ANALYSIS OF OCCUPATION OF THE RIGOROUS PROTECTION AREA OF APA JOANES/IPITANGA IN THE METROPOLITAN AREA OF SALVADOR, BAHIA, BRAZIL

Lucas Carvalho¹, Michael Heimer²

¹ Engineering student in surveying and cartography at UFBA, Tel.: (71)999900992, lcarvalho3@outlook.com
² Ph.D. in Geophysics, Professor of the Department of Transport Engineering and Geodesy at UFBA, Tel.: 55(71)3283-9821, mheimer19@yahoo.com.br

Abstract
This work aims to expose, through remote sensing, spatial analysis methods and a geographic information system (GIS), the situation of land occupation in the Restrict Protection Zone (ZPR) in the environmental protection area of Joanes / Ipitanga. Created by decree number 7,596 of June 5, 1999, the area of protection include some cities of state of Bahia, and it has an area of approximately 30,000 ha and an extreme importance for environmental conservation, for example, a dam called Ipitanga I. As results we observed that the hospital of Salvador appropriates 0.50 ha of the protection area, corresponding to an area inside protection of the water accumulation of the Ipitanga and Joanes rivers. It is possible as well to notice a presence of irregular settlements, with different society levels, creating a zone of land speculation.

Keywords: Visualization using Geotechnologies; Environmental protection area; Territorial conflict; Irregular land occupation

INTRODUCTION

Created by Decree No. 7,596 of June 5, 1999, in view of the provisions of Law no. No. 3,858, dated November 3, 1980, and based on Federal Law nº 6,902 of April 27 in 1981, and based also in the CONAMA resolutions nº10 of December 14, 1988, and nº 012 of September 14, the environmental protection area (APA), is covered by part of the municipalities as: Camaçari, Simões Filho, Lauro de Freitas, São Francisco do Conde, Candeias, São Sebastião do Passe, Salvador and Dias D’ Ávila, with an approximate area of 30,000 ha. The region where it’s inserted, presents hot-humid climate and abundance of water resources. Composed of restinga, a kind of singular vegetation, they shelter species of fauna and flora of great importance for the ecological balance, mangroves, rich in biodiversity, where are found in the estuary of the river Joanes (INEMA, 2016). In the APA are remnants of Atlantic Forest and wild birds quite representative. It was created with the main objective of ensuring the quality of the water supply and the sources found in the area, since it presents great value in the water resources of the cities that is compose it, with approximately 40% of that used in the city of Salvador, the capital of Bahia, as show in Figure-1.

In a brief historical review about the occupation around this area, it is only recorded that in the middle of the XVIII century (1758), Vila Nova Ambrantes do Esprírito Santo appears, located in the area of the present municipality of Camaçari, which had as a sub-existence some mills of sugar and alcohol processors. Between the XIX century and the middle of the XX century, such processors start a decline and in the decade of 50 some bases of extraction and refining of petroleum were implanted in the region, a fundamental element to trigger of the process, that culminated with an important cycle of development of the analyzed area. In the 60's and 70's, industrial buildings and processors of basic products for the fine chemicals were installed, represented by the Camaçari Petrochemical Complex - COPEC. The search for work made the Metropolitan Region of Salvador (RMS) grow considerably between the 1960 and 1990, triggering what was called by population overflow cycle (APA Environmental Diagnosis, 2010). However, the part referring to the city of Salvador remained in opposition to this flow of population until the 1980s. The region where today the APA is located covers the neighborhoods of Boca da Mata, Cajuzeiras and Fazenda Grande, places where did not have urban planning or infrastructure over the years, especially in the 90's, which was the peak of the local population. Being a popular neighborhood, there are no public policies to the people or the environment in question. Today the inhabited area is mainly composed of irregular occupation, much of which is inside an area of environmental protection, it's known as ZEIS-4 (Special Area of Social Interest), a zone characterized by the PDDU –Urban Development Master Plan of the city of Salvador in the years of 2008 and 2016. The ZEIS-4 has been done two times, the first in the PDDU of 2008 and PDDU at 2016. The ZEIS construction was done without a social and territorial
conception, that was a target of so many questions by the people who leave inside that zone. And this inconsistency made a “strong factor to increase some conflicts.”

The starting point for the study was to verify the information disclosed by social movements against the installation of the Municipal Hospital in that region of environmental preservation, and some people who fight for the natural area protection. In the first half of 2016, local social groups began to raise questions in public hearings, related to the building and in forums related to the preservation of watersheds and environmental rights, such as the XVIII Encontro National Rivers and Basin Committees (Encob). The projected blueprint of the hospital is comprised between the access of the highway and the edge of the water reservoir, which brings strong direct impacts to the ciliary margins of the dam of Joannes-Ipitanga.

In an interview with GAMBA (Bahia Environmental Group), the coordinator of the APA's managing council, Genici Braz, says that use of the project is not compatible with the zoning determined in the APA management plan, and the municipality was notified of the incompatibility.

During the research on the geometric definition of the polygons involved and the overlap with the image sets, it was possible to identify a good amount of urban housings of different social levels, with recreation equipment and areas used by irregular occupation, mainly with the fervor of real estate speculation after the construction announcement of the hospital. Inside of this identification process was found incompatibilities in the conflict’s scenario, some political-economic interests are overlapping the environmental issues and social rights. In this sense, the tools of geotechnology offer an enormous contribution to the visualization, analysis, and support to take conclusions about the conflicts installed there, making possible the decision making from several factors established there.

In a country with a continental dimension such as Brazil, with a great lack of adequate information to make decisions on urban, rural and about environmental problems, geoprocessing presents enormous potential, especially if it’s based on relatively low cost technologies, where knowledge is acquired locally, as CAMARA et. al. (2001) said.
IMPORTANCE OF GEOPROCESSING FOR TERRITORIAL CONFLICTS STUDIES

CAMARA et al. (2004) said that the geoprocessing term denotes the discipline of knowledge that uses mathematical and computational techniques for the treatment of geographic information. The diverse areas of the study can use the tools and benefits of a GIS, making it an interdisciplinary technology that allows the obtaining of information, from the processing of other variables that have been spatialized in the system. In this way, the concept of geographic space is an important link between the Science of Geoinformation and other sciences, whether natural or social. (Heimer and Carvalho, 2015).

Geotechnology, commonly called geoprocessing, is divided into several areas or tools, such as geoprocessing and GIS, remote sensing (SR), spatial analysis, photogrammetric products of different orbital levels, geodetic satellite positioning technologies (GNSS), among others. These are intended to describe, model and represent the space where the data are geographically located. In this context, the use of geotechnology aggregates values and brings us results of great importance for the current work, since it allows details of the space studied by the APA of Joanes-Ipitanga, coming from images of several satellite bases, through an online server, besides of the possibility of overlapping polygons in the Shapefile format, which were made available by official departments, such as the zoning of the Conservation Units of the state of Bahia (UC-BA), delimitation of neighborhoods in the city of Salvador, and hydrography of the state of Bahia. The representation of these data as layers in a GIS, allows us to model the situation according to the all parts involved. For CAMARA et. al. (2001) in a generic way, "If where is important for your business, then Geoprocessing is your working tool" Whenever what appears, among the issues and problems that need to be solved by a computerized
system, there will be an opportunity to consider the adoption of a GIS. In this scenario are inserted our objects of study, which are the housing facilities, the Municipal Hospital of Salvador and the new irregular subdivisions located in the ZPR of the APA of Joanes-Ipitanga.

![Figure 2 - Localizaition Zoom at ZPR area](image)

**MATERIALS AND METHODS**

Initially, a bibliographic review was done, based on the object of study and the use of geotechnology tools. In order to make possible the spatial analysis of the situation of the protected area of the Joanes-Ipitanga, was found the spatial information about the region, following a study of the current legislation in all administrative levels, as federal, state and municipal. This methodological procedure was conceived with the intention of constructing an accessible and low-cost step-by-step approach in order to bring the use of geotechnology closer to the other public, in areas where territorial, environmental or social conflicts exist or may arise. One of the first steps is to revise the legislation regarding the object of study, this step is very important, especially when inserted in the Brazilian reality of official data publicity. It’s necessary to make sure that the data has validity given by law. In this case, was performed a research in the current legislation of the sides involved in this scenario, both at federal, student and municipal levels. The main laws that served as reference were Federal Law nº 12651 of May 2012; Resolution nº 428 of December 2010 CONAMA; Law nº 10431 of December 2006 of the State of Bahia; CEPRAM Resolution nº 2974 of May 2002 and Law nº 9069 of 2016 of the municipality of Salvador-BA.

After a review of the legislation involved, we proceeded to the digital data acquisition process, it can be found or acquired in different ways, but it’s necessary to be alert to the data source and its metadata. Often official data can be available by government portals or required by formal requests. It’s also possible to enter data from a research center or data linked to universities and public research centers. This data can be available in different formats, like shapefiles, GeoTIFF, csv spreadsheets, text documents, KML format, CAD, among other different extensions that will need a certain treatment before use. In the analysis of the APA of Joanes-ipitanga the data of its limit were collected, inside a file that represented all the preservation areas of the state of Bahia. These data were obtained from Inema - Instituto do Meio Ambiente e Recursos Hidricos1, whose purpose is to execute the actions and programs related to the state policy...
on the environment, water resources, climate change and protection of biodiversity. The data of districts and basins are referring to the Caminho das Águas em Salvador – Bacias Hidrograficas, Bairros, and Fontes2 (SANTOS, M.E.P et.al.). All data processing was done in the free software Quantum GIS-QGIS (version 2.14 - Essen), the choice of the processing software started from the principle that the whole process must follow the line of low cost and that there are abundant materials on the internet, with a view to exemplifying the possibilities of the tool and for possible solutions. When inserted into the GIS software, the information previously acquired becomes data and through some plug-ins are geospatial, becoming layers of geoprocessing. With the help of three add-ons or also called plugin-in, all computations were started: was used a Open-layer tool that allows to add layers of free online mapping services to the visualization screen of your project, besides that we use the geo-referencing complement, which allows geo-locating or georeferencing rasters images to a geographic or projected coordinate system (metric), allowed the creation of a new GeoTiff image. In order to transform text lines of federal legislation documents into layers, it was necessary to perform a vectorization of a line referring to the river courses. From this, it was used the complement, MMQGIS, which is one of the most commonly used add-ons by QGIS users, allowed the determination of a layer of buffer, which are polygons that contour an object according to a linear parameter, or also called by radius of action software. According to the pertinent parameters in the environmental legislation, referring to the areas of permanent preservation, the rays were used based on the watercourse of the river, that includes all the extension of the dam. Once the Shapefile of the buffer was determined and created, it was possible to reference all the vectors in a single reference system and begin overlapping the layers. From the visualization of the satellite images, available in the Open-layers add-on, a vectorization of the anthropic areas was carried out, which are inserted in the strict protection zone. In order to know the location and validate some of the data present in the mapping, a field trip was carried out with a navigation GPS device, making it possible to take points that served as a spatial reference for some conflicts. In this trip to the field, it was possible to interact with residents and witnesses of the process of environmental change and degradation of the region.

RESULTS

One of the first results that were still observed in the process of data acquisition and validation of the maps, with the geovisualization, it’s possible to obtain information for the pre-field, facilitating and reducing the cost of the process. thereby was possible to clearly observe the territorial and environmental conflict that was represented by the spatial overlap between, the delimitation of the zone of strict protection of the environmental protection area of the Joanes–Ipitanga and the area occupied by the construction of the municipal hospital of Salvador. In other words, a duality of use an environmentally protected region. The area which the hospital appropriates is approximately 0.50 ha of ZPR, corresponding to the protection range of the water accumulation of the Ipitanga-Joane’s rivers. Figure 3 demonstrates this spatialization and how close to the bank of the dam, the Hospital is being constructed.

In this way, the environmental irregularity can accelerate the process of environmental degradation already established in the environment. Having already established the correlation and topology among the polygons, through the satellite image, a visual survey of the areas occupied by existing equipment within the ZPR was done, as shown in Figure-4 (Images 1,2 and 3). In an analysis it is possible to observe, there are several residences of different construction levels, making it clear, that not only are low-income houses or communities in a situation of low income, but also irregular buildings with large spaces of leisure, largely built area, with typology totally different from most of the houses of that locality.
These enjoy the natural beauty and exclusivity in the protection zone. After the field-trip, was possible to accurately identify the current state of the locality, since the satellite images available in the OpenLayers complement have a delay of approximately 7 to 12 months. Using the navigation GPS, points were taken of new irregular subdivisions, also inserted in the ZPR, as shown in image -4 of Figure-3, these are part of areas invaded due to lack of the inspection. These delimitations are barring some ways passages that give access to the dam, depriving the population of the common use of this urban infrastructure. Still on the process of irregular invasion of the protection area, according to some residents of the Boca da Mata region, there is a relationship with the invaders and the low income vulnerable population of the neighborhood, where, after the invasion and delimitation of the terrain, they receive a certain amount of money to remain to occupy the area, making it difficult to remove the occupied place. It is possible to identify the deforestation and delimitation of these sites in Figure-4. It was found, in fact, the municipal hospital of Salvador occupies an area of the strict preservation zone, settling very close to the Jonnes-Ipitanga dam, responsible for 40% of the drinking water supply of the city of Salvador, which according to specialists, increases the environmental imbalance and degradation of the area. In addition, it is clearly exposed many buildings and housings inserted inside the ZPR, a zone that does not admit duality in its use. Such equipment remains and continues to be built, due to the weak environmental inspection available. Consequently, the area is lost with vegetation and biodiversity, bringing several complications that mainly influence the quality of the urban environment.
CONCLUSIONS

It is clear that the use of the GIS tool allows the production, organization, and construction of possibilities in the use of spatial data. The use of this free tool, in a fast, simple and without the need for more complex techniques of the process, allowed to express the non-compliance with the environmental protection legislation and consequently the invasion and degradation of the infinitesimal piece of Atlantic forest remained inside the city of Salvador. This type of analysis is very important, it can enable managers and the public itself to have the power to analyze and make decisions, knowing exactly where to intervene, applying time and public money more efficiently and on target.

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BIOGRAPHY

He has experience in the Oilfield, working 4 years as a operations supervisor in the well completion. He is currently a student of surveying engineering and cartography at UFBA, working in the area of Geosciences, with emphasis on Basic Cartography, Geodesy, Remote Sensing, Geoprocessing and Spatial Analysis. Scholarship Initiative in the QualiSSA, volunteer research in a university project using Geotechnologies in the visualization of territorial, social and environmental conflicts, and Working as Intern at SPU - Superintendence of the heritage of the union.

Graduated in Geology by the Federal University of Bahia (1995), in Physics by the Federal University of Bahia (2003), Master in Geophysics by the Federal University of Pará (2001) and PhD in Geophysics by the Federal University of Bahia (2010). Has research in Geophysics in numerical modeling and in the inversion of geophysical data, having worked mainly with the magnetotelluric, electroresistance and GPR methods. He has experience as a professor of higher education, having been a substitute professor in the Department of Mathematics of UFPA and professor of the Electrical Engineering Course of the Faculty of Technology and Sciences (FTC). Since 2015 he has been Professor of the Department of Transport Engineering and Geodesy at the Polytechnic School of the Federal University of Bahia, where he teaches the subjects of Physical Geodesy, Geoprocessing, Geostatistics, Geodetic Observations Adjustment, Topography and Social and Territorial Legislation. Also since 2015 he has been working on the research of the use of Geotechnologies in the visualization of territorial, social and environmental conflicts.