# REMOTE SENSING TECHNIQUES FOR LAND USE CLASSIFICATION OF RIO JAUCA WATERSHED USING IKONOS IMAGES

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## ABSTRACT

In Puerto Rico the land use has been changing, every day new developments (urban, industrial, commercial and agricultural) are emerging. The purpose of this work is to develop the land use of Río Jauca a sub-basin of the Rio Grande de Arecibo watershed that is an important natural resource and supplies water to the metropolitan area. Remote sensing techniques can be used to assess several water quality parameters and also for land use classifications. For this work the ERDAS Imagine V8.5 computer software will be used to develop a land use classification using IKONOS images. The generated land use classification will be compared with a land use generated using Arc View, to decide which method provides better land use classification.

## INTRODUCTION

The area of study is located at the north central part of the island; Rio Grande de Arecibo watershed has a catchments area of approximately 45,000 ha (Figure 1-2.). It is a very important water supply, because it provides, since 1998, potable water to the metropolitan area of San Juan. High suspended sediment concentrations are a common problem in many streams in Puerto Rico. High suspended sediment concentration in streams is related to land use, especially urban development, agriculture and activities where soil movement is involved.

Remote sensing techniques have been used to monitor land use changes; this has an important role in urban development and the determination of water quality parameters. Also remote sensing is very useful for the production of land use and land cover statistics which can be useful to determine the distribution of land uses in the watershed. Using remote sensing techniques to develop land use classification mapping is a useful and detailed way to improve the selection of areas designed to agricultural, urban and/or industrial areas of a region (Selcuk, 2003). The evolution in technology of remote sensing has caused it to become one of the most commonly used techniques in the world.

In this study two different classification methods were used: Unsupervised and supervised classification. Unsupervised classification is the identification of natural groups, or structures, within multispectral data. Supervised classification is the process of using training samples, samples of known identity to classify pixels of unknown identity.

## OBJECTIVES

- Use remote sensing techniques to identify the land use of one sub-basin in the Río Grande de Arecibo watershed (Río Jauca).
- Compare the distribution of land use areas to identify which is the most predominant in the watershed (agriculture, urban area, forest, etc.)
- Compare the land use classification data generated by ERDAS vs. the data generated by using Arc View.

## METHODOLOGY

For this research, true color images of IKONOS will be used to identify the study area. Remote sensing techniques using ERDAS software to process IKONOS images for the area of interest will be used (*ERDAS, 1997*).

DEM (Digital Elevation Models) will be used to delineate the catchments area of the sub-basing (Río Jauca). Arc GIS (*ESRI, 2000*) will be used to process the data obtained from DEM's, (Figure 4)

The remote sensor to be used is IKONOS which produces 1-meter black-and-white (panchromatic) and 4-meter multispectral (red, blue, green, near infrared) imagery that can be combined in a variety of ways to accommodate a wide range of high-resolution imagery applications using supervised classification.

The IKONOS images: N18W066B6NE, N18W066B5SW and N18W066B6SE were obtained from the Geology Department at the University of Puerto Rico-Mayagüez. A mosaic was obtained from the three images and then a mask created to work in the study area.

Two unsupervised classifications were generated using ERDAS, one using ISODATA and the other using a K-Means method. Several supervised classifications were generated, to select the most appropriate. For this classification approximately 12 training samples were obtained from a visit to the area of study (Table 1) (Figure 3), using a Global Position System (GPS) to collect the data. The software used for this study is: ERDAS Imagine V8.5, ENVI, ARC View GIS, WMS, and Excel.

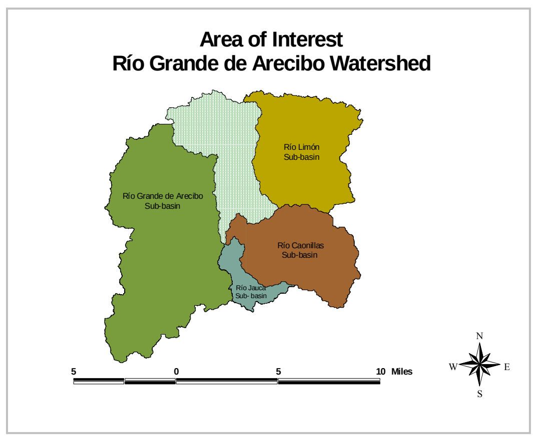


**Figure 1. Area of study**

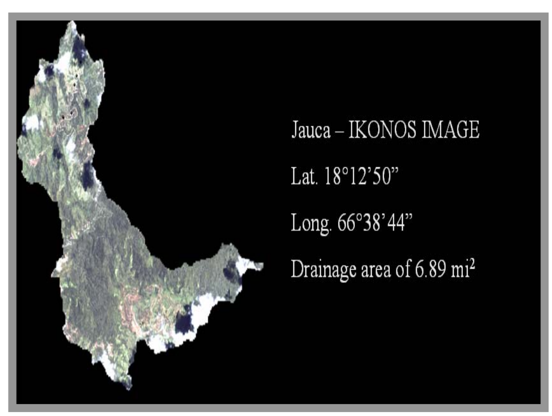


**Figure 2. Río Jauca Watershed, IKONOS**

**Table 1. Training Samples Description**

| Site | Lat. (°) | Lat. (') | Lat. ('') | Long. (°) | Long. (') | Long. ('') |
|---|---|---|---|---|---|---|
| **Sampling Site** | 18 | 12 | 43.248 | 66 | 38 | 42.296 |
| **River Point #1** | 18 | 12 | 43.025 | 66 | 38 | 42.27 |
| **River Point #2** | 18 | 12 | 42.79 | 66 | 38 | 42.388 |
| **River Point #3** | 18 | 11 | 50.53 | 66 | 39 | 0.23 |
| **Forest** | 18 | 12 | 42.59 | 66 | 38 | 42.64 |
| **Urban** | 18 | 12 | 11.135 | 66 | 38 | 48.632 |
| **Agriculture** | 18 | 11 | 53.43 | 66 | 38 | 52.04 |

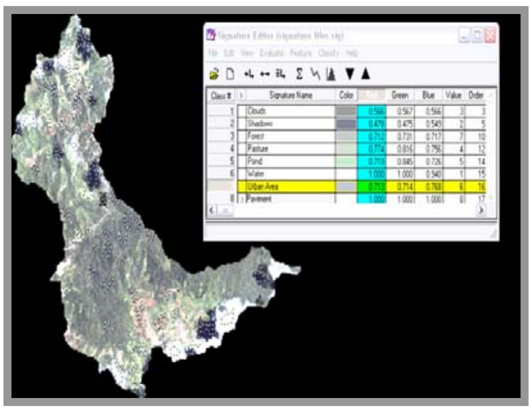

**Figure 3. Area of Interest (AOI) selection using training samples areas.**

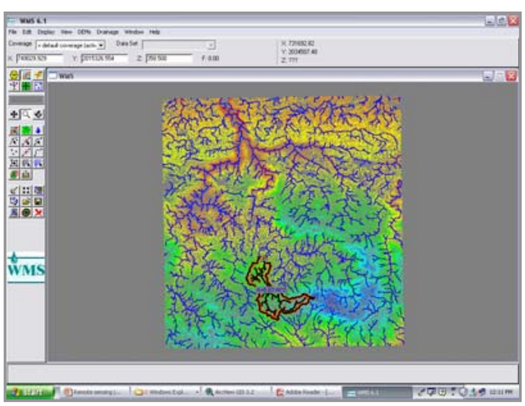

**Figure 4. Río Jauca Watershed delineation using the Water Modeling System (WMS)**

## RESULTS AND DISCUSSION

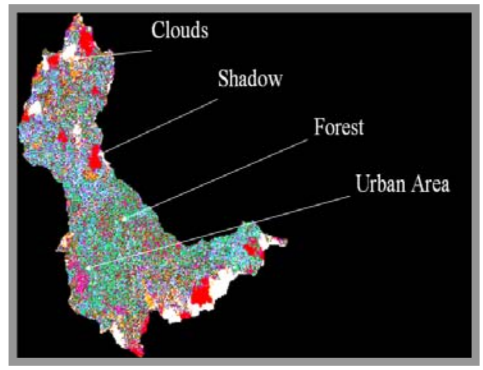


**Figure 5. Unsupervised (K-Means) (8) classes, (2) max iterations**

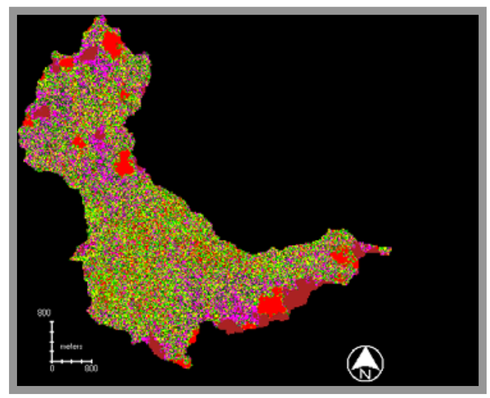

**Figure 6. Unsupervised Isodata, (6) classes, (2) maximum iterations, convergence threshold 0.950**

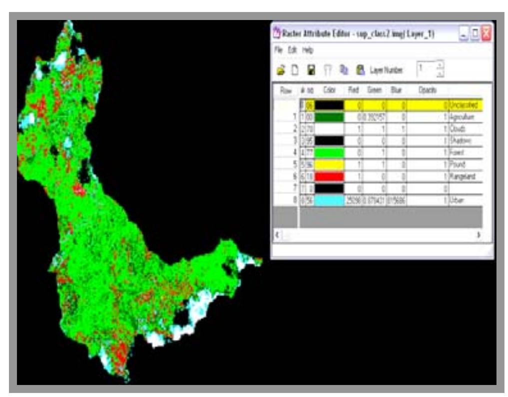

**Figure 7. Supervised Minimum Distance Method**

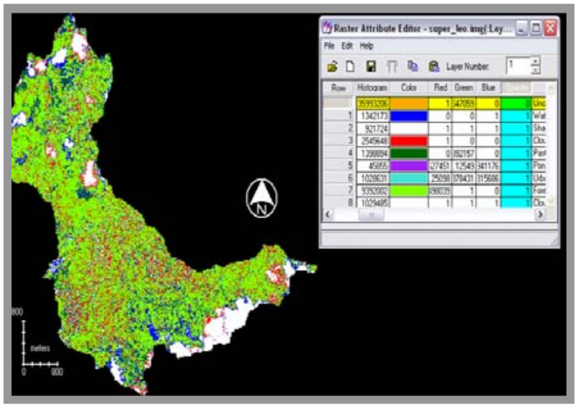

**Figure 8. Supervised Minimum Distance Method, using training samples.**

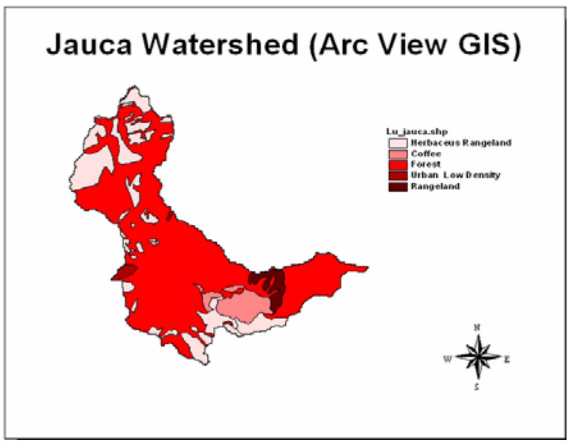


**Figure 9. Arc View GIS, Land Use Classification of Río Jauca.**

***Unsupervised Classification*** (Figures 5 - 6)
Performing this classification generated some errors, especially in the forest and agricultural land. This classification was a significant tool to continue with the supervised classification. In this classification the most common errors were observed between the agriculture, pasture and forest classes, also errors were found in the urban area, that were in some areas classified as clouds. These errors can be corrected using atmospheric corrections, for clouds and shadows in the original image of IKONOS.

***Supervised Classification*** (Figures 7 - 8)
After generated eight different supervised classifications using different parameters such as number of classes and parametric methods; maximum likelihood and minimum distance, It was found that minimum distance classification generated a better classification than maximum likelihood classification. In the supervised classification the most common errors were found in the classification of pasture and forest, in some areas the wavelength of these elements was confused, this can be due to the high intensity of green land cover of the area and the intensity of forest in the watershed.

***Arc View Classification*** (Figure 9)
In the land use classification generated using Arc View tools; the distribution of land use is the following: the predominant land use of the area is forest, followed by herbaceous rangeland, followed by agriculture, and a small portion of the watershed composed an urban area. In this classification the rangeland area that is located in the center of the watershed can not be observed.

**Conclusions**

- After used ERDAS to perform the classification, significant data has been obtained using a minimum distance supervised classification method.
- Correction methods need to be performed for clouds and shadows.
- Land use classification is more detailed using remote sensing tools such as ERDAS software than the Arc View GIS.

- ❖ Also land use classification using ERDAS, can be performed faster and with more precision, after you have your training samples.
- ❖ Using the obtained results from ERDAS and Arc View GIS for land use classification, can help to perform a more accurate classification.
- ❖ To perform a better classification of this area using ERDAS, it is recommended to use the Modeler tool, to correct the errors and be more accurate.

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