

Use of High Resolution Images for Evaluating the Sustainability of Green Areas in the City of Passo Fundo-RS

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Abstract—The rapid population growth of cities has caused the removal of vegetation cover raising the waterproofing and the occupation of riverine plains. As an important aspect of urban sustainable planning, the provision of green areas at various scales, should reduce pollution and contribute to the physical, social and psychological care of individuals. Planning, implementing and conserving green areas constitute a good of great value, making it essential for the composition of cities. This research aims to identify, quantify, classify the land use and permanent preservation areas (APPs) inserted in the urban perimeter of Passo Fundo through geoprocessing techniques, seeking to understand the reality of these areas. It was developed with the ArcGIS software, creating and manipulating georeferenced spatial data from municipal database and QuickBird satellite. The survey used a supervised classification tool to generate four classes of land use, together with the analysis of APPs, calculating the total area of these APPs and the area of each class of land use. Demonstrating that the municipality is splitted in about 56% of green areas against 44% of gray/constructed areas. Most of APPs presents arboreal occupation, representing 3% of the urban area and about 39% have an anthropical occupation by buildings, street layout and fields. With the analysis of the images was possible to identify, quantify, classify land use and APPs, generating data for the municipal administration develop public policies that aim sustainability, preservation, conservation and recovery of these areas of APPs, as well subsidies the realization of an urban and environmental planning.

Keywords—Environmental planning, Natural resources, Geographical Information System, Urbanization.

I. INTRODUCTION

Anthropical intervention are increasing the current state of environmental degradation. This leads to faster changes in the natural environment, making them difficult to be restored to their natural state.

The fast populational growth in the cities due, mainly, to the improvements in the economic conditions of the population itself leads to a high rate urbanization and the removal of original vegetation, increasing in the impermeable surface area and the occupation of the flood plains.

Life quality in urban environments is directly bonded to several factors that varies from the urban infrastructure,

to the social and economic development and the environmental management.

In the environmental case, the public green areas are composed by important elements to the well being of the population, mostly because of the direct influence on the physical and mental health of this population [18]. The substitution of these green and permeable areas by built elements, such as roads and buildings, end up increasing the risk of floods, the warming of urban surfaces and causing the heat island effect [4].

Forests and other types of vegetation present in water bodies margins are considered, by the Brazilian environmental laws, through the Law 12.621/12, as Permanently Protected Areas (PPA). This vegetation,

which develops in the margins of rivers and other water bodies is sensitive due its lack of ability to stay stable and perpetuate itself.

When structured, The riparian vegetation contributes significantly to the balance of the environmental and natural conditions and, thus for the productivity of the society through the stabilization of the soil, acting as a barrier to the pollution, increasing on the water infiltration and purification, increasing water storage in the subsoil, protection of aquatic species, balancing the thermal and chemical features of the water bodies, among other effects [16].

The delimitations of APPs has a high cost, because they usually needs field surveys, certain specific equipments and trained personal. For Stefanos [21], the utilization of Geotechnologies in the delimitations of APPs could facilitate the environmental and resources management processes.

The planning, implantation and conservation of green areas constitute an asset of great value to the community, becoming a important element in the urban composition.

According to Rosset [17], green areas are places where the arboreal vegetation is predominant, e.g. the squares, public gardens and urban parks, among other kinds of areas that provides aesthetical and ecological functions.

For the planning, must be applied georeferencing and analysis tools that allow the processing of the raw data in several steps of the project. In this sense, the application of Geographic Information Systems's technics has become a powerful tool that, when used along with other mapping softwares, allows not only a greater precision of the assessment, but also the ease of maintaining the database updated, leading to an most efficient way to monitor these areas [1; 20].

Besides, the geoprocessing allows that each area can be individualized through its features or digital signatures, so they can be better analyzed, expliciting the acting phenomena of each sector, reducing data interferences and thus obtaining more accurate results [15; 20].

The utilization of remote sensing applied to the study of the urban environment and mostly to the vegetation areas has advanced significantly with the use of high resolution satellite images, which allows a more detailed analysis of this environment [1; 3].

Henke-Oliveira & Santos [8], emphasize the importance of the development of computational technics that contemplates the structural and functional differentiation, what confers a dynamism to the environmental planning by allowing the information assessment to the management of these areas as well as

other elements associated to the environmental and life quality.

Therefore, this research has the objective to identify, quantify and classify the land cover and the PPAs within the urban perimeter of Passo Fundo, to better understand the reality of these areas and through the use of geoprocessing tools.

II. MATERIALS AND METHODS

The research was developed in the city of Passo Fundo (28°15'46"S e 52°24'25"W), located in the northern region of the state of Rio Grande do Sul, Brazil, which makes a total area of 783.423 km². The city has an average elevation of 687 m, with an average annual temperature of 17.5 ° C and rainfall index of 1787.8 mm / year. The estimated urban population is 184,826 people and the population density of 235.92 inhabitants per km² [9].

The survey of the areas of APP within the urban area of Passo Fundo followed a series of complementary steps.

2.1 Definition of raised criteria and the limits distances of APPs

As an initial step in this research, were defined the criteria that would be considered for the survey. From the objective of evaluating the Areas of Permanent Protection referring to banks of rivers and streams, we sought to focus the entire data acquisition and spatial processing techniques in this criteria.

2.2 Obtention of Data Base

After defining the criteria that would be considered in the work was done to obtain georeferenced data that would allow to survey with quality.

To evaluate the arboreal formations present in the urban area were obtained high-resolution images, derived from the QuickBird satellite. These images have a high spatial resolution panchromatic 0.6 m and multispectral of 2.4 m.

Aiming to raise all rivers and streams in the present area of study, we sought to obtain georeferenced data available and to provide quality. The data used for this survey were obtained through the Continuous Vector Cartographic Base of Rio Grande do Sul [7]. This database allowed to obtain a mesh in vector format (. Shp) with full coverage of the study area at a scale of 1:50,000.

2.3 Used Software

To conduct the survey of the areas of APP and vegetation cover of medium and large sized was used the software suite of ArcGIS 10.5, which allows you to manage and operate with spatial data [6].

Within this suite were used applications ArcCatalog, which allowed the organization of the data base of this study, and ArcMap, responsible for performing space operations, such as creating buffers and classification of images, from the data obtained.

2.4 Defining the Limits of the Study Area

As the objective of the survey aims APPs and vegetation cover present within the urban area of Passo Fundo, was necessary to perform a visual delineation of the region of study.

For this, we carried out a vectorization of the limits of the urban area from images obtained by satellites. Although this procedure being manual, the spatial resolution of the images allows for a very faithful approximation of actual limits of urbanization of the municipality (Fig. 1).

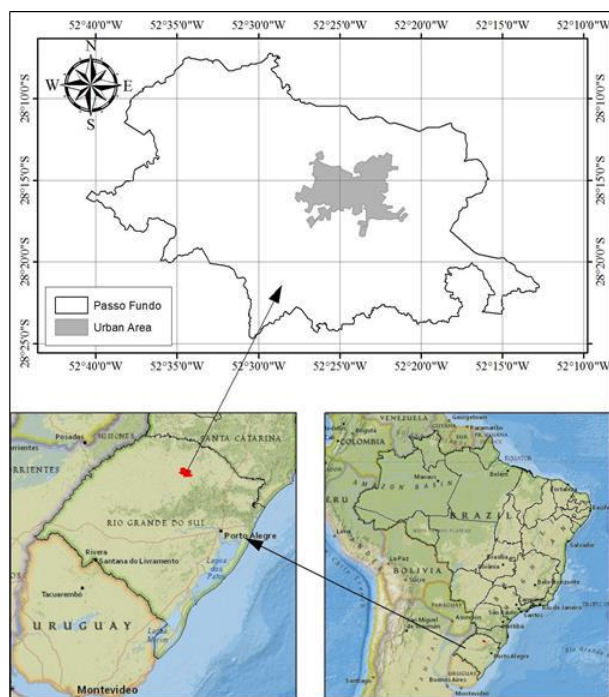


Fig 1: Location of the municipality of Passo Fundo.

2.5 Extraction of Data Base and Classification of the Images

After performing the delimitation of the study area was performed a extraction of data base within defined limits, so just kept the data pertaining to the study area.

The classification of the satellite images aimed at obtaining a mapping of areas with common characteristics within the study area. These areas were classified into four distinct classes, formations Arboreal, Fields, Buildings and Roads / Streets.

To realize this classification, we used a supervised classification technique, which classifies the original image into classes in accordance with a number of

samples. These samples aim to obtain statistical parameters of the digital values of each band used of the image.

2.6 Survey of Areas of Permanent Protection.

To obtain the APPs referring to the margins of watercourses present within the urban area of Passo Fundo was held to create buffers. These buffers create polylines parallel to the original lines, for both sides, generating a coverage area depending on the original vector file and the linear distance defined for the buffer. The buffer created was of 30 m on each side of the banks of watercourses.

This entire process was carried out with a eponymous tool, standard for ArcMap, generating a set of polygons in the vicinity of rivers and streams assessed. These polygons are defined as the Areas of Permanent Protection relating to the banks of watercourses.

2.7 Calculations of Total and Partial Areas

Aiming to obtain the total values of the areas of each class of land cover, areas of permanent protection and of the urban area, there was the process of calculating areas of polygons present in each data set.

This calculation of the areas was made inside the ArcMap, resulting in tables containing the total areas of each attribute, which were later used for the survey of land use in urban areas and in the APPs..

The calculation was performed taking into consideration each class of land use and each subclass of the areas of arboreal cover in order to get a representation of these classes and then subclass of woody debris.

2.8 Survey of Land Use in the Urban Area and in the APPs

After the individual calculation for each class of land use and the total area of APPs within the urban area of the municipality, was realized the crossing data to obtain the ratio of the total areas of urban area and the total of permanent protection areas and which proportion of land cover in these areas [1].

III. RESULTS AND DISCUSSION

In Fig. 2 we can see the image of the city after the supervised classification, where in the city center (area of high economic movement) is quite impermeable due to the concentration of buildings and civil buildings and the consequent concentration of population, which also expands along the main avenue of the city. In the central area the green areas can be explained due to the location of wooded squares [22].

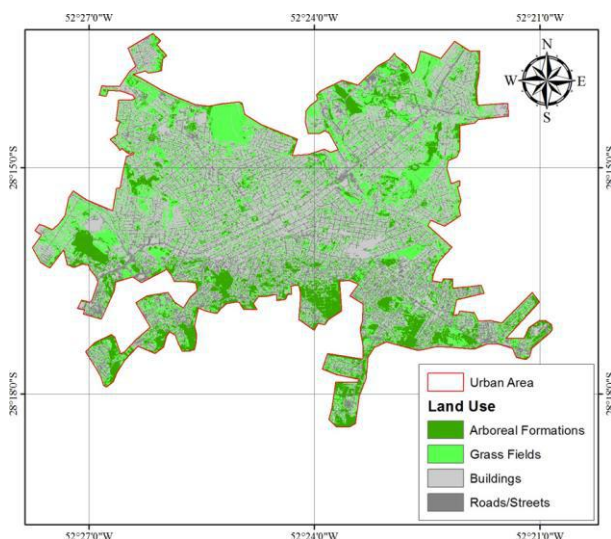


Fig 2: Map with soil classification in the municipalitie of Passo Fundo (Brazil).

This survey showed that the total urban area of the municipality is 4822.6 ha, being this distributed into, woody formations 1421.273 ha, fields 1293.246 ha, buildings 1169.669 ha and streets 938.026 ha. The portion of arboreal formation in the city of Passo Fundo corresponds to 29.47%, fields 26.82%, buildings 24.26% and streets / roads 19.45% (Fig 3).

Thus it can be stated that the sealed area of the municipality is 43.71%, which contribute, among other effects, to floods, and the heat of urban surfaces, causing negative effects on the quality of urban life. While the area of land covered with vegetation corresponds to 56.29% contributing to environmental sustainability by increasing evapotranspiration, improve the infiltration and reduce the runoff of rainwater. Besides that the preservation of vegetable fragments contributes to the improvement of the hydrological cycle and soil conservation, agreeing with statements of Melo et al.[11].

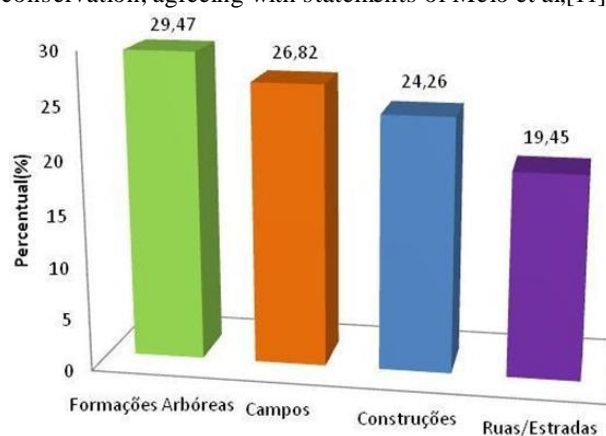


Fig 3: Percentual of land use in urban area

The areas of permanent preservation have an area of 142.2 ha within the municipal city limits, resulting in a representation of approximately 3% of APPs into the relation with the urban area total of the municipality, which are distributed in the following classes of land use: formation arboreal 86.94 ha, fields 38.52 ha, buildings 8.05 ha and roads 8.67 ha (Fig 4).

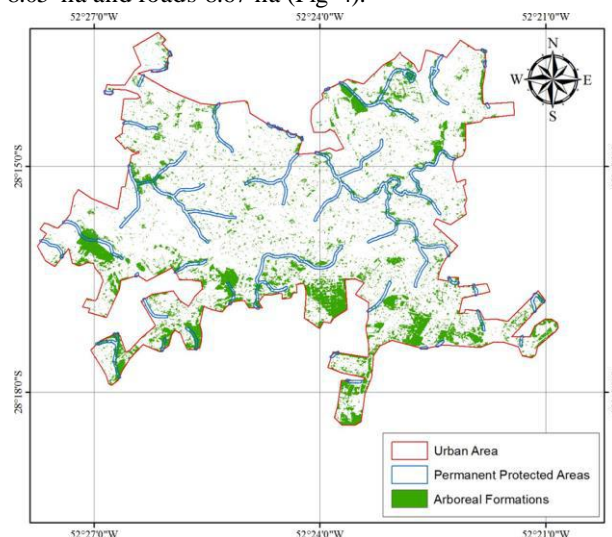


Fig 4: Map from the areas of app in the municipality of Passo Fundo.

Most APPs presents arboreal occupation with 61.14%. Although this is a good indication, is needed to observe that about 39% of APPs in the urban area present an anthropized occupation by buildings, street layout and fields (Fig 5).

The anthropic of these areas favors numerous environmental processes, such as decreased infiltration of rainwater, which increases the volume of water on rivers. These processes increase the capability to generate erosion which can cause instability, siltation of water bodies, reduction in water quality and changes in the water regime.

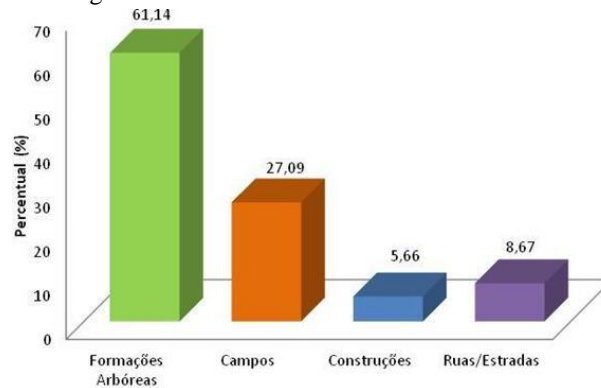


Fig 5: Percentual of land use inside the APPs.

In addition to the survey of land use in the urban area of the municipality of Passo Fundo, was carried out a classification of wooded areas in relation to the areas of each fragment of vegetation (Fig 6). The scenic beauty of the landscape and the leisure, including physical and recreational activities, are also functions of forest fragments embedded as squares, urban and natural parks. Contact with vegetation promotes wellness, improving people's health and quality of life [13].

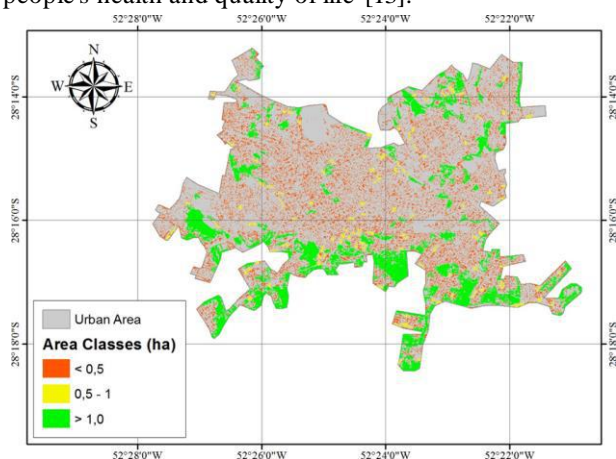


Fig 6: Fragments of vegetation in the municipality.

Along with the mapping was conducted a quantitative survey of these wooded areas. This survey relates the areas of each class with the total area of vegetation fragments (Table 1).

Table 1: Survey of vegetation fragments.

Area (ha)	Count	Representativity
<0,5	657445	99,964%
0,5 - 1	111	0,017%
>1	129	0,020%
Total	657685	100%

As can be seen in Table 1, most of the arboreal fragments present in the urban area of Passo Fundo have an area of 0.5 ha. The larger fragments, concentrated in great part in the southern region of the urban area and represent only 0.037% of all fragments present in this study area.

These results indicate a large presence of small fragments, which are arranged throughout the urban area. This is possibly due to the removal, almost entirely, of native forest aiming at the expanding of the urban area.

From the ecological point of view, the dispersion of fragments can be positive, since it creates more habitat for the survival of animal species. At the same time, can hinder some natural biological processes such as dislocations, search for food and reproduction [10].

It can be observed that in the map the present fragments in the city are presented barely interlinked. With this occurs with the depletion of forest fragments, which pass through a gradual loss of biodiversity and reduction of ecological functions [2]. The small fragments and isolated tend to impoverishment due to the inability of regeneration [3]. Hence the importance of recognizing the size of the fragments becomes an important factor, due to larger forest fragments and connection between them increase the carrying capacity of the fauna and flora [23].

The fragments even reduced and generally isolated, they are part of a unique ecosystem, holding a considerable wealth of plant species, which are responsible for house and feed some wildlife species [19].

The city of Passo Fundo receives many benefits of existing vegetation on it, because it influences the microclimate and increases the humidity of the air through evapotranspiration, providing a more comfortable environment population, and allow rainwater infiltrating the soil softening the rapid runoff, which is one of the factors that aggravate the formation of floods and inundations [12].

The leaves and branches of trees also act as filters, retaining part of the suspended particulate matter in the air, reducing levels of air pollution, the gas exchanges helps to increase the oxygen level available and contribute, equally, in reducing the amount of carbon in the atmosphere, seen that during their growth these plants capture large amounts of this element [5].

Historically the majority of Brazilian municipalities, had their growth, whether in rural or urban mean, municipal planning without considering the environmental issues. The natural vegetation in most cases, was being replaced by the city or by agriculture [14]. The city of Passo Fundo followed this reality, the urban spot viewed nowadays, was formed at the expense of vegetation that existed there.

Considering that the vegetation is an important factor for environmental quality, because the green areas minimize the effects of excessive waterproofing, regulate microclimate, softening the high temperatures produced by the concentration of the built or paved it must be preserved remnant vegetation of these sites, as well as the municipal administration must develop public local policies aiming at sustainability and recovery of areas of APPs, to meet the needs of society, who lives in an increasingly artificial environments, and avoid the declining of quality to urban life. Creating alternatives from the vegetation for the population that lives in the

city does not suffer the consequences of the lack of planning.

IV. CONCLUSION

A conclusion section must be included and should indicate clearly the advantages, limitations, and possible applications of the paper. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

The urban area of the city of Passo Fundo presents its area distributed on arboreal formations 29.47%, fields 26.82%, buildings 24.26% and roads 19.45%. The areas of permanent preservation resulted in a representativeness distributed, the following classes of land use: arboreal formation 61.14%, fields 27.09%, buildings 5.66% and roads 6.09%. And the majority of the arboreal fragments present in the urban area of Passo Fundo has an area of 0.5 ha.

The municipality of Passo Fundo receives many benefits of the existing vegetation on it, because it influences the microclimate and increase air humidity through evapotranspiration and allow the water resulting from precipitation infiltrating the soil mitigating floods and inundations.

With the analysis of the images was possible to identify, quantify, classify the land use and (APPs), generating data for the municipal administration develop public local policies that aim at sustainability, preservation, conservation and restoration of these areas of APPs as well as subsidies for the realization of an urban and environmental planning.

Managers can create guidelines of projects using this tool aiming the environmental sustainability.

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