MULTITEMPORAL ANALYSIS OF LAND COVERING AND VEGETATION AREAS UNDER QUATERNARY SUPERFICIAL FORMATION – A STUDY OF THE HYDROGRAPHIC BASIN STREAM PUITÃ, RIO GRANDE DO SUL – BRAZIL

Rafael Lacerda Martins[1], Helio Radke Bittencourt[2], Laurindo Antonio Guasselli[3]

[1-] ULBRA, rlmart@terra.com.br,

[2-] PUCRS and ULBRA heliorb@pucrs.br

[3-] CEPSRM/UFRGS and UNISC, laurindo.guasselli@ufrgs.br

ABSTRACT

The hydrographic basin of stream Puitã, located in the southwest of the state of Rio Grande do Sul – Brazil, is characterized by quaternary superficial formation. These formations are dominated by erosive features and sand strands located in the geological compartment of hills as well by bushes located on the hillside and ciliary's bushes located along the course of the water together with the campestre vegetation. The use of the land stands out with plots of land used to agriculture, intensified in the last decades. The agricultural activities left the soil fragile, causing erosive features. This study aims to identify the existent relationship between the type of vegetation and the soil degradation in the region of the hydrographic basin. The methodology is based on digital classification of Landsat-TM satellite images, data acquired between 1984 e 2004, on the correlation analysis between degraded areas, classes of land use and vegetation's types.

The results showed thematic maps that allowed identifying the different fragilities and susceptible areas to the sandification process. The multitemporal approach allowed to evaluate the modifications of the mapping classes and to identify the expansion or retracting of sand strands and erosive processes. It was detected that the agricultural use is the responsible agent for the amplification of the soil fragility.

INTRODUCTION

The expansion of the arenização in the Southwest of the state, and the growth of environmental problems that involve that process they have been causing serious impacts in those you set. These impacts indicate that the *arenização* areas should be monitored and that

its dynamics and space properties are very understood. In that way the evaluation of a series of data obtained by satellite, of that hydrographic basin, it can aid in the understanding of the variation of the dynamics of that ecosystem.

In relation to the environmental problem of the *arenização* process, we can mention the studies of the Department of Geography of UFRGS, accomplished in the Southwest of the Rio Grande do Sul state, where he/she stood out the conditioning geomorphology and use of the soil as being two important factors in the definition of the processes of formation of the *areais*.

The hydrographic basin of stream Puitã (392 km2), it is characterized by features associated *erosivo/deposicionais* the arenização in the Southwest of Rio Grande do Sul state. According to Suertegaray (1992), the explanation of this process adopts the term arenização, that is to say, the formation of the areais is resulted of the *arenização*. For the author the ordinance of deposits *areníticos* (not very consolidated) or sandy (not consolidated) they are the promoters in those areas of the difficulty of fixation of the vegetation due to the constant mobility of the sediments. "..The ordinace of those deposits, in the case, superficial formations, probably quaternary, it resulted of a dynamic morphogenetic where the processes superficial hidrology, matters the concentrated draining of the type *ravina* or *voçoroca* expose, it transports and it deposits the sand, giving origin the formation of areais that, in contact with the wind, they tend to a constant removal ".

AREA OF STUDY

The area of study has as location the border west of the Rio Grande do Sul state /Brazil. it is Located to east of the river Uruguay tends with extreme limit the meridian 58°W, the continental internal limit for the meridian 54° 30'W, to the north the latitude 28°, and in the south limit the border with Uruguay. The study area understands the hydrographic basin of the stream Puitã, locates to the North of the river Itú and to West of the mountain of Iguariaçá, among the latitudes 28^{o} 55'S and 29^{o} 15'S, and the longitudes 55^{o} 15'W and 55^{o} 35'W (it Represents 1). The stream Puitã corresponds to a tributary of the river Itú and that for its time is flowing of the river Ibicuí. The sub-basin of the stream Puitã is understood in the area of three districts of the area: Maçambará, Itaqui and São Borja.

Figure 1 - Location of the study area, Southwest of Rio Grande do Sul/Brazil.

OBJECTIVES

His work has for objective to identify the existent relationship between the classes of use of the soil and vegetal covering and the processes morphogenetic in the hydrographic basin. The methodology proposal is based in the classification digital of satellite images Landsat TM, data acquired between 1984 e 2004**,** and in the correlation analysis between the degraded areas and the use classes and vegetal covering.

DIGITAL IMAGE PROCESSING

For the use of the image Landsat TM5 (orbit point 224-81, bands 3, 4, 5 of 1988, 1994, 1997, 2000; 2004) firstly some were made pre-processings: 1) geometric enhancement with base in the letters to the scale of 1:50.000 of DSG; 2) generation of a limit polygon or " mask ", in format booleano, attributing the value zero for the external area and 1 for the area of the hydrographic basin. 3) the supervised classification of image multiespectral, it was accomplished in ambient IDRISI. The main steps for the classification were the following ones: location of examples of the representative areas for each class type presented in the image multiespectral, this step was called recognition of training areas. Several training areas should be defined for a same class, that is important to assure that the pixels to her belonging, be really representative of this class. The process has continuity with the elaboration of called files of ghastly signatures that contain the information of the training areas, that will be the base for the generation of the supervised classification.

For the elaboration of the classification, it was chosen a method classifier, MaxVer (maximum verisimilitude), that it is a method of classification " pixel the pixel " and the ghastly bands 3, 4, 5 of digital image of the satellite Landsat TM5. The classes defined in that mapping were the following ones: *areais; florestamento; corpos d`água; arbórea/arbustiva; campestre; agro-pastoril e solo exposto.*

It considers the ponderation of the distances among averages of the digital levels of the class, using statistical parameters. So that the classification is necessary, it is necessary a reasonable number of pixels, for each training group. Forming a safe base in the statistical treatment. The training groups define the diagram of dispersion of the class and its distributions of probability, considering the distribution of normal probability for each training class used in the process.

After the correspondence of the different classes it is verified in the classified image, with the purpose of observing some significant difference. What happens actually, they are some confusions in the ghastly behavior of the studied objectives, I eat for example, the difficulty of differentiation of the native forest with *florestamento* in the bands 3 and 4. In case it happens a relative confusion in the differentiation, it is processed the classifier again, with new training areas. The final product of a supervised classification is classified images, that they represent, then, the different classes, defined before the application of the method classifier.

RESULTS AND DISCUSSIONS

The products obtained in that healthy work presented in the form of thematic maps (I use of the soil and vegetal covering) and summarized in quantitative data in the form of referring tables to the different statistical methods (correlation analysis).

The illustrations 9, 10 and 11 show the images of the classifications of the use of the soil and vegetal covering for the different dates, elaborated through digital classification of images Landsat TM5. The illustrations represent the space distribution of the analyzed classes of use of the soil and vegetal covering.

To verify the existence of growth tendency or decrease of the values of the areas during the period, the significância of the coefficient of correlation of Spearman was

evaluated in each class. The table 1 summarizes the results, where it is noticed that the classes 3 and 7 just presented a significant growth tendency.

Table 1 –Classes size per year and test for trend

	Years					*Test for trend*
Class	*1988*	*1994*	*1997*	*2000*	*2004*	*(p-value)*
areais	1.246,14	1.003,05	1.180,98	1.251,90	1.641,60	0,188
florestamento	545,40	289,80	111,78	120,24	149,67	0,285
corpos d'água	44,37	26,73	49,23	66,51	210,96	0,037*
arbórea/arbustiva	3.604,41	2.460,87	2.273,76	2.928,69	2.957,31	0,873
campestre	22.037,13	27.638,91	26.160,57	21.002,94	25.160,04	0,747
agro-pastoril	7.738,92	2.923,92	1.821,96	8.004,69	1.407,60	0,505
solo exposto	4.209,39	5.082,48	7.827,48	6.050,79	7.898,58	0,037*

* Trend is significant at 0,05 level.

Table 2 – Spearman's Rho Correlation Matrix between classes

areais (1)	1,000						
florestamento (2)	-0,100	1,000					
corpos d'água (3)	0,900*	-0,500	1,000				
arbórea/arbustiva (4)	0,600	0,700	0,200	1,000			
campestre (5)	-0,700	0,000	-0,500	-0,600	1,000		
agro-pastoril (6)	-0,100	0,200	-0,300	0,200	-0,600	1,000	
solo exposto (7)	0,500	-0,700	0,800	-0,300	0,100	-0,700	1,000
	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7

* Correlation is significant at the .05 level (2-tailed).

Spearman's rho is the rank correlation coefficient between pairs of items. It ranges from -1 to +1, where +1 indicates strong direct correlation while –1 means strong inverse correlation. The correlation between classes 1 and 3 is highly significant, indicating that the variations in this classes are almost the same.

Figure 2 – Temporal Evolution - Class 1

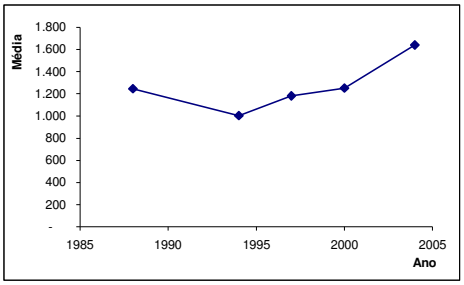


Figure 3 – Temporal Evolution - Class 2

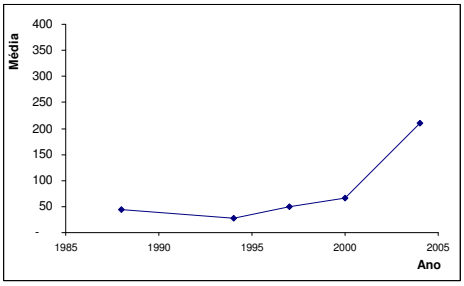


Figure 4 – Temporal Evolution - Class 3

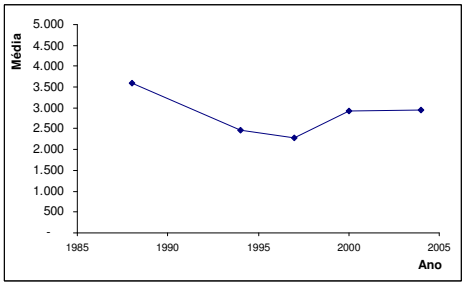


Figure 5 – Temporal Evolution - Class 4

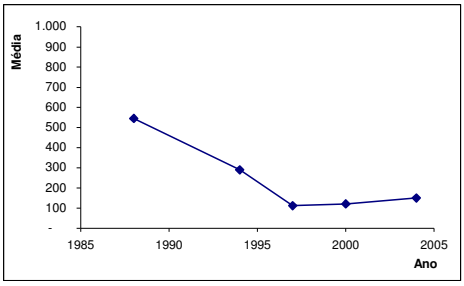


Figure 7 – Temporal Evolution - Class 5

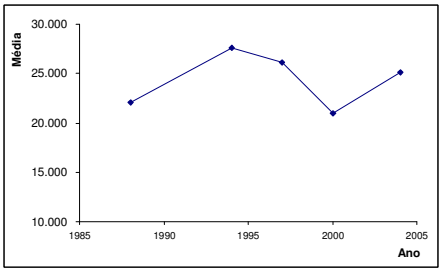


Figure 8 – Temporal Evolution - Class 6

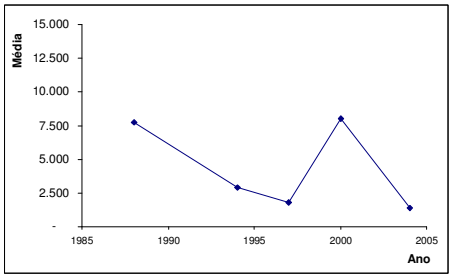
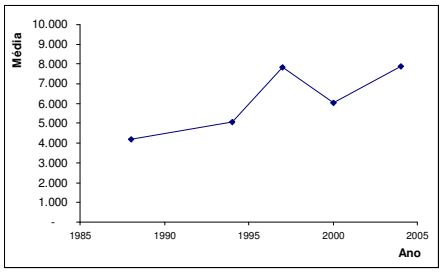


Figure 9 – Temporal Evolution - Class 7



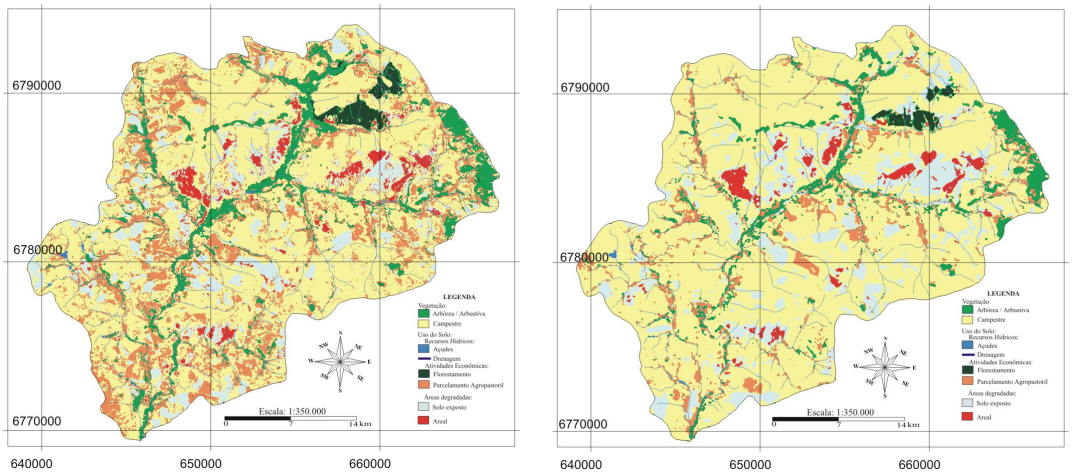


Figure 9. Use of land map and and vegetal covering (1988 and 1994).

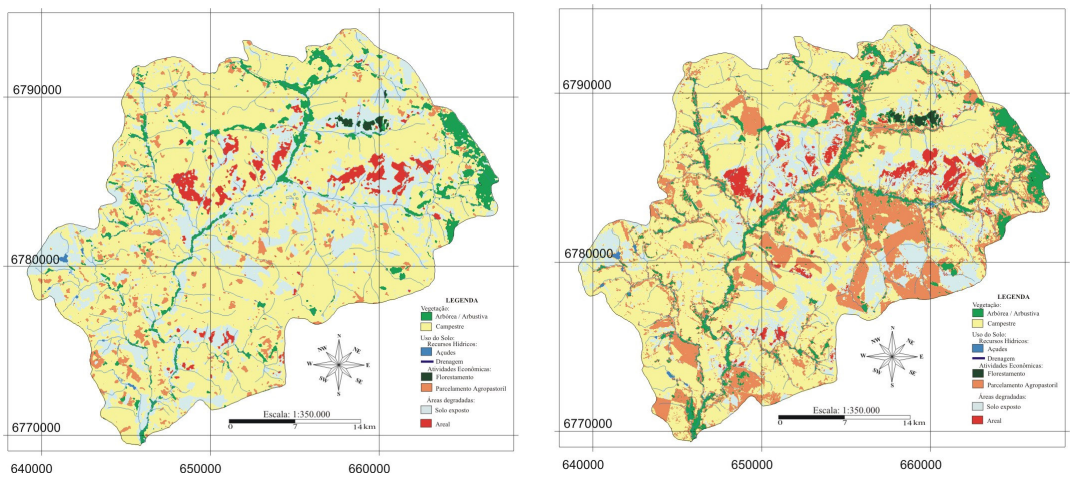


Figure 10. Use of land map and and vegetal covering (1997 and 2000).

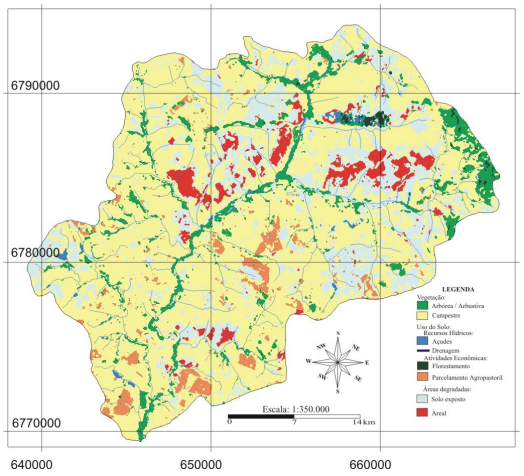


Figure 11: Use of land map and and vegetal covering (2004).

The table 3 summarizes the results, where it is noticed that the change in relation areais (2004). The biggest values belong the displayed alone class, in view of that areas of reduced biomass they had been incluidas in the areas of *areal*, these areas are converted into *agro-pastoril*.

Table 3 –Change in relation areais (2004)

	1988	1994	1997	2000
florestamento	42.57	14.04		
arbórea/arbustiva	5.94	8.64	2.16	4.95
campestre	208.17	157.05	296.82	135.63
agro-pastoril	67.77	3.96		20.52
solos exposto	523.8	753.93	473.94	703.44

Another important data are the values presented for the campestre class, that they show a relation with the arenização process, it facilitates for low the declivity, geomorphology hill compartment, being an interface with the process hydrology modellers of forms associates to the *arenização* (*ravinas* and *voçorocas*), indicating a referencia for the transformation of the areas.

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