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VARIATION OF HORIZONTAL STRUCTURE OF VEGETATION COVER IN THE URBAN AREA OF SANTA MARIA, RIO GRANDE DO SUL STATE, BRAZIL, BETWEEN 1980 AND 2011

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ABSTRACT

This study investigates the variation of horizontal vegetation structure in the urban area of Santa Maria, Rio Grande do Sul State, Brazil, based on the mapping and measurement of distributive dynamics of vegetation in the city in recent decades. The analysis used an aero photogrammetric survey from January 1980, consisting of a mosaic of 173 aerial photographs, and *Geoeye* image fragments with high spatial resolution from September 21, 2011, extracted from *Google Earth* 6.1. The materials were georeferenced and processed in Spring 5.1.7 software, which allowed to map and analyze the variation of vegetation cover in the city neighborhoods. Generally, we observed a loss of 12.38% of the city's total vegetation cover in the last 31 years, resulting in 4.6% of tree cover loss in the city. In some areas, such as Centro Urbano, the loss was about 20% of the total vegetation cover, roughly 15% loss of tree cover. The knowledge of these processes allows to identify the areas where vegetation losses increased and to promote management guidelines for urban and environmental planning considering a better distribution of green spaces and their functionality.

Key-words: Urban landscape, vegetation, environmental management, urbanization.

VARIAÇÃO DA ESTRUTURA HORIZONTAL DE COBERTURA VEGETAL NA ÁREA URBANA DE SANTA MARIA (RS) ENTRE 1980 e 2011

RESUMO

O presente artigo objetiva analisar a variação da estrutura horizontal da cobertura vegetal na área urbana de Santa Maria (RS), por meio do mapeamento e mensuração da dinâmica distributiva de vegetação na cidade nas últimas décadas. A análise foi feita com base em um levantamento aerofotogramétrico de janeiro de 1980, composto por um mosaico de 173 fotografias aéreas, e fragmentos da imagem *Geoeye*, de alta resolução espacial, de 21/09/2011, extraída do *software Google Earth* 6.1. Os materiais foram georreferenciados e processados junto ao *software* Spring 5.1.7, que permitiu a geração dos mapeamentos, analisados considerando a variação da cobertura vegetal nas unidades de bairros e Regiões Administrativas atuais da cidade. De forma geral, observa-se uma perda de 12,38% da cobertura vegetal total da cidade nesses 31 anos, onde se contabilizaram perdas de 4,6% da vegetação arbórea. Em algumas áreas, como na Região Administrativa Centro Urbano, os bairros perderam cerca de 20% de cobertura vegetal total, sendo aproximadamente 15% de perdas de cobertura vegetal arbórea. Acredita-se que a compreensão desses processos permite identificar as áreas onde as perdas de cobertura vegetal na cidade ocorreram com maior intensidade, o que possibilita o estabelecimento de diretrizes de gestão que auxiliem na elaboração de um planejamento urbano e ambiental que considere uma melhor distribuição dos espaços verdes e suas funcionalidades.

Palavras-chave: Paisagem urbana; vegetação; gestão ambiental; urbanização.

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INTRODUCTION

The urbanization process is a striking phenomenon of the 20th century, consolidating the city as the main residence of human populations. Measuring the growing indexes of urban population is a challenge for researchers and professionals that discuss environmental and urban planning to seek alternatives for managing existing conflicts in society-nature relationship in urban areas. The aim is to ensure good living conditions of human populations without compromising the natural conditions and considering the ecological processes for a better use of the benefits that they provide (DIAS, 1997).

The urban landscape, reflecting the direct coexistence of human with nature, is the space where environmental conflicts are more aggravated and apparent, which highlights the reality about the deterioration of the relations of urban individuals with the natural environment. When understood as systems where dynamic flows of energy, matter, and information are shown, cities began to differentiate themselves from their rural surroundings, suffering many times with the excessive artificialization of their structure leading to the loss of environmental features.

Regarding the natural attributes in planning the urban landscape, the main topic is the proper management of vegetation, which is a tool used to solve problems (NUCCI, 2008). Thus, vegetation cover, in both qualitative and quantitative terms, and its spatial distribution, must be carefully considered in the evaluation of environmental quality (TIAN et al., 2014; PHAM et al., 2012).

This study analyzes the variation of the horizontal structure of the vegetation cover in the urban area of Santa Maria, Rio Grande do Sul State, Brazil, using the mapping and measurement of the vegetation distribution in the city in recent decades (1980-2011). An understanding of this structure is essential to identify the areas where the loss of vegetation cover, and consequently its environmental functions, occurs more intensely. Once identified, these areas may be prioritized in recovery strategies within a process of environmental management to consider a better distribution of green spaces and environmental services associated with them, such as temperature regulation, water retention, humidity maintenance, dust retention, and leisure activities.

Urbanization process and vegetation cover contribution

When discussing the dynamics of urban landscape in relation to the growth of cities considering the use of space, we observe that impermeability of soils and the consequent reduction in vegetation cover in urban areas is one of the most noticeable factors, representing a reduction of environmental functions that urban vegetation needs to provide (ALBERTI, 1999; SPIRN, 1995).

Regarding the insufficiency or inadequacy of technological measures for the control of environmental degradation, Cavalheiro (2009) argues that it seems more logical that, first, we take advantage of what nature can offer with regard to self-regulation, and then study which technologies should be used.

The process of land use planning and regulation of urban activities must contain strategies tailored to each location for ecological maintenance, soil permeability, temperature control, shelter, and food production for certain species, to go beyond the simplistic concept of the landscape for its sole aesthetic purpose, like many municipal managers administrate the urban environment (BORGES et al., 2010).

Nucci (2008) highlights the role of vegetation cover to provide urban environmental quality, by identifying it as a very important attribute, however neglected, in the development of cities, which unlike the soil, air and water, is not perceived as an obvious need in the urban environment.

In the urban landscape, vegetation cover is more related with psychological satisfaction, neglecting the other environmental services that are provided by this natural structure.

Tian et al. (2014) argue that green spaces are important natural and cultural entities of cities, ensuring multiple benefits to urban residents. The environmental services provided by urban forest comprise air purification (SHAN et al., 2007; JIM and CHEN, 2008) and reduction of the heat island effect (MAIMAITIYIMING et al., 2014). Psychological benefits (FULLER et al., 2007) are related to stress reduction, improving physical health, enabling for example the extension of life expectancy of elderly people in major cities (TAKANO et al., 2002). In addition, Nucci and Cavalheiro (1999) state that vegetation cover can act as an obstacle against the wind, protect water quality, balance air humidity, buffer noises, absorb water and protect water springs and fountains, among others.

From the biotic perspective, vegetation cover in urban areas also fulfils a strategic role in decreasing the dryness of the urban matrix, ensuring a greater permeability of gene flow, as well as a connection between larger fragments located in peripheral areas (LÖFVENHAFT et al., 2002).

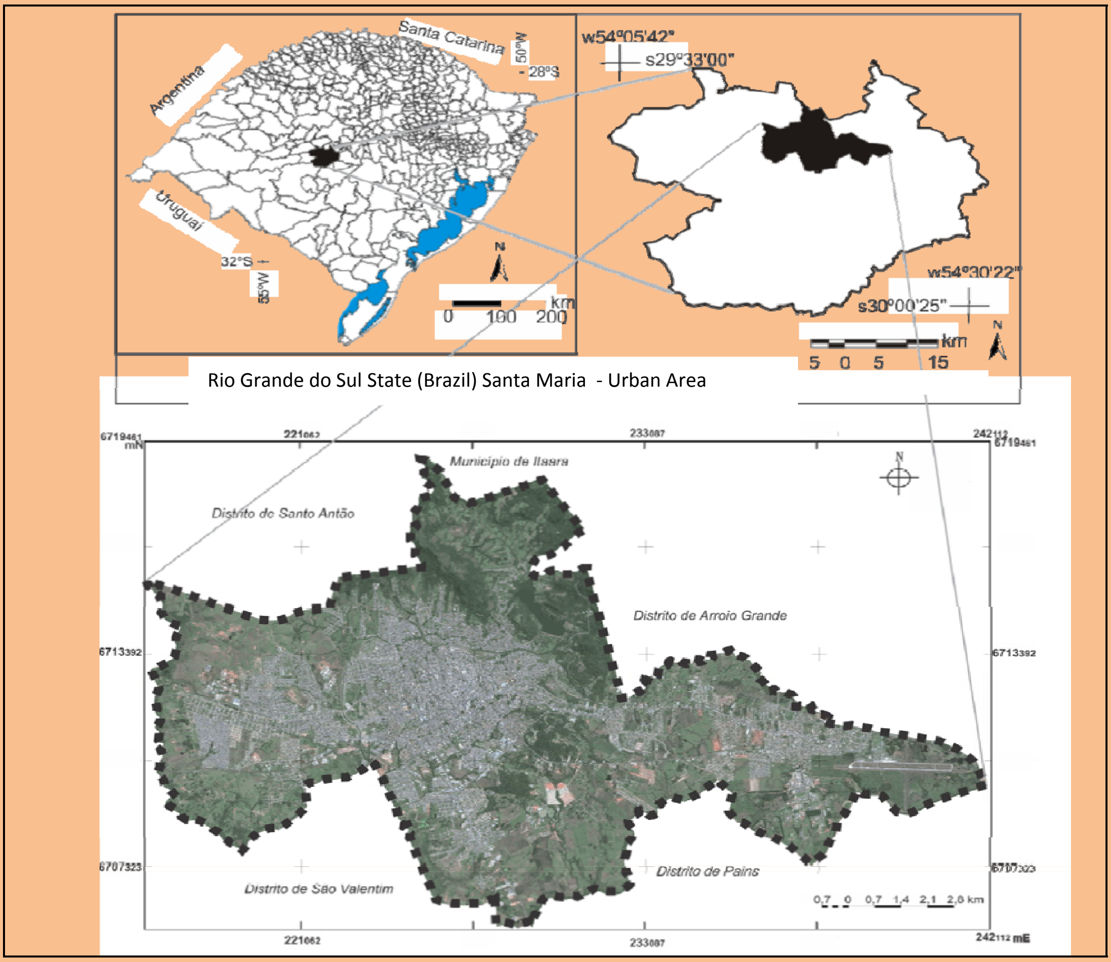
The understanding of these benefits provide by vegetation cover in urban areas shows the importance of the analysis of its distribution dynamics associated with the growth process of cities, to obtain data to subsidize environmental management guidelines with strategies for maintaining a good configuration structure of vegetation cover in urbanized landscapes.

Spatial characterization of the urban landscape in Santa Maria

The city of Santa Maria (Fig. 1) lies in a transition area between the geomorphological central depression of Rio Grande do Sul State and the southern Brazilian plateau (ROSS, 2001), with a transitional vegetation cover formation between the forest landscapes of the Atlantic Forest (Deciduous Stationary Forest) and the countryside of the Pampa Gaucho (CPRM, 2009; IBGE, 2012).

The indentation of the escarpment of the Serra Geral by erosion results in the formation, near the urban site, of a set of residual reliefs (hills), housing forest fragments with different levels of connectivity, which bear past limits of the forest ecosystem in this territory. In this sense, it is highlighted the central-western and northern sectors of the urban area, where the hills Cerrito, Mariano da Rocha and Cechela are located.

Figure 1. Location of city of Santa Maria in the state of Rio Grande do Sul, Brazil, with the urban perimeter highlighted.



Source: organized by the author. Image obtained from *software* Google Earth and corresponds to *Geoeye* image of Sept. 21, 2011.

Originally, Santa Maria had most of its urban site covered by a Deciduous Stationery Forest and it is considered an example of a medium-sized city with accelerated growth, where the urban vegetation cover was being suppressed, giving space to the buildings and the traffic routes, without concerns for the conservation of the original biotic heritage.

Currently the city comprises 261,027 inhabitants (IBGE, 2010), the city had major growth boosts associated with, in the first half of the 20th century, its main character of railway junction in the state and, in the second half of the 20th century, with the role of regional services hub, especially linked to the educational sector and military. Each of these boosts represented, and still do, significant losses of original vegetation cover, further exacerbated by the almost non-existent urban leisure equipment associated with parks and/or large green areas.

MATERIAL AND METHODS

We used the following materials: survey data collected through aerial photographs from January 1980, consisting of 173 aerial photographs of high spatial resolution, generated on the scale of approximately 1:7,000; *Geoeye* image fragments of high spatial resolution (0.64 m) from Sept. 21, 2011, obtained from the software *Google Earth* 6.1. The aerial photographs required treatment prior to import into a database in Spring *software*, where they were placed as a mosaic to obtain a single cartographic product. The *Geoeye* image was imported and registered directly. The georeferencing of the mosaic and the image was made based on an image already recorded (HRC/CBERS 2B sensor imaging).

Afterwards, the classes to be obtained were defined based on the mosaic of aerial photographs from 1980 and the image from 2011. We opted, in accordance with the availability of cartographic products, for the extraction of four classes in each map: arboreal vegetation cover, herbaceous and shrubby vegetation cover, built-up spaces, and drainage network.

The first class included areas with presence of large arboreal vegetation cover. In the second, due to the inability to distinguish clearly in the scale of analysis (1:10,000) the differentiation between herbaceous and shrubby vegetation, we decided to include both in the same class. In this class, we also included some areas of rural use situated in some urban-rural transition zones. The third class incorporated all the built-up environment and traffic routes, including the areas of exposed soils. The drainage network included water channels located in the urban area, and their water reservoirs, and were classified according to their river hierarchy.

Afterwards, we classified the materials available, starting from the data of 2011. The image was classified with an algorithm for pixel reading, based on classifier *Maxver*[4] (maximum likelihood) from the acquisition of training and testing sample polygons. The result of that classification was monitored and optimized, resulting in "the map of vegetation cover distribution of the urban area of Santa Maria (2011)". We included, together with the thematic classes, information concerning the plans divisions of neighborhoods, Administrative Regions[5] (ARs) and the drainage network.

The same procedure was used for the data from 1980, classifying them from the acquisition samples of testing and training, using the *Maxver* classifier. The image was subjected to a more detailed analysis than the data of 2011 because the mosaic presented images with certain photographs with different levels of contrasts, which made it difficult to classify. The drainage network did not show significant changes between the two dates, therefore, we used the same level of information. For comparison purposes, we decided to use the same administrative boundaries on both cartographic products generated, even if the neighborhoods in 1980 did not have the limits observed in 2011.

The precision analysis of the surveys was carried out based on the analysis of classification error array, using the values of overall performance, average confusion and *kappa* statistics, which according to Landis and Koch (1977), considers the optimal classification accuracy if the index is higher than 0.81. From the values of average confusion of sampling analysis, and considering that the classifications were submitted to a detailed visual supervision for their optimization, we

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[4] This classification method tends to overestimate the arboreal vegetation, since it often classifies turf areas and some soil areas exposed as tree crowns (Costa et al., 2012). To overcome this problem, we used more acquisition samples and tests (Ribeiro and Centeno, 2001).

[5] Administrative regions (ARs) correspond to a group of neighborhoods by geographical sector of the city, defined by the Municipal Government of Santa Maria.

defined an error margin percentage to compare the dates. The use of an error margin is relevant because of the comparison between classifications on a distinct basis.

Therefore, the measurements of the classes of each map were tabulated according to the division of neighborhoods and ARs of 2011, allowing quantitative analyses of shrinkage/expansion of mapped classes in these territorial units. To further analyze the total area per class according to the neighborhoods, we deepened the distribution analysis of fragments forest in 1980 and 2011. For that, we observed and described vegetation cover according to the percentage values of trees and the vegetation cover percentage in each district and AR. From the values of the total vegetation cover variation per unit area, we defined classes of percentage loss of vegetation (0-5%, 5-10%, 10-15%, 15-20%, 20-25%, >25%) and we generated a map that identified the areas of major and minor loss intensities in the analysis period.

RESULTS AND DISCUSSION

Variation of vegetation cover in the urban area of Santa Maria (1980-2011)

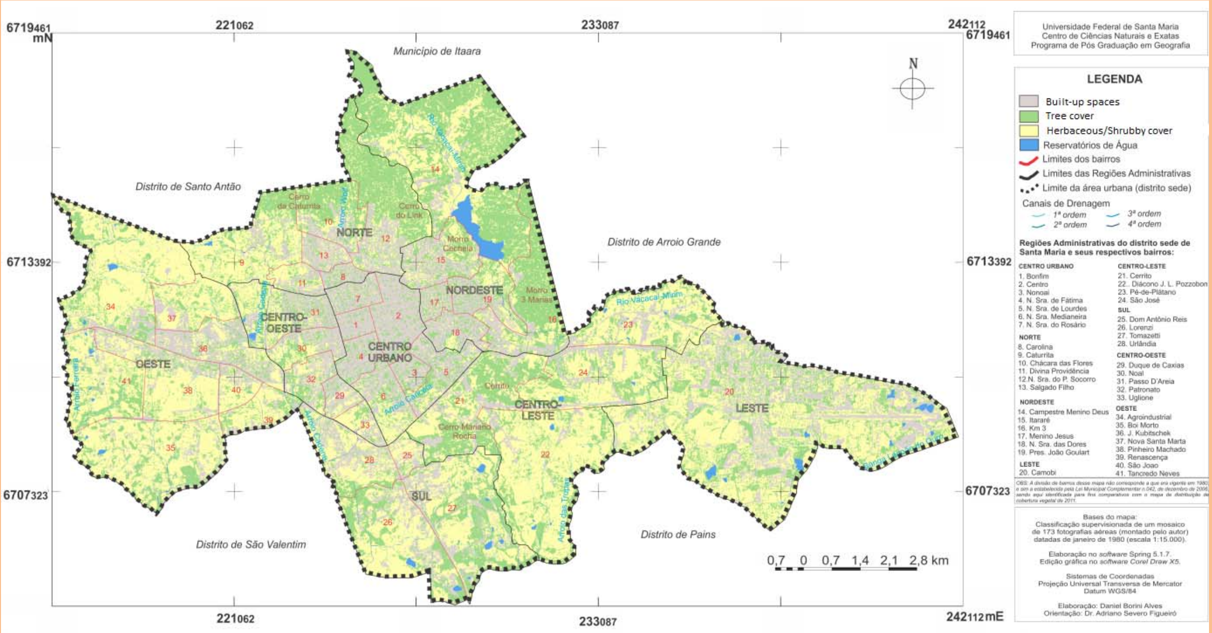
Based on the classification of the mosaics of aerial photographs from 1980, we designed the map of vegetation cover distribution of the urban area of Santa Maria for that period (Fig. 2). We used this map to obtain information per neighborhoods and ARs of Santa Maria urban area (Table 1). The sample analysis of the classification indicated an overall performance of 93.43%, with an average confusion of 6.57%. The *kappa* index indicates excellence in accuracy of classification (0.824).

In the AR Centro Urbano, the class of “built-up spaces” in 1980, the rate of coverage was approximately 53%, which already revealed a densification of buildings in central city neighborhoods. In this aspect, the neighborhoods Bonfim and Downtown stood out, with approximately 70% of the area occupied by buildings. The distribution of vegetation cover showed that, despite the densification of buildings, it was possible to observe a number of isolated arboreal vegetation.

The AR North presented in 1980 the formation of some neighborhoods with increase of the built-up environment, in spite of having only 17.81% of its area included in built-up class of spaces. The predominance of vegetation cover in this region is associated to the fact that part of these neighborhoods featured extensive wooded areas associated with the APP areas (Areas of Permanent Protection) on the hillside of Serra Geral, as in the case of the Chácara das Flores and Nossa Senhora do Perpétuo Socorro, with 60.29% and 66.74% of vegetation cover, respectively.

In some neighborhoods of the AR Northeast, we also observed areas along the hillside of Serra Geral, such as Campestre Menino Deus neighborhood, and the neighborhoods Km 3 and Itararé (contact with Cechela Hill), which increased its percentage of arboreal vegetation cover (roughly 49%).

Figure 2. Map of vegetation cover distribution in the urban area of Santa Maria (1980).



Source: elaborated by the authors.

In the AR Central-East, we observed that the rate of built-up spaces in 1980 was still low, with the fragments of arboreal vegetation of the hills Cerrito and Mariano Rocha, as the most expressive. The other areas still showed high level of herbaceous and shrubby vegetation cover, where some spaces were associated with agricultural activities practiced in the current urban area perimeter.

The ARs East and West presented similar conditions in relation to the predominant thematic classes. Both areas showed occupation of the built-up environment, still not very intense, which was formed along the areas of vegetation cover mostly herbaceous and shrubby, with the presence of more expressive arboreal fragments related to the forests along the canals for drainage systems. Toward the AR West, we observed the densification of buildings of the Juscelino Kubitschek neighborhood compared to other neighborhoods, which was associated with the creation of the Santa Marta housing estate.

In the AR Central-West, we observed an increase of the built-up areas in relation to the rates of RAs East, West and Central-East, where vegetation cover was associated to the banks of Arroio Cadena River and its tributaries. The buil-up spaces already represented circa 30% of the region, while vegetation cover accounted for circa 69% of the area.

In AR South, we identified low rates of the built-up environment in relation to vegetal cover spaces, occupying less than 10% of the total area. We observed fragments of arboreal vegetation well configured, large and near the drainage canals and their surroundings. The vegetation cover accounted for about 83% of the area.

In 2011, the advancement of the built-up areas and the reduction of vegetation cover of the urban area of Santa Maria can be seen in the image classification *Geoeye*. We also used the map of vegetal cover of 2011 (Fig. 3) to generate measurement classes for the neighborhoods and ARs (Table 2). The array of classification error indicates overall performance of 98.32%, with an average confusion of 1.68%, and the *kappa* index of 0.884 (optimal).

The map of vegetation cover distribution of 2011 is clearly inserted into a denser array of built-up spaces, where we observe that the advancement of the built-up environment was primarily vectored towards the West, East and South. While to the North, despite the increase in built-up area in relation to 1980, we observe a slight tendency of stagnation of urban progress due to the geomorphological barrier of the plateau escarpment.

The larger fragments with a greater connectivity level are still associated with the areas of escarpment and hillsides, and the forest fragments notoriously lost space where the advancement of built-up areas intensified, as the example of the surroundings of Arroio Cadena, the Central-West, and the surroundings of Arroio Cancela, south of Centro Urbano.

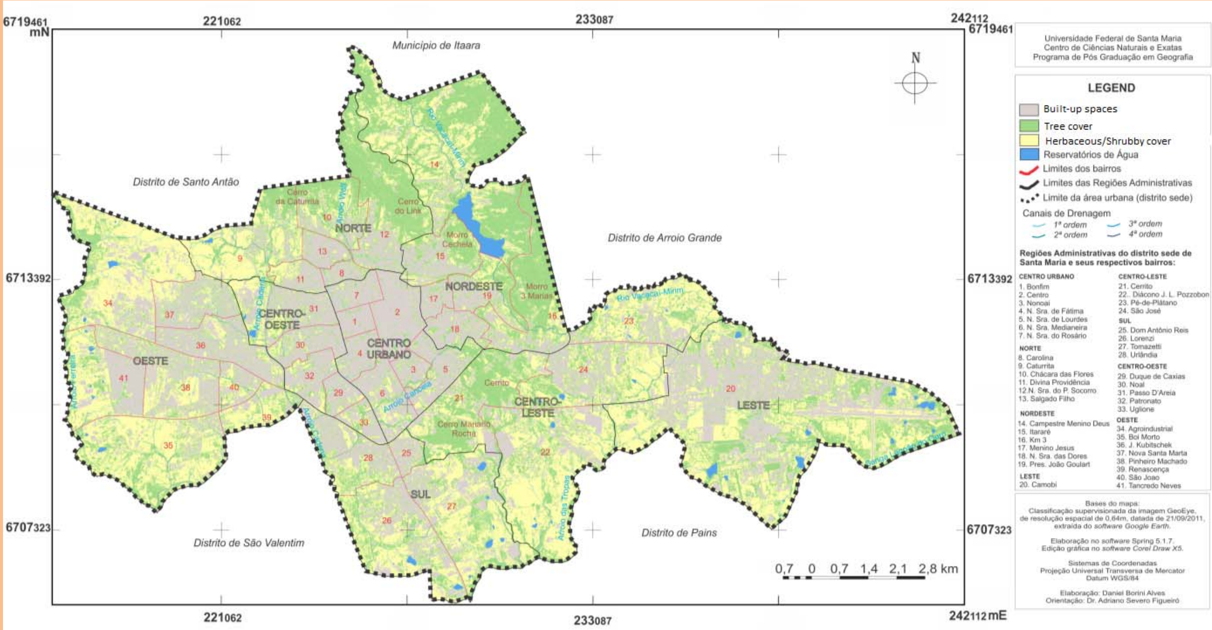
Table 1. Land use and vegetation cover per neighborhood in the urban area of Santa Maria (1980).

ARs	Neighborhood	Total Area (ha)	Land use and vegetation cover*							
			EC		CVA		CVHA		RD	
			(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)
CENTRO URBANO	Bonfim	55.46	37.91	68.36	13.83	24.94	3.72	6.71	0.00	0.00
	Centro	190.44	131.44	69.02	46.70	24.52	12.11	6.36	0.19	0.10
	Nonoai	60.91	30.64	50.30	22.81	37.45	7.22	11.85	0.24	0.39
	Nossa Sra. de Fátima	91.48	53.68	58.68	30.12	32.93	7.36	8.05	0.32	0.35
	Nossa Sra. de Lourdes	162.34	65.21	40.17	66.32	40.85	30.41	18.73	0.41	0.25
	Nossa Sra. Medianeira	162.12	50.56	31.19	54.40	33.56	56.58	34.90	0.58	0.36
	Nossa Sra. do Rosário	84.77	55.77	65.79	21.33	25.16	7.49	8.84	0.18	0.21
	TOTAL	**807.52**	**425.21**	**52.66**	**255.51**	**31.64**	**124.89**	**15.47**	**1.92**	**0.24**
NORTH	Carolina	46.63	25.35	54.36	15.79	33.86	5.26	11.28	0.23	0.49
	Caturrita	393.09	23.52	5.98	133.57	33.98	232.17	59.06	3.82	0.97
	Chácara das Flores	225.8	36.93	16.36	136.13	60.29	51.77	22.93	0.97	0.43
	Divina Providência	81.95	21.41	26.13	22.33	27.25	37.85	46.19	0.36	0.44
	Nossa Sra. do Perpétuo Socorro	458.61	74.03	16.14	306.08	66.74	77.79	16.96	0.71	0.15
	Salgado Filho	76.56	40.73	53.20	17.05	22.27	18.61	24.31	0.17	0.22
	TOTAL	**1,282.64**	**221.97**	**17.31**	**630.94**	**49.19**	**423.45**	**33.01**	**6.26**	**0.49**
NORTHEAST	Campestre Menino Deus	1089.78	32.17	2.95	687.96	63.13	310.31	28.47	59.34	5.45
	Itararé	222.41	69.03	31.04	102.02	45.87	51.27	23.05	0.09	0.04
	Km 3	377.73	59.33	15.71	261.85	69.32	55.99	14.82	0.56	0.15
	Menino Jesus	58.13	32.54	55.98	18.83	32.39	6.76	11.63	0.00	0.00
	Nossa Sra. das Dores	112.37	62.14	55.30	32.39	28.82	17.66	15.72	0.18	0.16
	Pres. Joao Goulart	178.06	58.32	32.75	74.40	41.78	44.35	24.91	0.99	0.56
	TOTAL	**2,038.48**	**313.53**	**15.38**	**1,177.4**	**57.76**	**486.34**	**23.86**	**61.16**	**3.00**
EAST	Camobi	2,040.29	392.50	19.24	632.97	31.02	988.11	48.43	26.71	1.31
	TOTAL	**2,040.29**	**392.50**	**19.24**	**632.97**	**31.02**	**988.11**	**48.43**	**26.71**	**1.31**
CENTRAL-EAST	Cerrito	462.13	63.34	13.71	261.54	56.59	136.84	29.61	0.41	0.09
	Diácono João Luiz Pozzobon	775.23	21.72	2.80	225.89	29.14	522.74	67.43	4.88	0.63
	Pé-de-Plátano	411.60	45.24	10.99	115.35	28.02	247.61	60.16	3.4	0.83
	São José	466	69.28	14.87	158.60	34.03	234.88	50.40	3.24	0.70
	TOTAL	**2,114.96**	**199.58**	**9.44**	**761.38**	**36.00**	**1,142.0**	**54.00**	**11.93**	**0.56**
SOUTH	Dom Antônio Reis	62.42	12.82	20.54	15.31	24.53	34.12	54.66	0.17	0.27
	Lorenzi	484.73	63.41	13.08	163.42	33.71	250.65	51.71	7.25	1.50
	Tomazetti	585.44	85.72	14.64	239.81	40.96	250.70	42.82	9.21	1.57
	Urlândia	273.88	58.75	21.45	78.26	28.57	135.56	49.50	1.31	0.48
	TOTAL	**1,406.47**	**220.70**	**15.69**	**496.80**	**35.32**	**671.03**	**47.71**	**17.94**	**1.28**
CENTRAL-WEST	Duque de Caxias	65.8	29.03	44.12	15.51	23.57	20.96	31.85	0.3	0.46
	Noal	124	39.17	31.59	45.08	36.35	39.34	31.73	0.41	0.33
	Passo D'Areia	265.37	69.28	26.11	95.93	36.15	96.75	36.46	3.41	1.28
	Patronato	118.32	37.34	31.56	44.68	37.76	36.06	30.48	0.24	0.20
	Uglione	67.79	16.89	24.92	19.41	28.63	31.32	46.20	0.17	0.25
	TOTAL	**641.28**	**191.71**	**29.89**	**220.61**	**34.40**	**224.43**	**35.00**	**4.53**	**0.71**
WEST	Agroindustrial	651.18	45.38	6.97	141.36	21.71	457.47	70.25	6.97	1.07
	Boi Morto	583.82	44.60	7.64	173.17	29.66	361.76	61.96	4.29	0.73
	Juscelino Kubitschek	247.98	113.08	45.60	61.42	24.77	72.70	29.32	0.78	0.31
	Nova Santa Marta	207.4	27.46	13.24	46.20	22.28	132.96	64.11	0.78	0.38
	Pinheiro Machado	356.34	61.70	17.31	77.13	21.65	217.16	60.94	0.35	0.10
	Renascença	141.86	17.65	12.44	43.80	30.88	79.74	56.21	0.67	0.47
	São João	85.17	15.10	17.73	17.75	20.84	52.09	61.16	0.23	0.27
	Tancredo Neves	340.41	19.60	5.76	118.60	34.84	198.20	58.22	4.01	1.18
	TOTAL	**2,614.16**	**344.57**	**13.18**	**679.43**	**25.99**	**1,572.0**	**60.14**	**18.08**	**0.69**
ALL	**TOTAL**	**12,945.8**	**2,309.7**	**17.84**	**4,855.1**	**37.50**	**5,632.4**	**43.51**	**148.53**	**1.15**

ARs=Administrative Regions; **EC**= Built-up Spaces; **CVA**= Arboreal Vegetation Cover; **CVHA**= Herbaceous and/or Shrubby Vegetation Cover; **RD**= Drainage Network.

*For each class, we indicate the vegetation cover area and the rate of vegetation cover (%) in relation to the total area of the neighborhoods.

Figure 3. Map of vegetation cover distribution of in urban area of Santa Maria (2011).



Source: elaborated by the authors.

In the AR Centro Urbano, every neighborhood already presented in the 2011, a level of built-up areas higher that the others, with coverage of more than 60% of its total area, where the neighborhoods Bonfim and Downtown had greater percentages, 86.57% and 86.25%, respectively. The vegetation cover distribution in the neighborhoods Nossa Senhora de Lourdes and Nossa Senhora Medianeira shows areas that still have more aggregated fragments, while in neighborhoods of greater urban density, arboreal fragments lost much space, represented by a few isolated individuals.

In the ARs North and Northeast, we observe a high rate of vegetation cover linked to vegetation associated with the presence of the hillsides. In these regions, few neighborhoods showed intensified urban density in relation to 1980, namely Divina Providência (which practically doubled its rate of built-up spaces, from 26.13% to 50.71%), Salgado Filho (from 40.73% to 69.93%) and Menino Jesus (from 32.54% to 75.80%) neighborhoods, which refer to the neighborhoods closest to the central area of the city. Overall, these two regions recorded the lowest rate of densification of the built-up environment (5.67% in the neighborhoods of the AR North and 2.96% in the neighborhoods of AR Northeast). The ARs Central-West, West and South also recorded high rates of advancement of the built-up environment to the detriment of previously most vegetated areas.

ARs=Administrative Regions; **EC**= Built-up Spaces; **CVA**= Arboreal Vegetation Cover; **CVHA**= Herbaceous and/or Shrubby Vegetation Cover; **RD**= Drainage Network.
*For each class, we indicate the vegetation cover area and the rate of vegetation cover (%) in relation to the total area of the neighborhoods.

Table 2. Land use and vegetation cover per neighborhoods in urban area of Santa Maria (2011).

ARs	Neighborhood	Total area (ha)	Land use and vegetation cover*							
			EC		CVA		CVHA		RD	
			(ha)	*(%)*	*(ha)*	*(%)*	*(ha)*	*(%)*	*(ha)*	*(%)*
CENTRO URBANO	Bonfim	55.46	48.01	86.57	5.55	10.01	1.90	3.43	0.00	0.00
	Centro	190.44	164.26	86.25	19.09	10.02	6.9	3.62	0.19	0.10
	Nonoai	60.91	41.08	67.44	13.21	21.69	6.38	10.47	0.24	0.39
	Nossa Sra. de Fátima	91.48	71.05	77.67	14.01	15.31	6.1	6.67	0.32	0.35
	Nossa Sra. de Lourdes	162.34	100.05	61.63	40.39	24.88	21.49	13.24	0.41	0.25
	Nossa Sra. Medianeira	162.12	99.43	61.33	30.82	19.01	31.29	19.30	0.58	0.36
	Nossa Sra. do Rosário	84.77	65.65	77.44	12.91	15.23	6.03	7.11	0.18	0.21
	TOTAL	**807.52**	**589.53**	**73.01**	**135.98**	**16.84**	**80.09**	**9.92**	**1.92**	**0.24**
NORTH	Carolina	46.63	29.91	64.14	11.51	24.68	4.98	10.68	0.23	0.49
	Caturrita	393.09	46.54	11.84	130.25	33.13	212.48	54.05	3.82	0.97
	Chácara das Flores	225.8	44.77	19.83	119.44	52.90	60.62	26.85	0.97	0.43
	Divina Providência	81.95	41.56	50.71	16.23	19.80	23.8	29.04	0.36	0.44
	Nossa Sra. do Perpétuo Socorro	458.61	78.42	17.10	304.82	66.47	74.66	16.28	0.71	0.15
	Salgado Filho	76.56	53.54	69.93	14.95	19.53	7.90	10.32	0.17	0.22
	TOTAL	**1,282.64**	**294.74**	**22.98**	**597.2**	**46.56**	**384.44**	**29.97**	**6.26**	**0.49**
NORTHEAST	Campestre Menino Deus	1,089.78	53.87	4.94	650.34	59.68	326.23	29.94	59.34	5.45
	Itararé	222.41	78.2	35.16	101.16	45.48	42.96	19.32	0.09	0.04
	Km 3	377.73	61.16	16.19	246.62	65.29	69.39	18.37	0.56	0.15
	Menino Jesus	58.13	44.03	75.74	10.46	17.99	3.64	6.26	0.00	0.00
	Nossa Sra. das Dores	112.37	75.8	67.46	24.53	21.83	11.86	10.55	0.18	0.16
	Pres. Joao Goulart	178.06	60.83	34.16	71.34	40.07	44.9	25.22	0.99	0.56
	TOTAL	**2,038.48**	**373.89**	**18.34**	**1,104.45**	**54.18**	**498.98**	**24.48**	**61.16**	**3.00**
EAST	Camobi	2,040.29	644.97	31.61	617.57	30.27	751.04	36.81	26.71	1.31
	TOTAL	**2,040.29**	**644.97**	**31.61**	**617.57**	**30.27**	**751.04**	**36.81**	**26.71**	**1.31**
CENTRAL-EAST	Cerrito	462.13	75.16	16.26	260.32	56.33	126.24	27.32	0.41	0.09
	Diácono João Luiz Pozzobon	775.23	125.18	16.15	196.14	25.30	449.03	57.92	4.88	0.63
	Pé-de-Plátano	411.60	80.25	19.50	105.78	25.70	222.17	53.98	3.4	0.83
	São José	466	123.99	26.61	134.99	28.97	203.78	43.73	3.24	0.70
	TOTAL	**2,114.96**	**404.58**	**19.13**	**697.23**	**32.97**	**1,001.22**	**47.34**	**11.93**	**0.56**
SOUTH	Dom Antônio Reis	62.42	37.64	60.30	14.00	22.43	10.61	17.00	0.17	0.27
	Lorenzi	484.73	139.44	28.77	130.2	26.86	207.84	42.88	7.25	1.50
	Tomazetti	585.44	140.9	24.07	160.14	27.35	275.19	47.01	9.21	1.57
	Urlândia	273.88	116.18	42.42	76.77	28.03	79.62	29.07	1.31	0.48
	TOTAL	**1,406.47**	**434.16**	**30.87**	**381.11**	**27.10**	**573.26**	**40.76**	**17.94**	**1.28**
CENTRAL-WEST	Duque de Caxias	65.8	45.14	68.60	12.02	18.27	8.34	12.67	0.3	0.46
	Noal	124	81.13	65.43	23.63	19.06	18.83	15.19	0.41	0.33
	Passo D'Areia	265.37	126.65	47.73	58.83	22.17	76.48	28.82	3.41	1.28
	Patronato	118.32	72.73	61.47	23.44	19.81	21.91	18.52	0.24	0.20
	Uglione	67.79	35.62	52.54	17.48	25.79	14.52	21.42	0.17	0.25
	TOTAL	**641.28**	**361.27**	**56.34**	**135.4**	**21.11**	**140.08**	**21.84**	**4.53**	**0.71**
WEST	Agroindustrial	651.18	118.99	18.27	136.01	20.89	389.21	59.77	6.97	1.07
	Boi Morto	583.82	61.45	10.53	171.18	29.32	346.9	59.42	4.29	0.73
	Juscelino Kubitschek	247.98	157.4	63.47	46.65	18.81	43.15	17.40	0.78	0.31
	Nova Santa Marta	207.4	109.94	53.01	43.04	20.75	53.64	25.86	0.78	0.38
	Pinheiro Machado	356.34	167.99	47.14	69.98	19.64	118.02	33.12	0.35	0.10
	Renascença	141.86	28.38	20.01	38.92	27.44	73.89	52.09	0.67	0.47
	São João	85.17	40.41	47.45	17.44	20.48	27.09	31.81	0.23	0.27
	Tancredo Neves	340.41	125.12	36.76	67.08	19.71	144.2	42.36	4.01	1.18
	TOTAL	**2,614.16**	**809.68**	**30.97**	**590.3**	**22.58**	**1,196.1**	**45.75**	**18.08**	**0.69**
ALL	**TOTAL**	**12945,8**	**3,912.82**	**30.22**	**4,259,4**	**32.90**	**4,625.21**	**35.73**	**148.53**	**1.15**

In the Central-West AR, we registered the highest increase of densification of buildings. The built-up spaces class showed a 26.45% increase, suppressing vegetation cover, which lost about 13% of tree vegetation cover and other 13% of herbaceous and/or shrubby vegetation cover. Much of this loss of tree cover refers to the illegal suppression of gallery forest, whose implications go far beyond the biotic system functionality, involving also a profound change in its hydrological feature.

In the AR West, the advance of built-up areas reflected mostly on the loss of vegetation cover of herbaceous and/or shrubby vegetation rather than on tree-sized vegetation, once 18.08% of the increase of built-up spaces referred to the loss of 14% of herbaceous and/or shrubby vegetation.

In AR South, which showed increase of built-up areas of approximately 15% compared to the map of 1980, we highlight for Dom Antônio Reis and Urlândia neighborhoods, which had an increase of densification of buildings of 39.76% and 20.97 %, respectively.

The ARs Central-East and East showed similar conditions, with an advance of built-up environment not as intense in comparison with the rates of 1980 (12.37% in AR East and 9.69% in AR Central-East), but these areas already show a trend of densification in the Camobi neighborhood. The Central-East AR showed a loss of about 3% of tree vegetation cover and other 6% of herbaceous and/or shrubby vegetation cover. In the AR East, the loss of herbaceous and/or shrubby vegetation cover was also more significant, about 11%, plus another 1% loss of tree vegetation cover.

Regarding the dynamics of vegetation cover between the dates mapped, we observe in Table 3, the vegetation loss per neighborhoods in the past 31 years. Given the limitations imposed by the distinction of base products of classifications, we established an error margin of 3.5% for comparison purposes between the periods analyzed.

We highlight that the variation in every neighborhood between both periods studied, for arboreal vegetation cover and total vegetation cover, presents a scenario of loss of green spaces. In General, there is a loss of 12.38% of the total vegetation cover of the city in these 31 years, and tree vegetation losses accounted for 4.6% of the total loss of vegetation cover in the city.

In comparative terms, the loss rates found for the urban area of Santa Maria are similar to values found for other Brazilian cities in similar periods and subjected to similar growth rate. In Curitiba, Paraná State, between 1986 and 2004, Vieira and Biondi (2008) identified losses of 9% of vegetation cover (from 39% in 1986 to 30% in 2004). In Salvador, Bahia State, between 1995 (43.75%) and 2007 (33.59%), Afonso et al. (2010) registered a 10.16% loss of vegetation cover.

Table 3. Variation of vegetation cover rate between 1980-2011 in neighborhoods of Santa Maria.

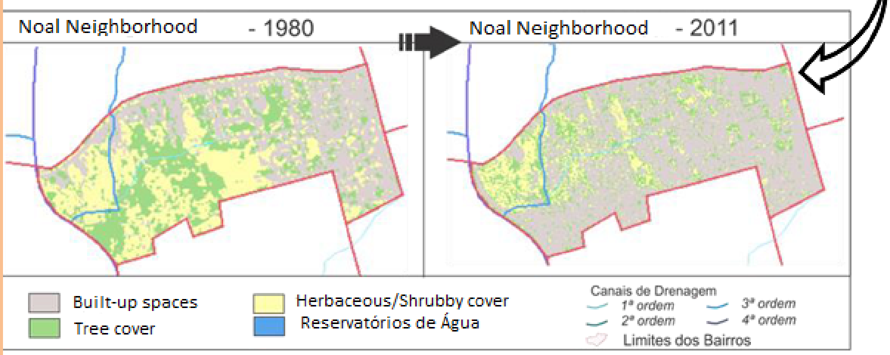
ARs	Neighborhood	Vegetation cover and its variation (%)					
		1980		2011			
		CVA	CVT	CVA	V	CVT	V
CENTRO URBANO	Bonfim	24,94	31.65	10.01	-14.93	13.44	-18.21
	Centro	24.52	30.88	10.02	-14.5	13.64	-17.24
	Nonoai	37.45	49.3	21.69	-15.76	32.16	-17.14
	Nossa Sra. de Fátima	32.93	40.98	15.31	-17.62	21.98	-19
	Nossa Sra. de Lourdes	40.85	59.58	24.88	-15.97	38.12	-21.46
	Nossa Sra. Medianeira	33.56	68.46	19.01	-14.55	38.31	-30.15
	Nossa Sra. do Rosário	25.16	34	15.23	-9.93	22.34	-11.66
	TOTAL	**31.64**	**47.11**	**16.84**	**-14.8**	**26.76**	**-20.35**
NORTH	Carolina	33.86	45.14	24.68	-9.18	35.36	-9.78
	Caturrita	33.98	93.04	33.13	-0.85	87.18	-5.86
	Chácara das Flores	60.29	83.22	52.9	-7.39	79.75	-3.47
	Divina Providência	27.25	73.44	19.8	-7.45	48.84	-24.6
	Nossa Sra. do Perpétuo Socorro	66.74	83.7	66.47	-0.27	82.75	-0.95
	Salgado Filho	22.27	46.58	19.53	-2.74	29.85	-16.73
	TOTAL	**49.19**	**82.2**	**46.56**	**-2.63**	**76.53**	**-5.67**
NORTHEAST	Campestre Menino Deus	63.13	91.6	59.68	-3.45	89.62	-1.98
	Itararé	45.87	68.92	45.48	-0.39	64.8	-4.12
	Km 3	69.32	84.14	65.29	-4.03	83.66	-0.48
	Menino Jesus	32.39	44.02	17.99	-14.4	24.25	-19.77
	Nossa Sra. das Dores	28.82	44.54	21.83	-6.99	32.38	-12.16
	Pres. Joao Goulart	41.78	66.69	40.07	-1.71	65.29	-1.4
	TOTAL	**57.76**	**81.62**	**54.18**	**-3.58**	**78.66**	**-2.96**
EAST	Camobi	31.02	79.45	30.27	-0.75	67.08	-12.37
	TOTAL	**31.02**	**79.45**	**30.27**	**-0.75**	**67.08**	**-12.37**
CENTRAL-EAST	Cerrito	56.59	86.2	56.33	-0.26	83.65	-2.55
	Diácono João Luiz Pozzobon	29.14	96.57	25.3	-3.84	83.22	-13.35
	Pé-de-Plátano	28.02	88.18	25.7	-2.32	79.68	-8.5
	São José	34.03	84.43	28.97	-5.06	72.7	-11.73
	TOTAL	**36**	**90**	**32.97**	**-3.03**	**80.31**	**-9.69**
SOUTH	Dom Antônio Reis	24.53	79.19	22.43	-2.1	39.43	-39.76
	Lorenzi	33.71	85.42	26.86	-6.85	69.74	-15.68
	Tomazetti	40.96	83.78	27.35	-13.61	74.36	-9.42
	Urlândia	28.57	78.07	28.03	-0.54	57.1	-20.97
	TOTAL	**35.32**	**83.03**	**27.1**	**-8.22**	**67.86**	**-15.17**
CENTRAL-WEST	Duque de Caxias	23.57	55.42	18.27	-5.3	30.94	-24.48
	Noal	36.35	68.08	19.06	-17.29	34.25	-33.83
	Passo D'Areia	36.15	72.61	22.17	-13.98	50.99	-21.62
	Patronato	37.76	68.24	19.81	-17.95	38.33	-29.91
	Uglione	28.63	74.83	25.79	-2.84	47.21	-27.62
	TOTAL	**34.4**	**69.4**	**21.11**	**-13.29**	**42.95**	**-26.45**
WEST	Agroindustrial	21.71	91.96	20.89	-0.82	80.66	-11.3
	Boi Morto	29.66	91.62	29.32	-0.34	88.74	-2.88
	Juscelino Kubitschek	24.77	54.09	18.81	-5.96	36.21	-17.88
	Nova Santa Marta	22.28	86.39	20.75	-1.53	46.61	-39.78
	Pinheiro Machado	21.65	82.59	19.64	-2.01	52.76	-29.83
	Renascença	30.88	87.09	27.44	-3.44	79.53	-7.56
	São João	20.84	82	20.48	-0.36	52.29	-29.71
	Tancredo Neves	34.84	93.06	19.71	-15.13	62.07	-30.99
	TOTAL	**25.99**	**86.13**	**22.58**	**-3.41**	**68.33**	**-17.8**
ALL	**TOTAL**	**37.5**	**81.01**	**32.9**	**-4.6**	**68.63**	**-12.38**

ARs= Administrative Regions; **CVA**= Arboreal Vegetation Cover; **CVT**= Total Vegetation Cover; **V**=Variation in relation to previous period.

The ARs Central-West and Centro Urbano (Fig. 4) showed the major losses in both classes. In Centro Urbano, the neighborhoods lost approximately 20% of total vegetation cover, approximately 15% of arboreal vegetation cover loss. The AR Central-West recorded an even greater loss of total vegetation cover (26.45%), roughly 13% of arboreal vegetation cover loss. In this last area, we highlight the vegetation loss for the neighborhood Noal, which featured 82.50% of vegetation cover in 1966 (ALVES, 2012), reduced to 68.08% in 1980 and, finally, to 34.25% of vegetation cover in 2011, showing a significant loss of ecological structure in recent decades.

Figure 4. Change in vegetation cover in ARs Centro Urbano and Central-West.

ARS	Neighborhoods	Vegetation cover (%) 1980 CVA	1980 CVT	2011 CVA	2011 CVT
URBAN CENTER	Bonfim	24,94	31,65	10,01	13,44
	Centro	24,52	30,88	10,02	13,64
	Nonoai	37,45	49,3	21,69	32,16
	Nossa Sra. de Fátima	32,93	40,98	15,31	21,98
	Nossa Sra. de Lourdes	40,85	59,58	24,88	38,12
	Nossa Sra. Medianeira	33,56	68,46	19,01	38,31
	Nossa Sra. do Rosário	25,16	34	15,23	22,34
	TOTAL	**31,64**	**47,11**	**16,84**	**26,76**
CENTRAL WEST	Duque de Caxias	23,57	55,42	18,27	30,94
	Noal	36,35	68,08	19,06	34,25
	Passo D'Areia	36,15	72,61	22,17	50,99
	Patronato	37,76	68,24	19,81	38,33
	Uglione	28,63	74,83	25,79	47,21
	TOTAL	**34,4**	**69,4**	**21,11**	**42,95**

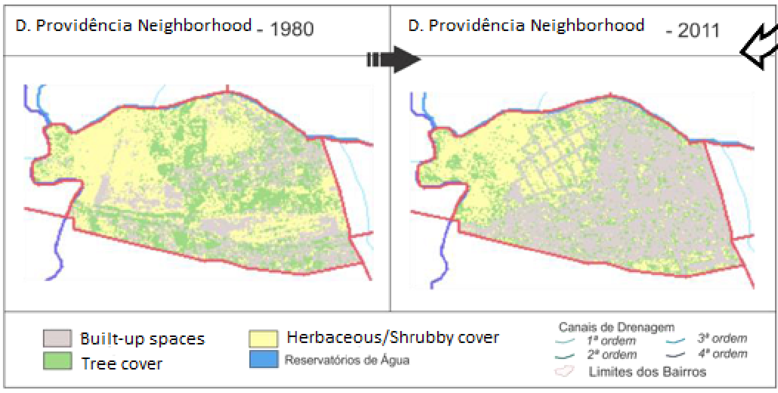


Source: elaborated by the authors.

The ARs Northeast and North presented the smallest rate of vegetation cover loss between 1980 and 2011. The AR North had 5.67% loss of total vegetation cover, while the AR Northeast showed a loss of 2.96%. Regarding the loss of arboreal vegetation cover, the picture was similar, with a loss of 2.63% in AR North and 3.58% in AR Northeast. Even though the general scenario of smaller loss compared to the other ARs, some neighborhoods, like Divina Providência (Fig. 5), presented a significant increase of built-up spaces.

Figure 5. Variation in vegetation cover in ARs Northeast and North.

ARS	Neighborhoods	Vegetation cover (%)			
		1980		2011	
		CVA	CVT	CVA	CVT
North	Carolina	33,86	45,14	24,68	35,36
	Caturrita	33,98	93,04	33,13	87,18
	Chácara das Flores	60,29	83,22	52,9	79,75
	Divina Providência	27,25	73,44	19,8	48,84
	Nossa Sra. do Perpétuo Socorro	66,74	83,7	66,47	82,75
	Salgado Filho	22,27	46,58	19,53	29,85
	TOTAL	**49,19**	**82,2**	**46,56**	**76,53**
Northeast	Campestre Menino Deus	63,13	91,6	59,68	89,62
	Itararé	45,87	68,92	45,48	64,8
	Km 3	69,32	84,14	65,29	83,66
	Menino Jesus	32,39	44,02	17,99	24,25
	Nossa Senhas das Dores	28,82	44,54	21,83	32,38
	Pres. Joao Goulart	41,78	66,69	40,07	65,29
	TOTAL	**57,76**	**81,62**	**54,18**	**78,66**



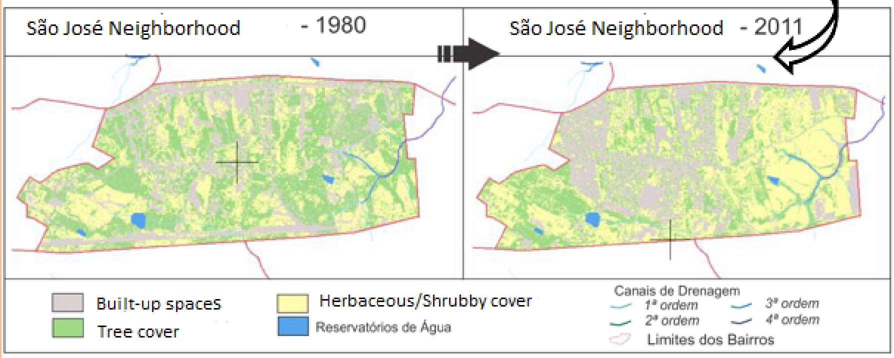
Source: elaborated by the authors

The ARs East and Central-East (Fig. 6) have similar scenarios, where total vegetation cover losses totaled 12.37% and 9.69%, respectively. In the AR Central-East, the loss of arboreal vegetation cover was slightly smaller than in the AR East, with respective values of 3.03% and 0.75%, respectively. The neighborhoods Camobi, Diácono João Luiz Pozzobon and São José recorded the largest total vegetation cover losses, greater than 10%, while the Cerrito neighborhood registered the smallest rate of vegetation cover loss, with approximately 3%

The ARs West and South (Fig. 7) are also show similar conditions. Both feature a reduction of vegetal cover of 17.8% and 15.17%, respectively. The two regions also have neighborhoods closer to the central area of the city that had their percentages of vegetal cover significantly reduced. In the AR West, especially Tancredo Neves and Nova Santa Marta neighborhoods, which totaled 30.99% and 39.78%, respectively, losses of total vegetation cover, while the Dom Antônio Reis and Urlândia neighborhoods, in the AR South, had a reduction of vegetation cover of 39.76% and 20.97%, respectively.

Figure 6. Variation in vegetation cover in ARs East and Central-East.

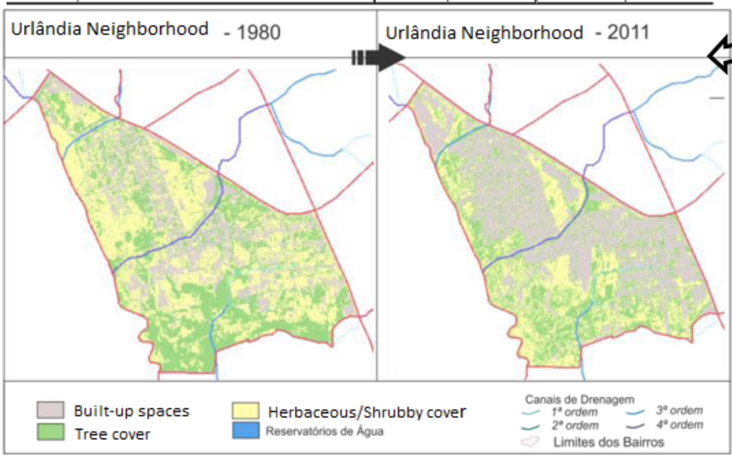
ARS	Neighborhoods	Vegetation cover (%) 1980 CVA	1980 CVT	2011 CVA	2011 CVT
East	Camobi	31,02	79,45	30,27	67,08
	TOTAL	**31,02**	**79,45**	**30,27**	**67,08**
Central-East	Cerrito	56,59	86,2	56,33	83,65
	Diácono João Luiz Pozzobon	29,14	96,57	25,3	83,22
	Pé-de-Plátano	28,02	88,18	25,7	79,68
	São José	34,03	84,43	28,97	72,7
	TOTAL	**36**	**90**	**32,97**	**80,31**



Source: elaborated by the authors

Figure 7. Variation in vegetation cover in ARs West and South.

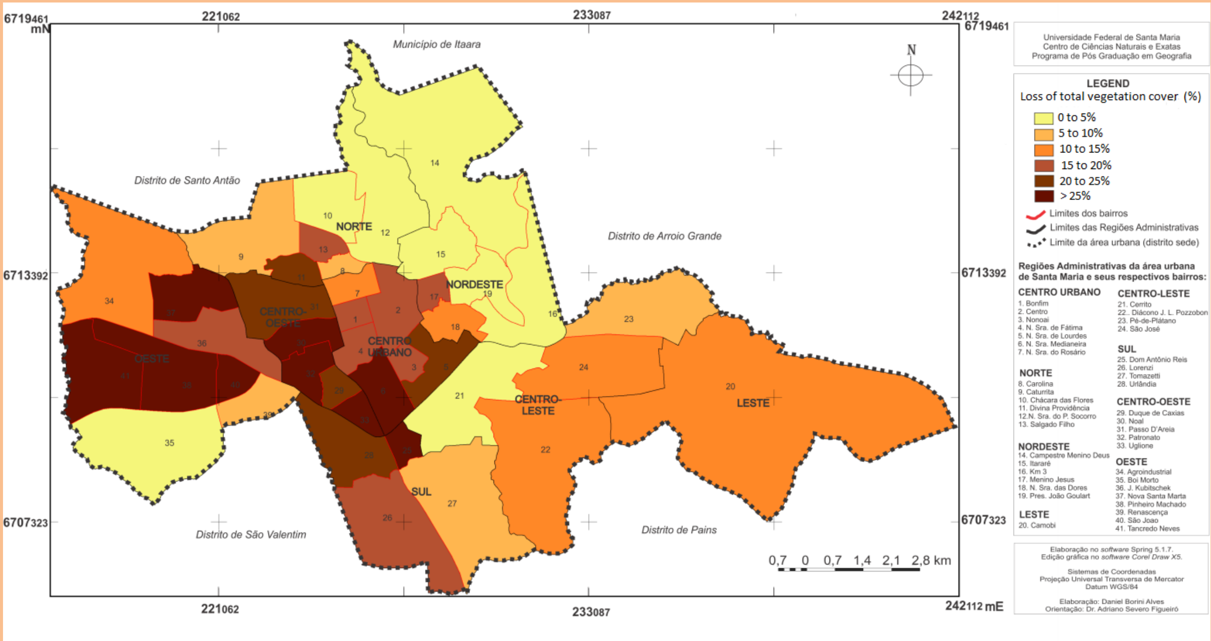
ARS	Neighborhoods	Vegetation cover (%) 1980 CVA	1980 CVT	2011 CVA	2011 CVT
West	Agroindustrial	21,71	91,96	20,89	80,66
	Boi Morto	29,66	91,62	29,32	88,74
	Juscelino Kubitschek	24,77	54,09	18,81	36,21
	Nova Santa Marta	22,28	86,39	20,75	46,61
	Pinheiro Machado	21,65	82,59	19,64	52,76
	Renascença	30,88	87,09	27,44	79,53
	São João	20,84	82	20,48	52,29
	Tancredo Neves	34,84	93,06	19,71	62,07
	TOTAL	**25,99**	**86,13**	**22,58**	**68,33**
South	Dom Antônio Reis	24,53	79,19	22,43	39,43
	Lorenzi	33,71	85,42	26,86	69,74
	Tomazetti	40,96	83,78	27,35	74,36
	Urlândia	28,57	78,07	28,03	57,1
	TOTAL	**35,32**	**83,03**	**27,1**	**67,86**



Source: elaborated by the authors

We classified the neighborhoods according to the percentages of variation of total vegetation cover in the period studied (Fig. 8), where the losses occurred with greater intensity in city sectors.

Figure 8. Classification of vegetation cover loss (1980-2011) per neighborhoods.



Source: elaborated by the authors

The neighborhoods that had the smallest percentage of vegetation cover loss (loss between 0-5%) comprise those that presented geomorphic barriers of densification (hillsides and plateau slopes), namely Cerrito, Chácara das Flores and Itararé neihgborhoods. The exception is the Boi Morto neighborhood, in the AR West, where the limitation of urban sprawl is given, in large part, by the presence of large military training areas of the Brazilian Army.

On the other hand, contrary to expected, the neighborhoods of AR Centro Urbano did not show the largest reduction of vegetation cover in the period 1980-2011. However, it is attributed to the fact that this region be in better conditions for vegetation conservation cover than the others, but this region is approaching a biological desert, that is, the level had little to increase, especially because it is an area of occupation almost fully consolidated. Still, the N. Sra. Medianeira and N. Sra. de Lourdes neighborhoods included in the class of the largest loss of vegetation cover in recent decades.

The ARs Central-West and West had most districts included in the class of higher rates of vegetation cover losses, which clearly shows the main vector of densification of the built-up environment of the city in recent decades. In the AR Central-West, the highest percentages of losses were observed in Noal, Patronato and Uglione neighborhoods, while in the AR West, Nova Santa Marta, Tancredo Neves, Pinheiro Machado and São João neighborhoods showed the highest rates.

The neighborhoods in the ARs East and Central-East were included mostly in the class of losses between 10 and 15%, which shows that this area has been gradually losing significant amounts of vegetation cover. A prospective analysis indicates that possibly the neighborhoods in the ARs Central-East, East and South should present the major variations of vegetation cover in the coming decades with the advances of built-up spaces.

Framework of actions considering the losses of vegetation cover identified

In this scenario of gradual suppression of vegetation cover that the urban landscape of Santa Maria has faced in recent decades, the most densely urbanized neighborhoods, for example the neighborhoods of ARs Centro Urbano and Central-West, may achieve improvements with the creation of urban parks in some free areas still existing. In addition to the direct ecological gains, the improvements may also be associated with the leisure of the city residents. Another suggestion refers to possible incentives of the Municipal Government to adopt green roofs, especially in densely populated areas with the presence of buildings, where reintroduction of vegetation cover seems to be currently unfeasible.

In the spaces where urban density has not yet reached large proportions, for example the neighborhoods in the AR East, it is possible to encourage afforestation of free areas, seeking to integrate residences and gardens and optimize the distribution of green cover, while residential construction should be avoided with high density of buildings. In the Camobi neighborhood, identified as one of the areas with most expansion of built-up spaces in recent decades, we observe the deployment of a large number of condominiums with high rates of built-up area. It is extremely relevant to study carefully the limits and possibilities of restriction for densification of these areas, without compromising certain environmental features.

Special attention should be given to areas on the banks and near water springs of the rivers. We must analyze the areas of permanent preservation (APPs) linked to water resources inserted in the urban grid, identifying sites that require the recovery of APP. Some examples are the banks of the Arroio Cancela stream, which are inserted near highly densely populated areas, and the banks some tributaries of the Arroio Cadena stream in the Passo D'areia and Noal neighborhoods, which are much deteriorated.

In the areas of hillsides mainly in the ARs Central-East, North and Northeast, it is necessary to continue avoiding extension of road meshes and expansion built-up areas. The creation of protected areas, as discussed in Nascimento and Foleto (2010), can contribute to the containment of this expansion, and they must have the Atlantic Forest Biosphere Reserve as a reference in zoning of the environmental protection area of Vacacaí-Mirim, Rio Grande do Sul State, Brazil. In areas with a good array of vegetation cover with little progress of the built-up environment, it is important to maintain the condition of natural conservation, avoiding major built-up density.

The creation of parks is also how a good strategy to maintain these attributes, emphasizing that the implementation of parks should comply with the concept parks from the National System of Conservation Units (SNUC) (BRASIL, 2000).

The more peripheral areas with little advancement of buildings are strategic for urban expansion in the coming decades. Alternatives for preserving vegetation cover should be discussed to ensure that the expansion be conducted smoothly with the attributes and natural processes, especially in the lower areas and lower slope, which should continue to serve as absorbers of rain water in more intense precipitation episodes

The implementation of these green areas should be contextualized in environmental educational actions to educate the population about the importance of maintaining these natural attributes in the urban environment.

CONCLUSIONS

The dynamics of land use and vegetation cover in the past 31 years in the urban area of Santa Maria reveals that the increase of the built-up environment shows a scenario of vegetation cover loss in the most distinguished neighborhoods of the city.

We expected that the results obtained and discussed in this study, concerning the relevance of urban vegetation cover and its trend of suppression in recent decades, may also serve as support for policies of the Municipal Government may take suitable actions towards the preservation of natural attributes of the urban environment in a more contextualized and integrated aspect.

Vegetation cover can greatly contribute to the management of urban environment, therefore, we highlight that urban environmental policies should be restricted only to preserving the vegetation cover. It is extremely important to consider other attributes such as quality control and protection of water resources, maintenance and land use limitations according to geomorphological conditions, among others, in order to be attain better conditions and environmental quality of life in urban areas.

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