

# Mapping Areas of Environmental Protection in Lagoon Olho D'água (Jaboatão dos Guararapes – Pe, Brazil) using Submetric Image

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**Abstract.** Application of Remote Sensing in high spatial resolution images using QUICKBIRD, orthoimage georeferenced allow visual interpretation of appropriate zoning Areas of Permanent Protection (APP) in accordance with Brazilian law Resolution No. 303/2002 of CONAMA (National Council of the Environment) and areas Protection to the Basic Law of the Urban Municipality of Jaboatão Guararapes, Law No. 165 of 11.20.1980. The study area is located around the Olho d'Água Lagoon, City of Jaboatão Guararapes / PE. The Lagoon Olho D'Água is very important in areas cleared for urban growth, and for drainage of various neighborhoods of the city of Recife (Boa Viagem e Setúbal) and Jaboatão Guararapes (Piedade, Prazeres, Cajueiro Seco e Candeias), currently presenting several irregular occupations within the study area. The results of this work were a image map and a thematic map that allowed not only identifies the areas occupied irregularly that contradict the legislation and identify the differences of urban growth 1986 and 2005. It also enabled the mapping of protected areas, protected areas irregularly occupied, and free green areas subject to new occupations.

**Keywords:** Subnormal Occupation, Remote Sensing, Environment Protection

## 1. Introduction

Areas of occupation typically subnormal have problems with basic infrastructure such as sanitation, water supply, paved roads network proper channels, regular garbage collection, among other services essential to quality of life population.

Another aspect of the occupations around subnormal water bodies is disrespectful to the limits of protection indicated by the environmental legislation, situation feature surrounding a lagoon.

The area surrounding the lagoon is large and in this work it was chosen a smaller area of study for demarcate tracks provided protection (in relation to shores of the lagoon in the study), and the images demarcate the sectors actually invaded with construction dwellings.

This thematic mapping and preliminary updated (scale to allow observation of streets, channels, smaller streams and lagoon) is an essential task for bodies which provide analysis of planning urban and environmental enforcement officers and campaigns municipal governments to respect the educational environment. In the case of Olho d'Água Lagoon, the thematic mapping of the areas of public domain environmental protection and occupations presents the disrespect legislation.

Application of Remote Sensing in high spatial resolution images using QUICKBIRD, orthimage georeferenced allow visual interpretation of appropriate zoning Areas of Permanent Protection (APP) in accordance with Brazilian law Resolution No. 303/2002 of CONAMA (National Council of the Environment) and areas Protection to the Basic Law of the Urban Municipality of Jaboatão Guararapes, Law No. 165 of 11.20.1980. The study area is located around the Olho d'Água Lagoon, City of Jaboatão Guararapes / PE. The Lagoon Olho D'Água is very important in areas cleared for urban growth, and for drainage of various neighborhoods of the city of Recife (Boa Viagem e Setúbal) and Jaboatão Guararapes (Piedade, Prazeres, Cajueiro Seco e Candeias), currently presenting several irregular occupations within the study area.

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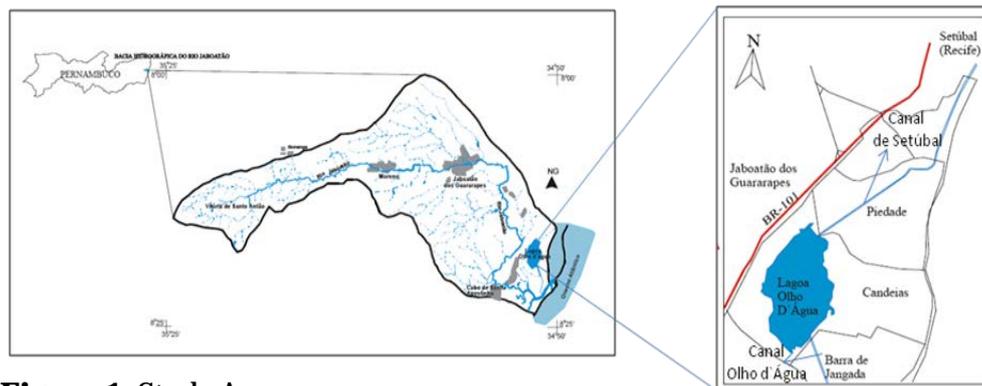
## **2. The study area**

The chosen area for this study belongs to Jaboatão Guararapes (Figure 1) located in the Metropolitan Region of Recife, a city that has an area of 256,073 km<sup>2</sup> and estimated population of 581,556 inhabitants (IBGE, 2004). The municipality contains 28 neighborhoods and is divided into 5 districts: Jaboatão Guararapes (1st District); Jaboatão (2nd District);

Cavaleiro (3rd District); Curado (4th District) and Jardim Jordão (5th District).

The study area of this work lies on the east bank of the Olho d'Água Lagoon, and inserted in the neighborhood of Candeias, as the map shown in Figure 1.

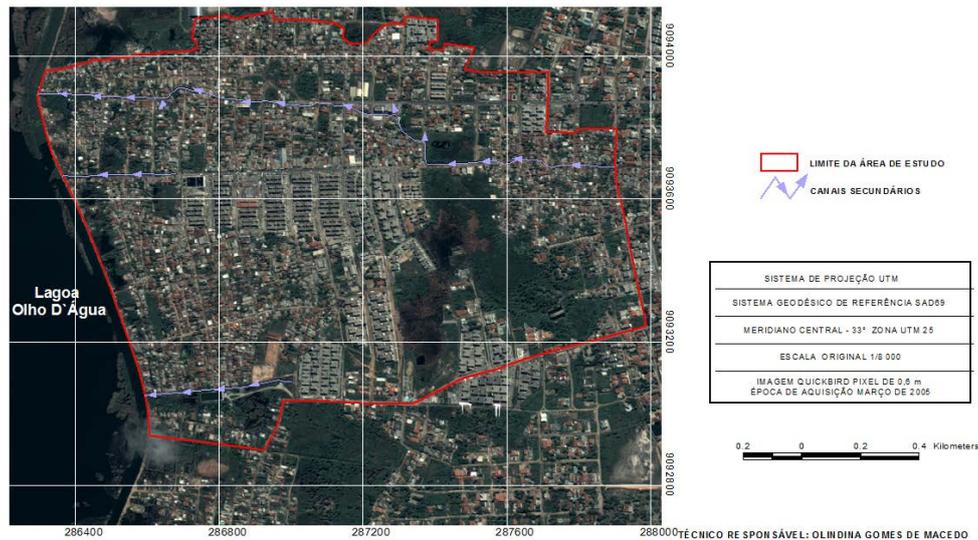
The Olho d'Água Lagoon is approximately 2.4 km away from the coast, from the point of its east bank nearest the coast, and corresponds to an extremely shallow lagoon system of several smaller ponds, forming micro Jaboatão River basin. Two artificial channels: Canal de Setúbal (ending at the Lagoon), and Channel Olho D'Água with output at Jaboatão river. Figure 2 identify the location of the study area with its limits on QuickBird image study area has the type multifamily residential complexes, commercial buildings and residential occupancy and subnormal. The delimitation of the area that is red in Figure 2 coincides with the sectors of the IBGE (Brazilian Institute of Geography and Statistics) census of 2000.



**Figure 1.** Study Area.

In the study area there are three other smaller channels, highlighted in Figure 2, which drain the sewage and storm water in the general direction from east to west, and falling into a channel width of 20m that surrounds the entire margin Eastern of Olho d'Água Lagoon. The level of the water depth of the Lagoon is subject to several factors including: 1 - The average annual rainfall of 2000 mm (mainly from May to June) which tends to raise the level of the lagoon; 2 - The tidal regime, which hinders the flow of the waters of the Canal Olho d'Água Lagoon connected south to Rio Jaboatão 3 - The volume of sediment and debris released by Channel Setúbal (which connects the lagoon to the Olho d'Água Lagoon mangrove Radio Station Pina); 4 - To grounding system of lagoons surrounding the Olho d'Água Lagoon; 5 - The number of flows and capacity of smaller canals that empty

into the lagoon; 6 - Rubbish thrown by people into the Olho d'Água Lagoon; 7 - Evaporation and soil erosion near the banks of the Lagoon, especially during rainy periods, 8 - Another issue influential variation in the volume of Olho d'Água Lagoon is the increase in impervious area contributing to the



increased uptake of rainwater for fewer storm sewers and open trenches in the ground, besides decreasing the area of natural soil for the relative water uptake.

**Figure 2.** Study Area with the three secondary channels of the study area that drain east to west.

## 2.1. Forest Code and Urban Basic Law of the Municipality of Jaboatão Guararapes

According to the Forest Code, Federal Law No. 4.771 of 15/09/1965, the regions bordering lakes and ponds are considered Permanent Preservation Areas - APP, its limits, parameters and definitions are listed in Resolution No. 303/2002 of CONAMA, which stipulates in its Article 3 that Permanent Preservation Area is the area located: item III - around lakes and natural ponds on track with footage minimum: a) 30m (thirty meters), for those who are located in areas urban statements.

Turn on Urban Basic Law of the Municipality of Jaboatão Guararapes, law No. 165 of 20.11.1980, around the Olho d'Água Lagoon is defined as the range of 100 m (one hundred meters), measured from the level d 'water elevation in the reservoir maxi-maximorum being considered an Environmental Preservation Zone type Z4.10, where any building is not allowed,

excepting only construction of retaining wall, access ladders, plumbing works and drainage waters, plumbing and sewers, ornamental fountain or works as defined in Art.15 her of the said law.

The growing disorderly occupation in the study area without environmental enforcement and effective, and without the knowledge of the laws of population, uncontrolled increases the disorderly occupation, focusing on environmental degradation, and contamination of soil, water of Olho d'Água Lagoon and decreased quality of life, because the population is more exposed to sewage, contaminated soil, and contaminated water of Olho d'Água Lagoon, where locals bathe and perform subsistence fishing.

## **2.2. Expansion and Occupation of Areas of Environmental Protection**

In the process of urban expansion a reality outstanding knowledge of Brazilian public is buying properties in flat areas not flooded by the sea and near the higher income classes, because they have a high real estate value. Moreover, the low areas subject to flooding in high tides, flooding and overflows Lagoon located, and no infrastructure of canals and sewage, are inhabited mostly by the lower classes (Melo, 1978).

According to Souza (2007), the highest percentage of the population is located in urban areas and low-income population has little or no right to essential services such as water supply, electricity, sanitation, transport, health, safety, education, and housing.

Considering the intense growth of urban population, the deficiency in housing quality standard minimal and the absence of a housing policy coordination of federal, state and local, that meets the needs of the low income population, the occupation is a consequence subnormal logic.

Another aspect of risk occupation subnormal important quote (not quantified in this study) refers to land without drainage infrastructure, which has influenced the low-income population to occupy areas rails floods and river beds and temporary ponds not flooded in the dry season, or the banks of rivers and lakes permanent flood risk areas.

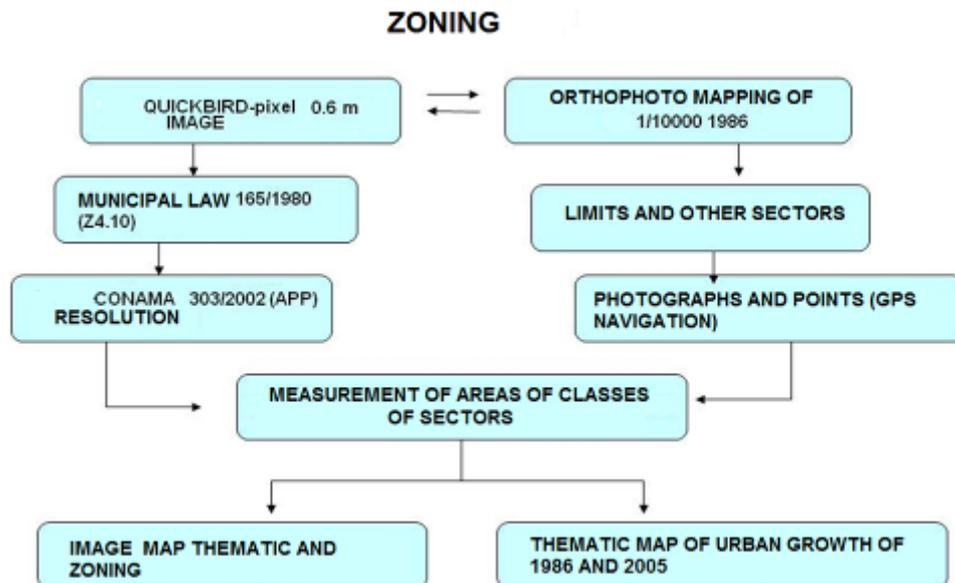
During the rainy season, or anomalies of maximum rainfall, the areas are flooded resulting in property damage and pain and suffering to the population, in addition to requiring the transfer of federal funds for emergency and palliative measures. The damage caused by the floods do not exclude the risk of the local population, growing in irregular occupations, which increases the pollution of soil, rivers, lakes (Guerra & Cunha, 2001; Braga et al., 2002).

The areas close to rivers, lakes and water bodies are generally protected by a specific environmental legislation and, when occupied by the population, increases risks from possible flooding.

The demarcation letters pictures of areas protected by environmental legislation is essential in the analysis of public agencies related to planning and environmental monitoring and urban need for both a thematic mapping (Macedo et al., 2009).

### 3. Methodology

The steps of the methodology consisted of (Figure 3): 1- visual analyze of the original image with spatial resolution of 0.6 m, acquisition date in March 2005 and orthophoto map 89-50 - digital 1986, corresponding to the study area 2 - georeference the images in UTM/SAD69 using the software SPRING and ARCVIEW and the delimitation of the study area; 3 – definition of the limits of the shores of Olho d'Água Lagoon; 4 - QuickBird image insertion in the geographical boundaries of environmental protection as environmental legislation on ponds; 5 - demarcation of the following classes: multifamily sector, multi-sector activities (including housing) sector and not built green area, sector of occupation subnormal, and main drainage network; 6 - measurement of the class of industries area.



**Figure 3.** Methodology of the work.

The original radiometric resolution of eleven bits was modified to eight bits to facilitate image processing in chosen software like SPRING and ARCVIEW.

The spatial resolution multispectral QuickBird image of 0.6 m was carried out using a pre-processing of the original image, previously georeferenced in SAD/69. The outline of the study area made the whole scene of Quick-Bird image corresponds to the study area of 133.075 ha.

The image was properly studied were chosen few points for field visitation and inspection of certain aspects of the land, namely, on the state and aspect of land use canal east bank of the Olho D'Água Lagoon, along the canals, lagoons on land, location of streets and houses. At field inspection in 2009 several locations were observed, photographed and positioned with GPS navigation, to be inserted in the georeferenced image and to associate the pictures terrestrial targets corresponding to the image.

The line interface water/ground on the stretch of border Olho D'Água Lagoon within the study area is important to define the Permanent Protection Areas, APP, 30 m according to Resolution 303/2002 of CONAMA, and the Environmental Protection Zone (ZPA) Z4.10, which is a specific standard for Olho d'Água Lagoon as the Municipal Law 165/1980 to mark the 100 m. We performed a chart image with the environmental zoning with APP and ZPA, being defined polygons constructed area, the area is not built, the residential and commercial sector and multifamiliar This environmental zoning was obtained independent of automatic classification using visual analysis, a field visit and photographs to land previously chosen points in the image.

Also an analysis was performed comparing the visual image of 2005 and orthophoto map in digital media of 1986 giving a position to assess the urban sprawl of the study area over 19 years.

#### **4. Results and Evaluation of Visual Classification**

The first step, therefore, is to separate, the homogeneous areas in terms of visual variables such as color, shape, size and texture, in the digital image (Table 1). Then it is assign an identity to the homogeneous areas, or establish a correspondence between image areas in separate classes and the true meaning in the real world of such classes. The proprieties are:

Location - The location oriented to identify of tht bodies of water avoiding the confusion of other targets that have similar reflectance

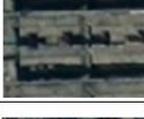
Texture - addition of color as element identification soil wetter was used also element texture, differentiation soil with mulching.

**Color** - the color was used to identify soils exposed in the study area

**Size** - Depending on the spatial resolution, the size factor was identification of Olho d'Água Lagoon to determine its limit

**Shadow** –It was used to identify objects that characterize urban concentrations that have disordered patterns of streets and houses, which in the study area are represented by ZEIS

**Pattern** - Important identifier in urban areas, as observed objects above have peculiar contours that facilitate the identification of an urban area, for example.

Elements of the image	sample	
	Original image	Photo of the area
Localization		
Texture		
Color		
		
Size		
Shadow		
Pattern		
		

**Table 1.** Local sample Homogeneous in image and area photography

Table 2 shows that in the study area, typically residential and commercial area of 133.075 ha total, the building area represents 76.84% of the study area (23.16% free area) and the area did not built within the Environmental Protection Zone is 3.32%, and the area outside the boundary of the Environmental Protection Zone is 19.8% of the total area of study. While representing 3.32% of the total area of study, the area built within the Environmental Protection Zone is evidence of non-compliance with environmental legislation.

Table 3 presents a comparison with urban expansion of da Expansion since year of 1986 to year 2005.

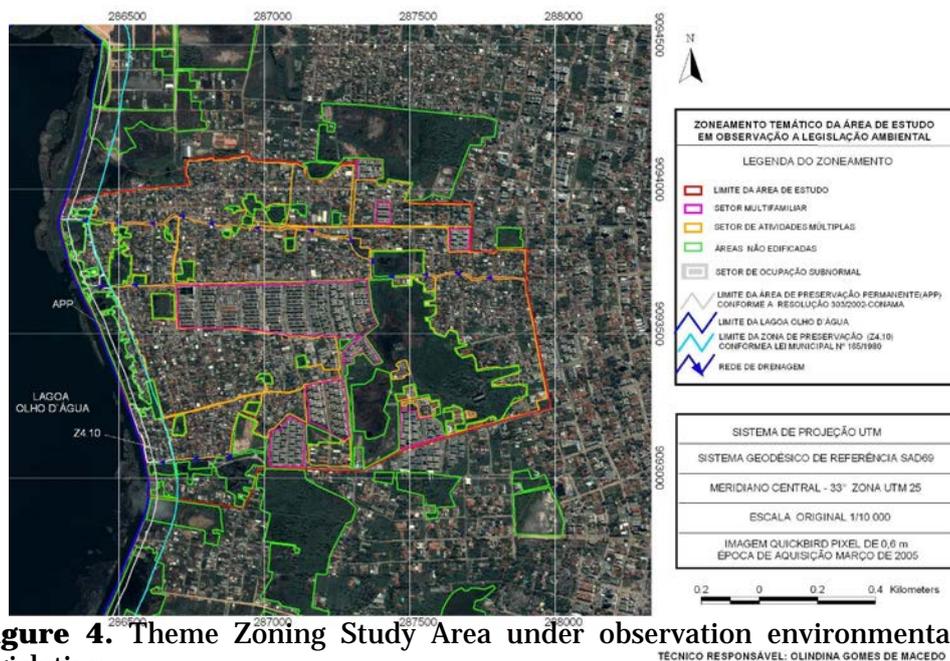
Zoning Zone Environmental Protection Z4.10 and APP around the Olho's D'Água Lagoon was one of the results contained in the map image (Figure 4). The color Magenta defines de familiar sector, yellow one defines the multiple activities sector, the green one defines the areas inbuilt and the red one defines the limit of the study area

ZONING – 2005 QuickBird image		
AREA	Definition area	Area (ha)
NOT BUILT	Area not constructed within the limits Z4.10	4,413
	Area not constructed outside the boundary of Z4.10	26,401
	<b>Total area unbuilt</b>	30,814
BUILT	floor area within the limits Z4.10	4,946
	Floor area (Multifamily Residential)	18,137
	Floor area (residential / commercial)	79,178
	<b>Total built up area</b>	102,261
Total area of the study (ha)		133,075

**Table 1.** Date of quantitivity zoning

STATISTICS OF ZONING		
QuickBird from 2005 and orthoimage from 1986 (No. 89-50)		
Type of the Area	DESCRIPTION	Quantitative Data (ha)
Built 2005 (ha)	Area built on the outskirts of Z4.10	4,95
	Floor area (Residential Multi-Family)	18,14
	Floor area (residential / commercial)	79,18
	<b>Total built up area</b>	<b>102,26</b>
Built 1986 (ha)	area built on the outskirts of Z4.10	0,00
	Floor area (Residential Multi-Family)	7,29
	Floor area (residential / commercial)	5,91
	<b>Total built up area</b>	<b>13,20</b>

**Table 2.** Comparison with urban expansion of da Expansão 1986 and 2005 year.



**Figure 4.** Theme Zoning Study Area under observation environmental legislation

## 5. Conclusion

The visual classification determined classes such as vegetation, building and water, allowing the identification of free and occupied areas within the range of environmental protection on the APP and ZPA Olho D'água Lagoon

The urbanization growth since 1986 to 2005 like showed in Figure 4 . The visual classification also allowed to quantify the extent of built area and not built, in 1986 regarding orthoimage and in 2005 regarding the high resolution image. The percentage of growth over a period of 19 years was checked and showed it Table 2.

With the evaluation of visual classification was possible identify the highways most characteristic influence on urban expansion, still under development, are the streets Frágoso John de Medeiros and Peter, while the edifices of Dom Hélder Câmara is a unify hub of urbanization.

In summary this mapping done in this work allows to visualize areas of occupation as the irregular (Figure 4) assisting urban and environmental law and still act in: A - prevention of irregular occupations as law sector of APP and Z4.10 , B - proposed environmental education campaigns in communities underserved sector of occupation subnormal;-C facilitate raising families residing in areas at risk to enter them in the city housing projects and urban regeneration.

The Remote Sensing using submeter resolution images is a science and technology in key thematic mapping of protected areas around bodies of water, representing great power of technology integration with the urban geography and environmental.

## 6. Acknowledgment

Department of Civil Defense of Jaboatão Guararapes, Pernambuco to let us use the data of the area analyzed.

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