Geological Aplication of Remote Sensing

Seek of Specific Soils in Puerto Rico using IKONOS

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ABSTRACT.- The present work demonstrates the similarities of the purest minerals which are Kaolinite and Ottawa for the clayey soil and sandy soil respectively and the main objective is to compare this last four kind of soils with some of the principal soils in Iraq due to the importance of physical and chemical transport for explosives in the soils. The intention of this project is just compare the reflectance curves and not to avoid explosion or transport of chemical contaminants explosives. Compare the curves generated by field experiments conducted by the U.S. Geological Survey and those generated by ENVI 4.0 from images of IKONOS sensor.

INTRODUCTION

The purpose of this project is due to consideration for further applications. Merely to do a comparison between the soils in Iraq and if there is any similarity in Puerto Rico.

Considering the importance of the soils capacity to transport explosive chemicals. Focusing my work in the specific comparison of Kaolinite and Quartz.

Which final propose is the detection of landmines to prevent explotion. In this work I try to demonstrate the similarities of reflectance curves of the purest materials from they class such as clayey and sandy soils.

METHODS AND MATERIALS

Study area

Puerto Rico's land area is approximately 8900 Km^2. From northeast to southwest as a triangle figure different soil properties claim

the country specifically those related to clay and sandy which are of my interest.

But particularly I show only one region in the north west of Puerto Rico in my analysis due to the largest number of pixels generated by every image produced by the Satellite (sensor IKONOS) .

My study area is defined too, due to the convergence of the two principal soils searched which are Coto Clay as the clayey soil and Algarrobo sand class for the sandy soil. Which correspond to Hatillo region near the coast.
See Figure 1.

The selected study area was found based on a extensive search in technical papers, journals and publication of the soil taxonomy, U.S. Department of Agriculture and the geo-referencing was made by Arc View.

Ensure correct location of soils by Arc View 3.2a utilized to locate the soils and find the area of convergence between sand and clay. With the specified properties of purest materials in they class found in the technical reports.

Compare the differences (reflectance) from IKONOS images vs. specific data from US Geological Survey, Report 93-595.

Then I access IKONOS updated images supplied by the PaSCoR laboratory.
Finding the following types of soils in PR at northwest area:

Sand, similar to Quartz are
(no calcareous, low physical and chemical reactivity, and high permeability).

Clay, similar to Kaolinite are
(low physical and chemical reactivity, high permeability, non expandable).
Finally process the images in ENVI 4.0

To get the reflectances and compare the curves to those generated by the U.S. Geological Survey.

STUDY AREA: HATILLO REGION

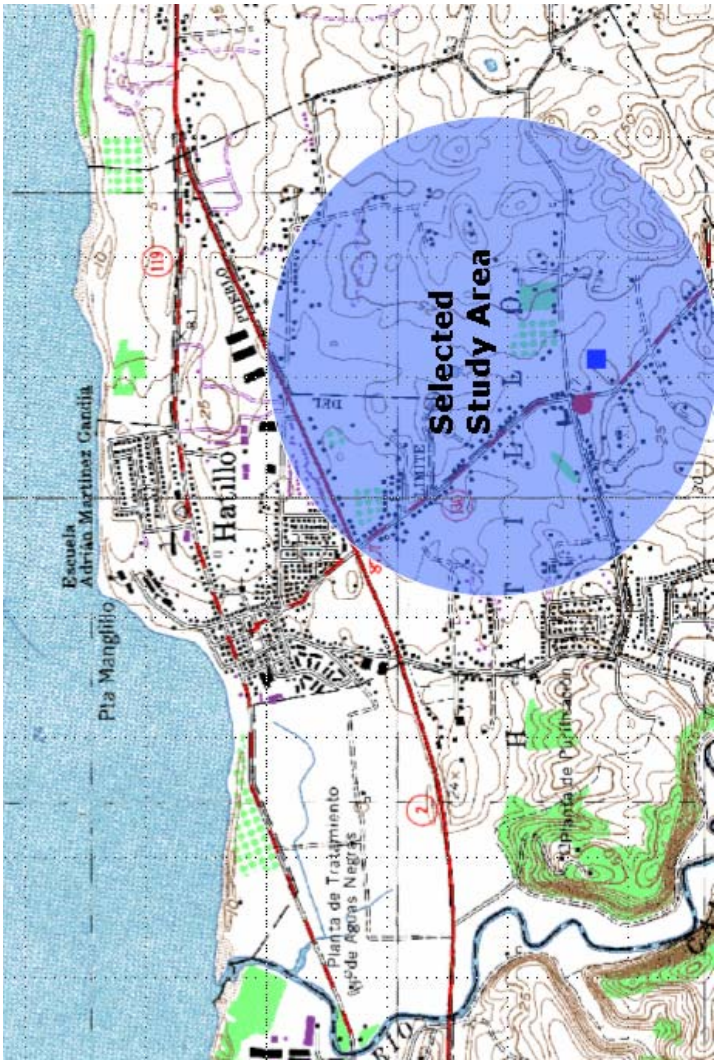

Figure 1. Represented Selected study area in the Hatillo region, northwest of Puerto Rico.

Image Data

The images from the IKONOS sensor were processed using ENVI 4.0. Figure 2 show the true color image used to locate the region of interest and to define by true color which was grass, buildings, between others in general terms. To make a quick classification.

Figure 2. True Color Image of the Subset for Hatillo Region

Use an RGB image to locate the points of interest. See Figure 2.

Crop by a subset from Hatillo Region Reduce excess use of virtual memory and do not slow down the system on my computer and make fast the analyses.

Where clearly one can note the association of Red color (False Image), Figure 3; and the greenish (NDVI), Figure 4; due to the Infrared Radiation.

IR (Infrared Radiation) shown in different displays one in red and the other in red too, but the color was degraded to green/white.

Figure 3. False Color Image of the Subset for Hatillo Region

Theses image classification were made to identify the absorbance in the infrared spectrum which is in the range of 0.72 to 1000 micro-meters. Doing at least four different classifications to compare and discuss the results and differences and similarities.

Figure 4. NDVI Image of the spatial subset of Hatillo Region

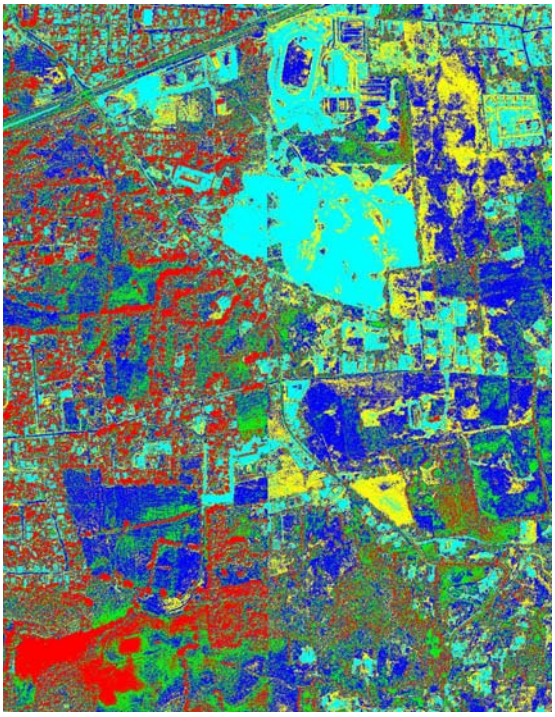

Figure 5. Unsupervised Classification K-means for the spatial subset of the Hatillo Region

An Unsupervised classification was performed to identify comparatively the regions know of clayey and sandy soils to those generated by the K-means unsupervised classification, see Figure 5.

Where one can find that the colors mean the following: Cyan, corresponds to sand deposits and some buildings. Yellow, corresponds to clay.

Then the z-profile was used as well as the mineral libraries by the U.S. Geological Survey taken with AVIRIS sensor to compare the plots with those generated by the U.S. Geological Survey in the field with a spectro-photometer.

Finally results were obtained and discussed in the following pages.

RESULTS

In the following graphs Figure 6 and Figure 7, one shows the reflectance of the purest sand or well known as Ottawa sand and the other the Algarrobo -Arecibo sands which correspond to Puerto Rico soils, respectively.

The curves looks pretty similar if only focus our interest in the selected interval.

This corresponds to the wavelength from 0.4 to 3.0 micro-meters. But, here we can appreciate the range of absorbance to the near to medium infrared region. The highest peak is out of our interest because it is about in the 10 micro-meters.

For the curves generated for Kaolinite represented by Figures 8 and 9 the results are quite similar in terms of the shape and even considering the interval only from 0.4 to 3.0 micro-meters, but the reflectance values are not the same as in the previous results gotten for the Ottawa sand. Here there is a discrepancy in the Y-axis values. But the shape looks very similar.

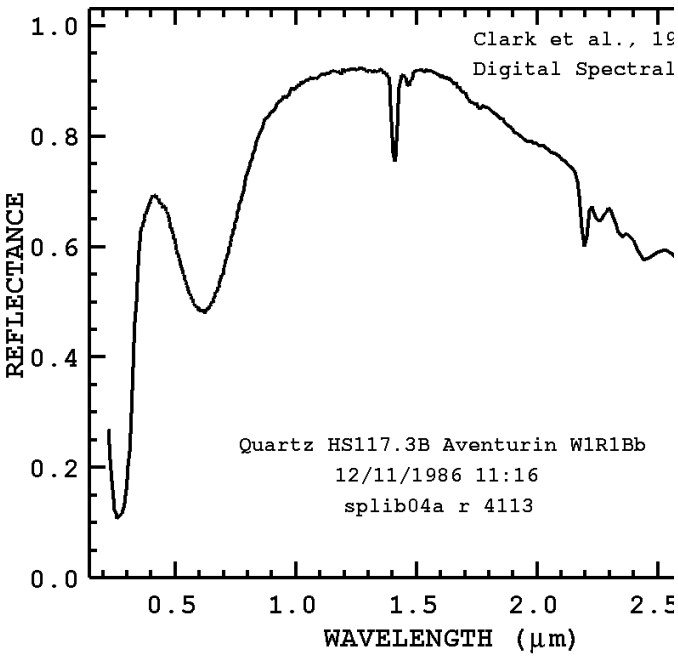

Figure 6. U.S. Geological Survey by a field measurement for Quartz.

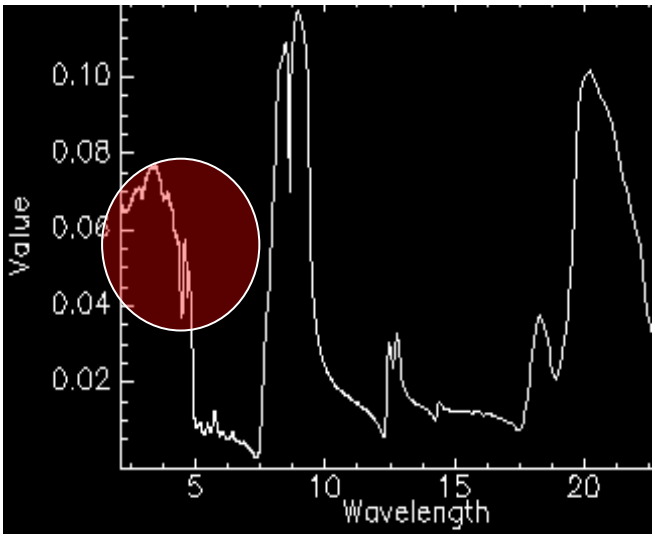

Figure 7. U.S. Geological Survey by AVIRIS or spectral libraries for Quartz.

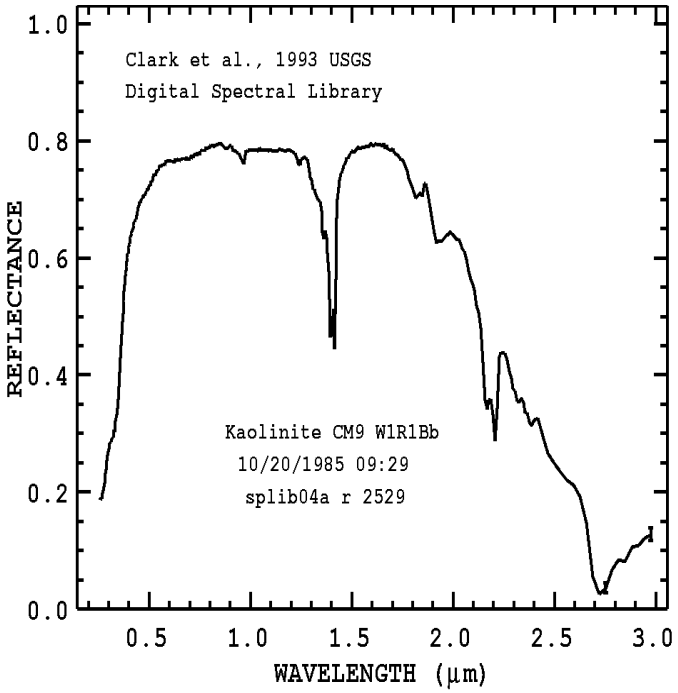

Figure 8. U.S. Geological Survey by field measurements for Kaolinite.

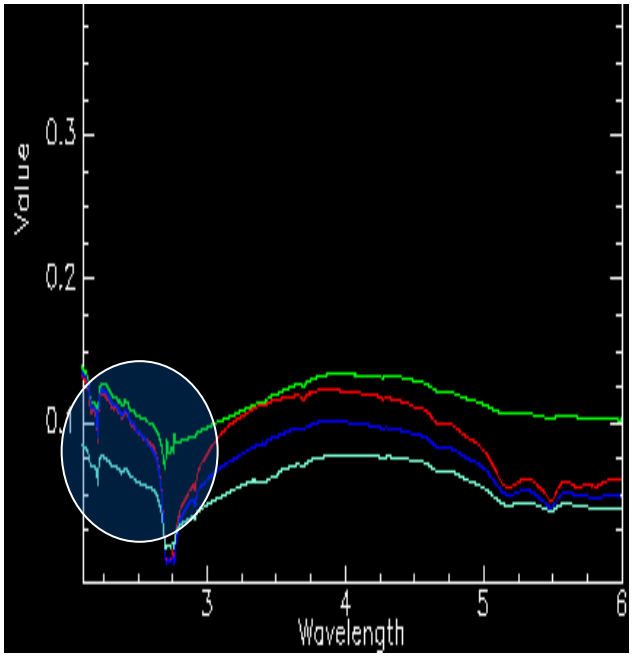

Figure 9. U.S. Geological Survey by AVIRIS or spectral libraries for Kaolinite.

DISCUSSION

Reflectance of the selected clay is similar to kaolinite. The problem was overall in my project that the IKONOS sensor doesn't fit my needs. One method for calibrating the image and considering it for further applications and methods could be the addition, subtraction, multiplication and division of bands to compare and as a cleaning error method.

Reflectance of arecibo sand was similar to ottawa sand (purest material) by assumption because the calibration was not made and my research was not successful I use the spectral libraries to compare with AVIRIS sensor.

The properties are quite similar in physical & chemical properties, well it is relative, because as well as Remote Sensing is newest there are a lot misunderstands parameters and variables to presume from a reflectance curve the physical or chemical properties, so it isn't possible to know this last ones.

IKONOS Images were not the best option for the analysis due to the low radiometric resolution and the data missing on the 2001 images gotten from PaSCoR, without date, hour exact of the image to accomplish image calibration as an automatic function of the program ENVI 4.0..

The ranges of absorbance for clayey and sandy soils are between 0.72 to 1,000 µm. I compare the results from the USGS reports taken form the field with a spectro-radiometer vs. those taken with AVIRIS and supplied in ENVI 4.0 as spectral libraries. Even I compare the

results obtained with the Z-Profile and were similar.

Suggested sensors for sediments, clay, silt, sandy soils and in general for TERRA's characteristics or land properties are: LANDSAT, Ground Sensors, soil profiles. Or those sensors containing lot of bands in the Near Infrared, Medium Infrared, Far Infrared.

The NDVI was calculated too, due to the importance of reflectance in the vegetation and the importance or roll played in the NI (Near Infrared) absorption, but this can be a confusing with the vegetation vs. soil materials.

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