and others six dry months, even so have differences what it perceived in the research is that a period is intimately on to the other. In accordance with the reached results, certainly the next rain cycle will modify the point most dynamic, which will be constantly in a remount process in relation to the 3 points adopted for the research, being that the shown values indicate that the forms of gully evolve in direction the average and the high source in length, widening and depth. Therefore, the gotten results will be of important relevance for the planning of the governmental authorities for the elaboration and execution of workmanships of recovery and resetting of this and other areas inside of the urban or same perimeter in the agricultural way, therefore, for way of these pointers can be foreseen new occupations that will be made in the city in order to organize the city space and at the same time to preserve the environment.

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