ANALYSIS ON THE SUSCEPTIBILITY TO EROSION AND LAND USE CONFLICTS BY GEOTECHNOLOGIES IN THE MICRO-REGION JAURU – MATO GROSSO STATE, BRAZIL

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Abstract

The objective of this study was to evaluate the susceptibility of erosion and land use conflicts in the micro-region Jauru, Mato Grosso State, using geo-technologies. From the area under study, maps on Geomorphology-Pedology, as well as a map on Susceptibility to Soil Erosion were generated. The Soil Erosion Susceptibility map was obtained with the intersection of this map with the land use capacity map. The micro-region presents 12 soil units, among which the Luvisols are the most representative (27.03%). A large portion from the micro-region (74.74%) presents a class with high susceptibility to sheet water erosion. Those areas identified with a high erosion potential represent 52.45% of the total area. It is concluded that in the Jauru micro-region soils with high erosion potential predominate, with a light rolling to flat terrain. There are sections extremely susceptible to erosion with inadequate soil, classified as land use with medium conflict.

Keywords: Land use Capacity. GIS. Environmental conservation.

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Resumo

Análise da suscetibilidade à erosão e de conflitos no uso da terra por meio de geotecnologias na microrregião de Jauru- Mato Grosso, Brasil

O objetivo do trabalho foi avaliar, por meio de geotecnologias, a suscetibilidade à erosão e os conflitos de uso da terra, na microrregião de Jauru, Mato Grosso. Foram gerados os mapas de compartimentação morfopedológica da área; mapa de suscetibilidade à erosão dos solos, que foi obtido por meio da combinação do mapa de erodibilidade com o de fator topográfico e mapa de potencial atual à erosão, gerado a partir da intersecção do mapa de suscetibilidade à erosão com o de uso atual da terra. Para avaliar os conflitos foram analisadas as informações dos mapas de suscetibilidade à erosão e a capacidade de uso da terra. A microrregião apresentou doze unidades pedológicas, sendo que os Luvissolos são os mais representativos (27,03%). Grande parte da microrregião (74,74%) apresentou a classe extremamente suscetível à erosão hídrica laminar. As áreas identificadas com alto potencial à erosão representaram 52,45% da área total da região. Concluiu-se que na microrregião de Jauru predominam solos com alta erodibilidade, em relevo plano à suave ondulado, fazendo com que existam áreas extremamente suscetíveis à erosão, com uso inadequado do solo classificado com médio conflito de uso.

Palavras-chave: Capacidade de uso da terra. Sistema de Informação Geográfica. Conservação Ambiental.

INTRODUCTION

The different territorial divisions of a country seek to group the localities according to its idiosyncrasies. These divisions have different dynamics. The Brazilian Federation is composed by meso- and micro-regions. The geographic micro-regions are groups of contiguous municipalities, defined as parts of meso-regions which present specificities, regarding the space organization (LIMA *et al*., 2002, p. 5).

Mato Grosso State has 5 meso-regions divided in 22 micro-regions and this division varies in accordance with the specificities of space organization and the production structures of the municipalities which compose each micro-region (BRASIL, 2010).

Livestock predominates as the main economic activity in almost 70% of the micro-region, while the percentage of seasonal crops is below the average of Mato Grosso State. The agricultural establishments occupied by crops, woods and forests and those unused areas come up to 32.4%, which is less than half the area of properties occupied by pasture (CUNHA *et al*., 2004, p. 119).

According to the *Instituto Brasileiro de Geografia e Estatística* (Brazilian Institute for Geography and Statistics) in 2012, the Jauru micro-region had a cattle herd of 1,916.374 heads, wherein the municipality of Porto Esperidião appeared with 26% of this amount (497.843 heads). Approximately 41.26% of the territory from this municipality is inserted in the Pantanal biome, evidencing the need to apply conservationist management practices for the pasture, aiming to conserve this biome. Extensive livestock with inadequate soil management, hilly topography, friable soils and concentrated rainfall all together resulted in different erosion processes and among them the accelerated linear or sheet erosion (SALGADO *et al*., 2008, p. 77).

Soils classified with a high degree of erosion potential, such as Ultisols, Inceptisols, Alfisols, Entisols and Oxisols, when exposed to an incorrect management, suffer under the removal of clay from the surface horizons. Under this situation there is no formation of textural gradients, profiles where the B horizon emerges due to the complete removal of horizon A, reducing the plant productivity and contributing to excessive soil losses (OLIVEIRA *et al*., 2008, p. 2421).

The geo-technologies for soil erosion susceptibility studies have been are largely used and GIS is employed for data generation and integration. Hermuche *et al.* (2010, p. 116) and Nunes *et al.* (2013, p. 194) used in their studies geomorphologic and pedologic criteria to define the compartments (units), and these were used as a spatial reference for the analysis of conflicts derived from land use, which were identified by a GIS integration in maps of land use capacity, susceptibility to erosion and actual land use. Studies that identify spaces susceptible to erosion contribute to the choice of priority areas for conservation, reducing its environmental fragility. Priority and flooded areas contained in the watersheds basins are more likely to risks generated by a disordered use, contributing to the degradation of the biodiversity from these habitats. According to BRASIL (2014, p. 27) it is not enough to protect a stripe of land along river courses, leaving its scope and functionality unprotected. In this context, the objective of this study is to evaluate the susceptibility to erosion and conflicts derived from land use in the micro-region of Jauru, Mato Grosso State, using geo-technologies.

MATERIAL AND METHODS

Study Area

The micro-region Jauru, with an extension of 18,798.38 Km² (BRASIL, 2010), is constituted by 12 municipalities (Figure 1), being inserted in the meso-region SW Mato Grosso State. The area under study is characterized by 3 biomes: Pantanal, Cerrado (Savanna) and Amazon (MATO GROSSO, 2007). The predominant soil type is Alfisol (MATO GROSSO, 2007). The predominant climate is of Tropical Sub-Humid type, with two well-defined seasons: the rainy season from October to April and the dry season from Mai to October, although there are variations as to the beginning, end and duration of them (FERREIRA, 2001, p. 269-602). The largest part of micro-region Jauru (84.28%) is inserted in the Jauru watershed, whose main course is a tributary to Paraguai river. This hydrographic unit presents a high economic potential, due to different livestock activities, five small hydroelectric centrals (PHC) and one hydroelectric power plant (UH).

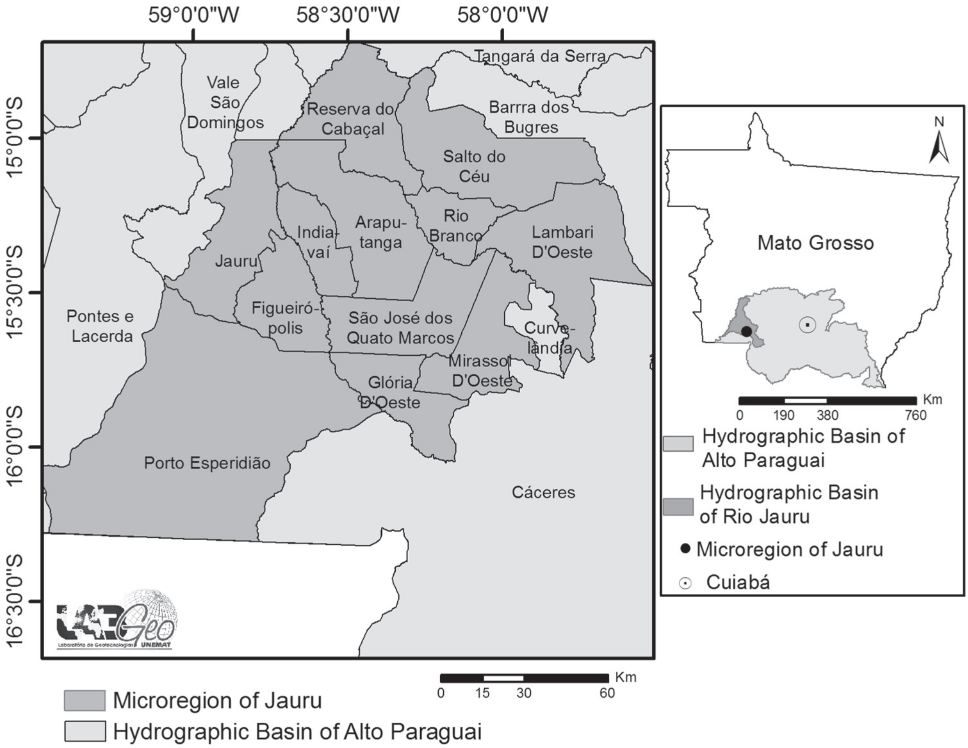

Figure 1 - Municipalities of micro-region Jauru within the Upper Paraguai Watershed in Mato
Grosso State. Source: LabgeoUnemat (2015)

Methodological procedures

The following methodological steps were considered in this study: geomorphologic-pedologic compartment, evaluation of susceptibility to sheet erosion, analysis of soil use capacity and evaluation of conflicts due to land use.

Initially a survey was done of thematic maps produced by governmental institutions (SEPLAN/MT, SEMA/MT, IBGE, MMA, INPE and ANA). All cartographic data were at scale 1:250,000. Data of interest were compiled, matched and organized in a Geographic Databank (GDB) in ArcGIS, version 9.2 from ESRI (2007).

The geomorphologic-pedologic compartment was done by association of geomorphologic and soil maps (MATO GROSSO, 2007). The definition of each compartment varied in accordance with the physical characteristics analyzed together, such as: Relief, Soils, Geomorphology. Watersheds and drainage nets constituted the borders of the compartments. Afterwards the data underwent a refining sequence which constituted a classification, by a table of attributes from the geomorphologic-pedologic compartments. The tool Intersect allowed the union of Geomorphology and Soils information, as well as its areal extent. The erodibility map was generated by insertion into the soils map, whose nomenclature was upgraded according to EMBRAPA (2006, p. 339), referring to classes and erodibility indices, suggested by Salomão (2010, p. 239). At table 1 the types of soils, its territorial representantions, the respective classes and indices of erodibility, as well as the source from where they were obtained, are presented.

Table 1 - Description, representation, and erodibility classes of soils from micro-region Jauru/Mato Grosso state

Type of Soil	Area (ha)	Area (%)	Classes	IRE*
Psamment	270,502.93	14.39	Very high	10.0 a 8.1
Udorthent	81,530.42	4.34	Very high	10.0 a 8.1
Oxisol	56,228.38	2.99	Very high	10.0 a 8.1
Alfisol	508,053.15	27.03	High	8.0 a 6.1
Ultisol red-yellow	472,628.15	25.14	High	8.0 a 6.1
Ultisol red	85,308.13	4.54	High	8.0 a 6.1
Inceptisol	14,563.61	0.77	High	8.0 a 6.1
Udox	215,499.37	11.46	Low	4.0 a 2.1
Udox red	147,490.53	7.85	Low	4.0 a 2.1
Oxisol	3,947.90	0.21	Low	4.0 a 2.1
Histosol	4,248.42	0.23	Null	2.1 a 0.0
Udalf	19,837.08	1.05	Null	2.1 a 0.0
Total	**1,879,838.07**	**100**		

* IRE = Index of Relative Erodibility.

The association of the erodibility map, prepared based on the erodibility indices from the soil units of the micro-region and the Topographic Factor (LS) originated the map of water erosion. The definition of erosion susceptibility classes, based on the slope inclination, followed the criteria of IPT (1990, p. 25) which are: I) Extremely susceptible; II) Very susceptible; III) Moderately susceptible; IV) Little susceptible and V) Little to not susceptible.

The map of the Topographic Factor (LS) corresponds to the map of iso-declivities from the methodology proposed by Salomão (2010, p. 240). It was generated using scenes from the DEM (Digital Elevation Model) originated from the bank of geo-morphometric data TOPODATA (VALERIANO, 2005, p. 3599). In this bank, data was generated by the interferometric radar SRTM (Shuttle Radar Topography Mission), C band, whose resolution was improved from 3” to 1” (~30 m). The images were prepared as mosaics and masked for the area under study, resulting in the DEM of the region under investigation. The projection WGS 84 was converted to SIRGAS 2000 UTM, using tool “Project” of module ArcToolbox from ArcGIS. From the raster file of the DEM of the area under study and computer techniques, slope inclination maps and direction of water flow were made. These maps were reclassified and combined to generate a map of homogenous ramps from which the values of average ramp declivity and height of ramp were extracted according to a methodology developed by Fornelos and Neves (2007, p. 29).

For the definition of the relief classes, the proposal from Lemos and Santos (2002, p. 24) was used, which associates declivity with relief classes, as follows: Declivity from 0 to 3% flat relief; from 3.1 to 8% - gentle rolling relief; from 8.1 to 20% - rolling relief; from 20.1 to 45% - strong rolling relief; from 45.1 to 75% - mountainous relief; and > 75% - relief with cliffs.

In order to obtain the map of actual potential to water erosion, a compatibility of the susceptibility to erosion map was made with the present land use map. The classification of the potential erosion was done according with the proposal from Salomão (2010, p. 242-243): Class I: high potential – present land use is incompatible with the susceptibility of sheet erosion by water; Class II: medium potential – present land use is incompatible with the susceptibility to sheet erosion by water, which could possibly be controlled by adequate conservationist practices; and Class III: low potential – present land use is incompatible with the susceptibility to sheet erosion by water.

In order to evaluate the conflicts, the information derived from maps of present potential to water erosion and land use capacity were analyzed (LEPSCH, 1991, p. 50). The classification of conflicts as well as the relation among susceptibility to water erosion and land use capacity was done by a methodology proposed by Hermuche *et al*., (2009, p. 118).

Analysis of susceptibility to erosion, erosion potential and most representative land use conflicts were made for each one of the twelve municipalities encompassing the Jauru micro-region. With the shapefiles added in the ArcGIS program, information was extracted, using the tool Intersect, for each municipality, and quantified afterwards.

The validation of the elaborated maps was done by field survey, using a GPS to localize those points suffering water erosion.

The errors originated from the map elaboration process were corrected by information obtained in the field and afterwards in ArcGIS. Layouts were elaborated and the quantification is found in the results shown below.

RESULTS ANDS DISCUSSION

In the micro-region Jauru, 20 Geomorphologic-Pedologic compartments were identified (Table 2). The largest one among them was the 11th formed by Alfisols + Regional Aplanation System 3, constituting 18.27% of the area from this micro-region. It was followed by compartment 8 formed by Udox + System of Folded Strips, occupying 11.46% of the area (Figure 2).

Among the soil types identified (Figure 3), the Alfisols occupy 27.03% of the area from the micro-region studied. These soils present a median depth, colors varying from red to gray, horizon B textural or nitic below, weak A horizon, moderate or E horizon, clay with high activity and high base saturation, according to BRASIL (2007, p. 292).

They present generally a reasonable differentiation among superficial and sub-superficial horizons (BRASIL, 2007, p. 292). In the area under study the Alfisols are found in compartments 10 and 11, presenting water bodies, livestock, agriculture and urban influence.

Table 2 - Description and representatives of geomorphologic-pedologic compartments of micro-region Jauru/Mato Grosso state

Comp.*	Geomorphology-Pedology	Area (ha)	Area (%)
1	Ultisol red-yellow + Dissection System	164.300,33	8.75
2	Ultisol red-yellow + Dissection System in Hills and Mountains	60.233,25	3.20
3	Ultisol red-yellow + Regional Aplanation System 2	50.246,30	2.67
4	Ultisol red-yellow + Regional Aplanation System 3	197.848,27	10.52
5	Ultisol red + Dissection System in Hills and Mountains	47.200,00	2.51
6	Ultisol red + Regional Aplanation System 3	38.108,13	2.03
7	Inceptisol + Dissection system in Hills and Mountains	14.563,61	0.77
8	Udox + System of Folded Strips	215.499,37	11.46
9	Udox + Regional Aplanation System 3	147.490,53	7.84
10	Alfisol + Dissection System in Hills and Mountains	164.620,50	8.76
11	Alfisol + Regional Aplanation System 3	343.432,71	18.27
12	Udorthent + Dissection System in Hills and Mountains	42.719,50	2.27
13	Udorthent + System of Folded Strips	14.700,42	0.78
14	Udorthent + Systems of Plateaus and Horizontal Strata	24.110,50	1.28
15	Udorthent + Dissection System in Hills and Mountains	69.081,75	3.67
16	Udorthent + Regional Aplanation System 2	201.420,05	10.72
17	Udox + Dissection System in Hills and Mountains	3.947,97	0.21
18	Fibrist + Meandering Alluvial Floodplain	4.248,42	0.24
19	Udalf + System of River Floodplain	19.837,08	1.06
20	Ustox + Dissection System Lakes	56.229,38	2.99
Total		**1.879.838,07**	**100**

* Number of Geomorphologic-pedologic compartments.

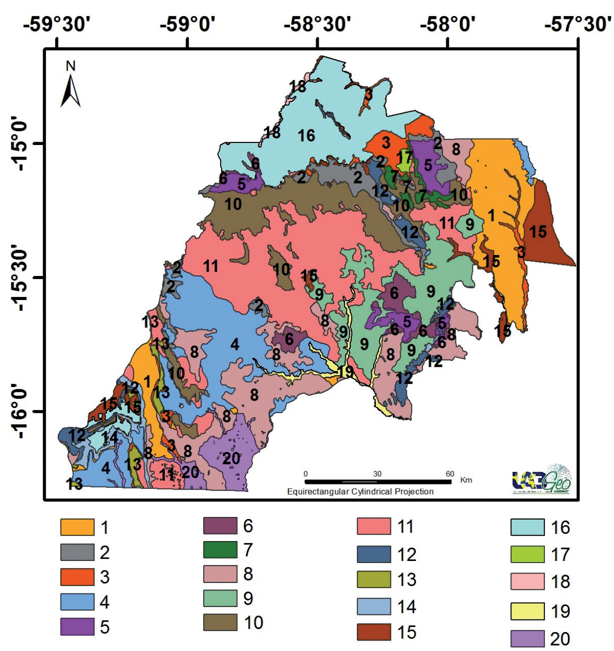

Figure 2 - Geomorphologic-pedologic compartments of micro-region Jauru / Mato Grosso state
Source: LabgeoUnemat (2015)

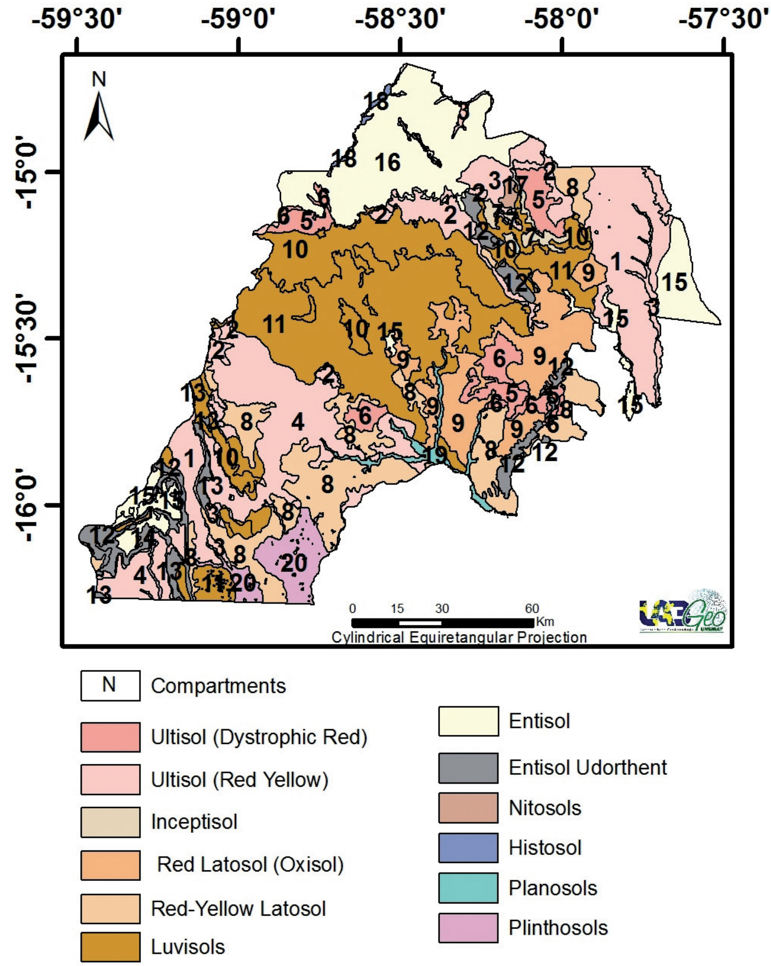

Figure 3 - Soils of micro-region Jauru/Mato Grosso State

Source: LabgeoUnemat (2015)

The Ulfisols constitute 25.14% of the area under study and are the largest soil class (Figure 3). They present high erodibility, are very deep, and it is possible to discriminate sharply the horizons. They present clay to medium texture, are well-drained and moderately porous (VALLE JUNIOR, 2008, p. 63). When associated to undulated to strongly undulated terrain they can suffer erosion processes.

The Psamment occupy an extension of 270,502.93 ha (14.39%) in the Jauru micro-region and are found under flat to light undulated terrain. The main land use is agricultural activities, predominating livestock, sugar cane and reforestation (Table 3). The fragility of this soil type, when occupied without order, may cause, in sections susceptible to erosion, severe soil degradation processes. The sandy soils are considered ecologically as very fragile and its agricultural use should be avoided (ZUO *et al*., 2008, p. 2010). In spite of its high depth (at least 150 cm depth) and permeability of these soils (EMBRAPA, 2006, p. 222), the sandy texture along the profile is considered a strong soil limitation (LEPSCH, 1991, p. 102), and confers a low cohesion among the particles, making them very susceptible to erosion (SALES et al., 2010, p. 668).

The largest erodibility class was 68%, and referred to pedologic units Alfisols, Udult red-yellow, Udult and Inceptisols. The second most expressive class was very high (21.72%), constituted by Oxissols, Udorthent and Psamment.The erodibility classes (Figure 4) represent the susceptibility of soils to erosion. Some soils are more erodible than others, although the slope, precipitation, vegetation cover and practices of soil erosion control are the same. This difference, caused by inherent soil properties is referred as "Soil erodibility" (BERTONI; LOMBARDI NETO, 2010, p. 215).

The predominant relief in the micro-region is plan (LEMOS; SANTOS, 2002, p. 25), occupying 56.58% of the area, followed by a smooth undulated relief with 35.96%. When summing up the predominant relief types, around 92% from the micro-region Jauru present plan to smooth undulating terrain (Figure 5).

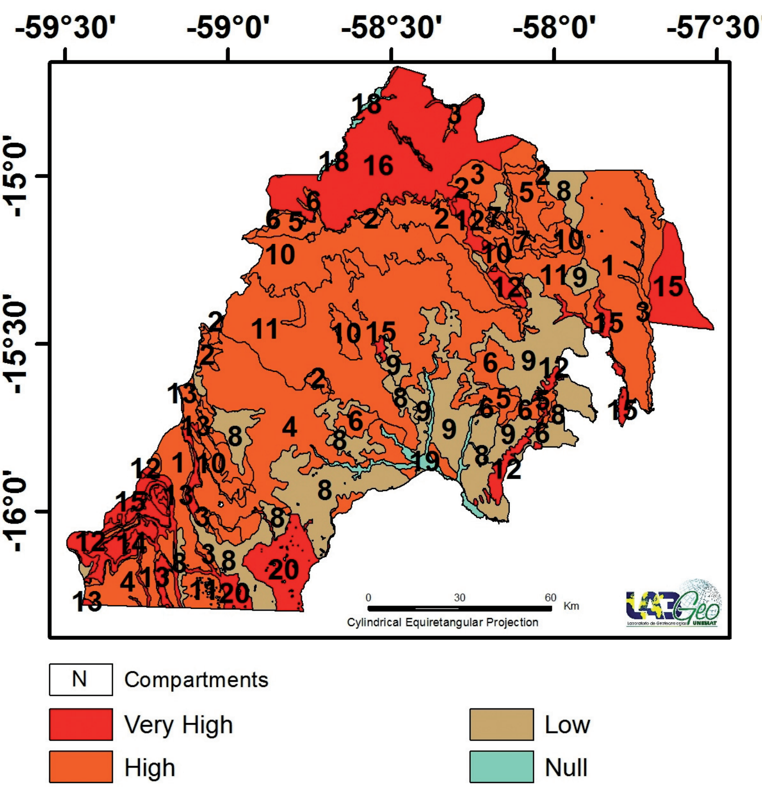

Figure 4 - Soil erodibility classes in micro-region Jauru/Mato Grosso State

Source: LabgeoUnemat (2015)

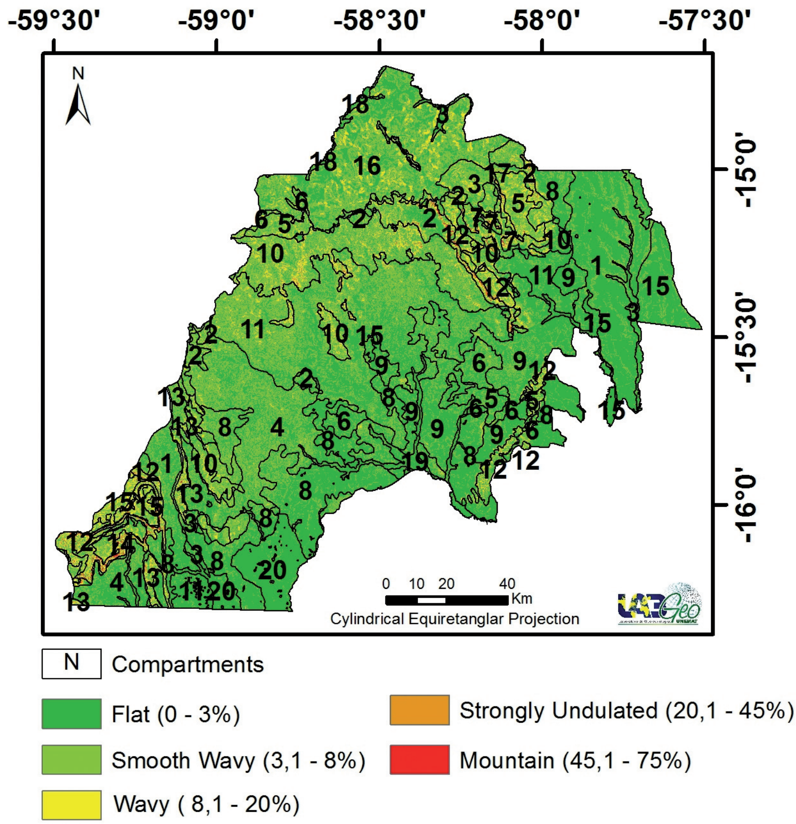

Figure 5 - Relief classes in micro-region Jauru/Mato Grosso State
Source: LabgeoUnemat (2015)

Fragile soils such as the Psamment, when localized on slopes above 3%, are vulnerable to erosion. On the other hand, its position on the landscape, i.e. in plan terrain, makes them more resistant to erosive processes (VALE JÚNIOR *et al*., 2009, p. 7).

Table 3 - Characterization of the geomorphologic-pedologic compartments and classification of land use conflicts in the micro-region Jauru – Mato Grosso state

Compartment	Vegetation cover and actual land use	Relief	¹Suscep.	²Pot.	³Cap.	⁴Con.
1. Ulfisol Red-Yellow + Dissection System	Livestock + Secondary Vegetation; Sugar cane; Water masses; Alluvial forest (Arboreal, Bush, Herbaceous); Savanna/Deciduous seasonal forest; Tall Wooded Savanna + Tall Woodland (*Cerradão*) and Savanna without riparian forest.	Gentle Rolling	EXT.	High	VII – VIII	Med.
2. Ultisol Red Yellow + System of dissection in hills and mountains	Urban Influence; Livestock+Secondary Vegetation; Tall Wooded Savanna+Park Savanna+ Tall Woodland (*Cerradão*); Savanna/Deciduous Seasonal Forest; Alluvial forest (Arboreal, Bush, Herbaceous); Sub-montane deciduous seasonal forest.	Plan	EXT.	High	VII – VIII	Med.
3. Ultisol Red-Yellow + Regional Planation System 2	Livestock; Cattle raising+ Secondary Vegetation; Alluvial Forest (Arboreal, Bush, Herbaceous) – along rivers; Tall Woodland (*Cerradão*) + Tall Wooded Savanna (*Campo Cerrado, Cerrado*, open *Cerrado*); Water masses (reservoirs, dams, rivers, creeks, channels, lakes, salines) and Savanna/Deciduous Seasonal Forest.	Plan to Gentle Rolling	EXT.	High	VII – VIII	Med.
4. Ultisol Red-Yellow + Regional Planation System 3	Livestock+Secondary Vegetation; Reforestation; Sugar cane; Alluvial Forest (Arboreal, Bush, Herbaceous) – along rivers; Water masses (reservoirs, dams, rivers, creeeks, channels, lakes, salines) and Savanna with riparian forest.	Plan	EXT.	High	VII – VIII	Med.
5.Ultisol red + System of dissection in hills and mountains	Livestock+Secondary forest; Alluvial Forest (Arboreal, Bush, Herbaceous) – along rivers; Water masses (reservoirs, dams, rivers, creeks, channels, lakes, salines); Sub-montane deciduous seasonal forest (Woods, Dry Woods, Calcareous Woods).	Gentle Rolling	EXT.	High	VII – VIII	Med.
6. Ultisol red + Regional Planation System 3	Urban Influence; Livestock+ Secondary Vegetation; Sugar Cane; Reforestation; Park Savanna+Tall wooded savanna (*Campo Cerrado, Cerrado*, open *Cerrado*); Alluvial forest (Arboreal, Bush, Herbaceous) – along rivers; water masses (reservoirs, dams, rivers, creeks, channels, lakes, salines)	Plan	EXT.	High	VII – VIII	Med.
7. Inceptisol + System of dissection in hills and mountains	Urban influence; Livestock+Secondary Vegetation; Tall wooded savanna (*Campo Cerrado, Cerrado,* open *Cerrado*) +Tall woodland (*Cerradão*) e Sub-montane deciduous seasonal forest (Woods, Dry Woods, Calcareous Woods)	Gentle Rolling	EXT.	High	VII – VIII	Med.
8. Udox + System of Folded Bands	Urban influence; Livestock+Secondary Vegetation; Reforestation; Sugar cane; Cattle raising; water masses (reservoirs, dams, rivers, creeks, channels, lakes, salines); Alluvial Forest (Arboreal, Bush, Herbaceous) – along rivers; Tall Woodland (*Cerradão*)+ Grassy-Woody Savanna (*Campo, Campo Limpo, Campo Sujo, Caronal* and *Campo Alagado*); Savanna/Deciduous Seasonal Forest	Plan	MOD.	Med.	IV	Low
9. Udox + Regional Planation System 3	Livestock+Secondary Vegetation; Sugar cane; Cattle raising; Urban influence, Sub-montane deciduous seasonal forest, (Woods, Dry Woods, Calcareous Woods) Tall wooded savanna (*Campo Cerrado, Cerrado, Cerrado Aberto*) + Tall woodland (*Cerradão*)	Plan	MOD.	Med.	IV	Low
10. Alfisol + System of dissection in hills and mountains	Urban influence; Livestock+Secondary vegetaation; Reforestation; water masses (reservoirs, lakes, rivers, creeks, salines); Alluvial forests (Arboreal, Bush, Herbaceous) – along rivers; Tall wooded savanna (*Campo Cerrado, Cerrado, Cerrado Aberto)* + Park Savanna+Tall woodland (*Cerradão*) and Sub-montane semi-deciduous seasonal forest	Plan to Gentle Rolling	EXT	High	VII – VIII	Med.

11. Alfisol + Regional Planation System 3	Urban Influence; Livestock+Secondary Vegetation; Reforestation; Cattle raising; Sub-montane Deciduous Seasonal Forest; (Woods, Dry Woods, Calcareous Woods) +Secondary Vegetation; Alluvial Forest (Arboreal, Bush, Herbaceous) – along rivers; Water masses (reservoirs, dams, rivers, creeks, salines); Sub-montane semi-deciduous seasonal forest (Woods) + Secondary Vegetation	Plan to Gentle Rolling	EXT.	High	VII – VIII	Med.
12. Udorthent + System of Dissection in hills and mountains	Livestock+Secondary vegetation; Sugar cane; Tall wooded savanna(*Campo Cerrado, Cerrado, Cerrado Aberto*) +Tall Woodland (*Cerradão*); Sub-montane deciduous seasonal forest (Woods, Dry Woods, Calcareous Woods).	Gentle Rolling	EXT.	Med.	VII – VIII	Med.
13. Udorthent + System of folded bands	Livestock+Secondary Vegetation; Park Savanna+Tall wooded savanna (*Campo Cerrado, Cerrado, Cerrado Aberto*); +Tall Woodland (*Cerradão*); Savanna/Deciduous Seasonal Forest (Woods)	Gentle Rolling	EXT.	Med.	VII – VIII	Med.
14. Udorthent + Systems of plateaus with horizontal strata	Livestock+Secondary vegetation; Sugar cane; Park savanna+Tall wooded savanna (*Campo Cerrado, Cerrado, Cerrado Aberto*); Savanna/Deciduous Seasonal Forest (Woods); Savanna without riparian forest	Plan to gentle Rolling	EXT.	Med.	VII- VIII	Med.
15. Psamment + System of dissection in hills and mountains	Livestock+Secondary vegetation; Sugar cane; Reforestation; Tall wooded savanna (*Campo Cerrado, Cerrado, Cerrado Aberto*) +Tall woodland (*Cerradão*); Sub-montane semi-deciduous seasonal forest (Woods)	Plan	EXT.	High	VII – VIII	High
16. Psamment + Regional Planation System 2	Livestock+Secondary vegetation; Reforestation; Alluvial forest (Arboreal, Bush, Herbaceous) – along rivers; water masses (reservoirs, dams, rivers, lakes, creeks, salines); Savanna without riparian forest; Sub-montane deciduous seasonal forest (Woods, Dry woods, Calcareous woods)	Plan to gentle Rolling	EXT.	High	VII – VIII	High
17. Udox + System of dissection in hills and mountains	Livestock+Secondary vewgetation; Sub-montane deciduous seasonal forest (Woods, Dry Woods, Calcareous woods); Tall wooded savanna (*Campo Cerrado, Cerrado, Cerrado Aberto*) +Tall Woodland (*Cerradão*); Alluvial forest (Arboreal, Bush, Herbaceous) – along rivers	Plan to gentle Rolling	MOD.	Med.	IV	Low
18. Histosol+ Meandering floodplain	Livestock+Secondary Vegetation; Park Savanna+Tall wooded savanna (*Campo Cerrado, Cerrado, Cerrado Aberto*); Savanna with riparian forest	Plan	NS	Null		Low
19. Alfisol + System of floodplain	Urban influence; Livestock+Secondary vegetation; Reforestation;Water masses (reservoirs, lakes, Rivers, creeks, salines); Alluvial forest (Arboreal, Bush, Herbaceous) – along rivers; Tall Woodland (*Cerradão*) + Tall wooded savanna (*Campo Cerrado, Cerrado, Cerrado Aberto*) +Park Savanna	Plan	NS	Null		Low
20. Udox + System of dissection/lakes	Livestock+Secondary Vegetation; Park Savanna+Tall wooded savanna (*Campo Cerrado, Cerrado, Cerrado Aberto*); Alluvial Forest (Arboreal, Bush, Herbaceous) – along rivers; Savanna without riparian forest; Tall wooded savanna (*Campo Cerrado, Cerrado, Cerrado Aberto*) + Tall Woodland (*Cerradão*)	Plan	EXT.	High	VII – VIII	Med.

[1]Susceptibility to water erosion; [2] Present potential to water erosion; [3] Capacity of land use; [4]Conflict with land use. MOD. – moderately susceptible to erosion. MUI. – very susceptible to erosion. EXT.- extremely susceptible to erosion. NS. – not susceptible to erosion. Med. – Median.

The map of susceptibility to water erosion (Figure 6), obtained by the association of both the erodibility map and the slope map, demonstrate that 74.74% of the area under study are constituted by the class "Extremely susceptible to sheet water erosion", 4.37% is very susceptible and less than 1% is little to not susceptible to erosion.

The Geomorphologic-Pedologic compartments 8 and 9 are classified as moderately susceptible to erosion, corresponding to 19.33% of the area from the micro-region. The predominating soils in these compartments are classified as Udox and Ustox, which present a low degree of erodibility.

Classes of potential sheet water erosion indicate the intensity of human activities in areas susceptible to erosion. Approximately 52% of the area from the micro-region presents high potential to erosion, 32% medium, 6% low and 1.41% null potential to erosion (Figure 7).

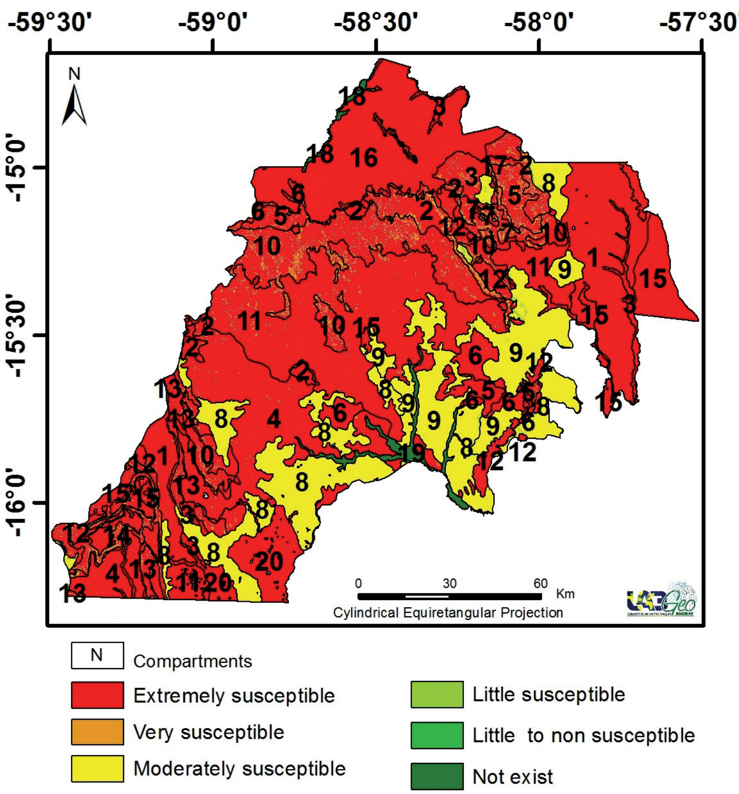

Figure 6 - Susceptibility to water erosion from the soil of Geomorphologic-Pedologic compartments in the micro-region Jauru / Mato Grosso state

Source: LabgeoUnemat (2015)

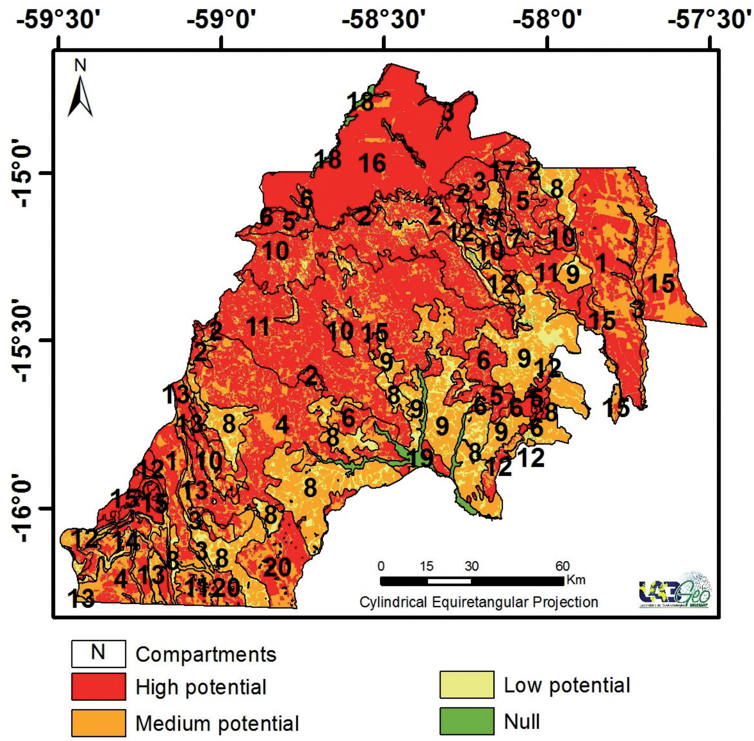

Figure 7 - Present potential to water erosion of soil from Geomorphologic-Pedologic compartments in the micro-region Jauru / Mato Grosso state

Source: LabgeoUnemat (2015)

In those areas classified as with high potential to water erosion (Figure 7), there are soils of high to medium erodibility, which increases the susceptibility to erosion processes. In these areas family farms and livestock predominate (Table 3).

The compartments 1, 2, 3, 4, 5, 6 and 8 are classified as with medium potential to erosion and are composed by Ultisols, Oxisols, Udorthent and Udalf, where the predominant use and occupation are family farms and livestock. There is a need of actions related to land use so that this activity is done rationally. Mato Grosso State contains three biomes, namely: *Pantanal* (7%), *Cerrado* (Savanna) (40%) and *Amazonia* (53%), which in 2009 presented a deforested area of 24.09%, 47.14% and 35.18% respectively. These percentages reflect the disordered occupation from Mato Grosso State, which did not consider its physical and biotical characteristics, as well as its potentialities and natural fragilities. The definitions of public policies, based on the socio-economic and ecologic diagnosis of this State, will allow the continuity of development, however on a sustainable base (MATO GROSSO, 2012, p. 9).

In 14.39% of the area under study the present land use is incompatible with the capacity on the use of the soil, causing a high conflict of land use (Figure 8). In these areas the predominant soil type is Psamment, which according to Junqueira *et al.* (2010, p. 2) are deep, very porous, excessively drained and with low silt content.

They occur generally in plan or gently rolling relief, constituting non-consolidated layers of sand and therefore susceptible to erosion. Due to the characteristics of these soils, there is an urgence to adopt conservationist practices in this area to prevent degradation processes because they present serious limitations to annual cultures, including those considered as protectors, such as pastures and reforestation.

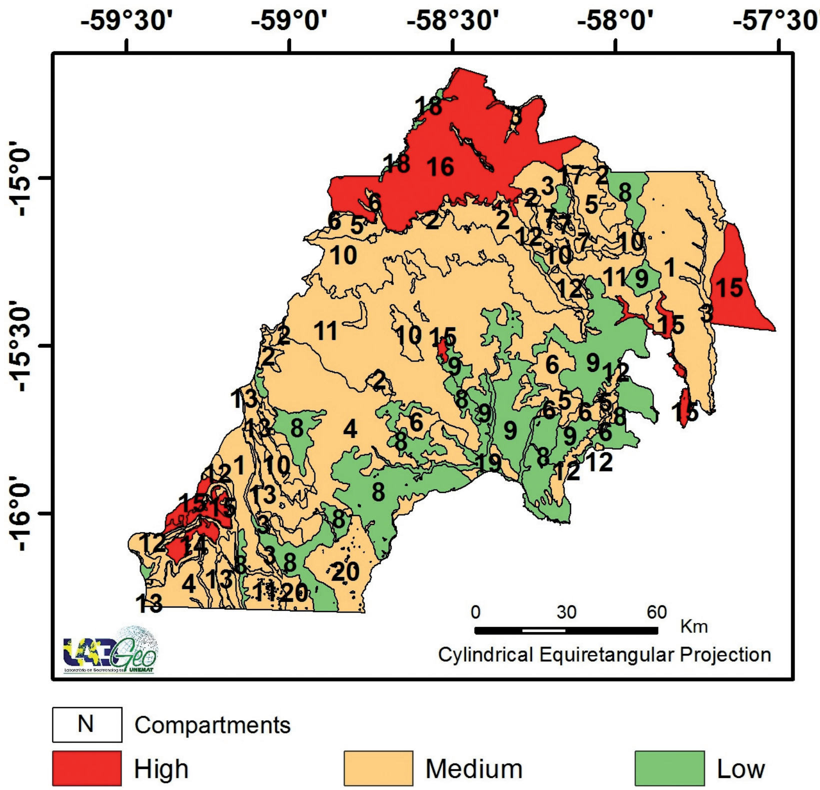

Figure 8 - Conflicts of land use in the geomorphologic-pedologic compartments in the micro-region Jauru – Mato Grosso state

Source: LabgeoUnemat (2015)

Approximately 20.58% of this micro-region presents low conflicts related to land use due to the presence of Udox, Histosols and Udalfs in plan relief and thus replying positively to conservationist practices, increasing its resistance against erosive processes.

From the micro-region studied, 64.8% present a medium conflict (Figure 8) on land use, due to the predominance of Alfisols, Ultisols, Inceptisols and Oxisols, in areas of plan to gently rolling relief and the conflict on land use is moderately incompatible with the real capacity of soil use. In this region there are humid areas (Pantanal), where Oxisols predominate, which are not appropriate for cultivation. They are indicated only for the protection of the environment and/or flora and fauna, permanent preservation, recreation, tourism and for impoundment of water. According to Moraes

(2008, p. 20) to conciliate the conservation of the Pantanal and the economic use of its natural components, it is necessary to define strategies which would guarantee the sustainable use of its resources, the maintenance of the biological diversity and the ecological processes which regulate the ecosystem.

The human action in potentially fragile areas, such as the deforestation of hillslopes with accentuated declivity and high levels of susceptibility to erosion, for cattle raising activities, causes silting and pollution of water courses, accelerating the sedimentation rates (SILVA NETO; NUNES, 2011, p. 2). In this context it is necessary to adopt preventive actions against the degradation of natural environments, as well as the adequate management of land according to its capacity of use.

Land use planning must be considered by municipal governments to delineate organization systems of land use/occupation. For the 12 municipalites within the micro-region Jauru / Mato Grosso State, classes of erosion susceptibility, erosion potential and larger land use conflicts were determined (Table 4).

Table 4 - Identification of soil units, classes of susceptibility to erosion, potential to water erosion and land use conflicts of the municipalities from the micro-region Jauru, Mato Grosso state

Municipalities	Soil units	[1]Susc.	[2]Pot.	[3]Can.
Araputanga	Alfisols	EXT	High	Medium
Figueirópolis D' Oeste	Alfisols	EXT	High	Medium
Glória D' Oeste	Ustox; Udox	MOD	Medium	Low
Indiavaí	Alfisols	EXT	High	Medium
Jauru	Alfisols	EXT	High	Medium
Lambari D' Oeste	Ultisols; Psamment;	EXT	High	Medium
Mirassol D' Oeste	Udox; Ustox	MOD	Medium	Low
Porto Esperidião	Ultisols; Udox; Alfisols	EXT	Medium	Medium
Reserva do Cabaçal	Psamment	EXT	High	High
Rio Branco	Udorthent; Alfisols	EXT	High	Medium
São José dos Quatro Marcos	Udox; Alfisols	EXT	Medium	Medium
Salto do Céu	Ultisols; Psamment	EXT	High	Medium

[1]Susceptibility to water erosion; [2] Actual Potential to water erosion; [3] Conflict with land use.
MOD. – moderately susceptible to erosion. EXT.- extremely susceptible to erosion.

At the municipalities of Araputanga, Figueirópolis D' Oeste, Indiavaí and Jauru, the conflicts classified as "Medium" where the most representative ones, corresponding to 71.47%, 98.86%, 96.76% and 86.61% of the respective municipality areas. These four municipalities present a high potential to water erosion, due to the types of fragile soils (Table 4), which are extremely susceptible to water erosion and that during its occupation suffered under inadequate management.

The land use conflict was low in the municipalities Glória D'Oeste and Mirassol D'Oeste, corresponding respectively to 71.36% and 74.79% of the municipal territories. In these municipalities predominate (NUNES; CASSOL, 2011, p. 546) the Udox and Ustox soil types, with a high clay content, organic carbon, iron oxydes and higher indices of stability for aggregates in water (NUNES; CASSOL, 2011). Soils with a clay texture are generally more resistant to the disaggregation of its particles by the action of erosive agents, and thin soils with sandy texture.

In most of the municipalities the susceptibility is moderate, as well as a medium potential to erosion, evidencing that the actual land use is incompatible with the susceptibility. According to Valenzuela *et al*., (2010, p. 1), the economic development of the municipality Mirassol D'Oeste has been characterized by the constant use of natural resources without planning.

There has been a medium land use conflict in the municipalities of Lambari D' Oeste (66.68%) and Salto do Céu (72.32%). The soil types found there are Ultisols and Psamment, extremely susceptible to erosion, and it presents an actual land use incompatible with its susceptibility to erosion. Nunes *et al*. (2013, p. 202) also verified that in the municipality Salto do Ceú there are conflicts related to land use in 81.82% of its area.

The predominant soil type in the municipality Reserva do Cabaçal is Psamment (83.49%), considered ecologically very fragile and inadequate uses resulted in a high conflict of land use (84%).

In Porto Esperidião the medium land use conflict occurred in 69.87% of the area from the municipality, and the most representative soil units are Ultisols and Udox. This is the largest municipality among the 12 which compose the micro-region Jauru, occupying around 31% of the micro-region.

In the municipality of Rio Branco the soil units Alfisols and Udorthent constitute respectively 50.40% and 20.70% of the municipal area.

These are extremely susceptible soils to erosion, occupying 78.32% of the municipality, causing a medium land use conflict in 95.57% of the municipal extension.

In the municipality of São José dos Quatro Marcos predominate Udox (36.48%) and Alfisols (35.65%). The Udox presents a low erodibility rate (Table 1), differently from the Alfisols which present a high erodibility, reflecting the predominance of a medium potential to erosion. So 56.97% of its territorial extension is classified as extremely susceptible to erosion, presenting a medium potential to sheet water erosion in 43.46% of the municipal area and the largest part of the municipality (57.02%), presenting a medium land use conflict.

CONCLUSIONS

In the micro-region Jauru the predominant soil types Alfisols and Ultisols were identified, on plan to gentle rolling relief, characterizing so areas of medium potential to water erosion. The classes of potential sheet erosion by water indicate the existence of human activity in areas extremely susceptible to erosion.

In the Geomorphologic-Pedologic compartments there was predominance of medium land use conflict, as well as in the municipalities, due to the occurrence of unduely occupied areas for agriculture and livestock.

Data and information generated in this study can be used as a subsidy for environmental planning of the micro-region, contributing for its conservation and recovery of degraded areas.

ACKNOWLEDGMENTS

The authors thank the Coordination for the Improvement of Higher Education Personnel (CAPES) for their awarding of scholarship grants. We used information derived from Project Modeling environmental indicators for the definition of priority and strategic areas for the recovery of degraded areas in SW Mato Grosso State. This project is connected to the subnet of social, environmental and technological studies for the production system of SW Mato Grosso (REDE ASA), funded in the frame of edict MCT/CNPq/FNDCT/FAPs/MEC/CAPES/PRO-CENTRO-OESTE Nº 031/2010. Data from this project contributed to the execution of this study.

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