GIS 6127 Hyperspectral Remote Sensing

FINAL PROJECT

Submitted by

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ASD SPECTRUM ANALYSIS OF SEDIMENT COMPOSITION IN JUPITER BEACH SEDIMENTS

INTRODUCTION

Beaches in Florida are very important economic resources and home for thousands of sea turtle nests every year. Beaches in Florida are nourished every year with different sediment sources (inland, offshore, or upland mine). The composition of the beach sediments impacts the sediment temperature which in further influence the sea turtle nesting success rate. As, we know the sea turtle gender discrimination is dependent on the sediment chamber temperature. Slight increase or decrease of the threshold temperature could cause the embryonic mortality. So, it is important to understand what mineral composition is on the beaches to know their impact on the temperature which further impacts the sea turtle incubation. This project will study the mineral composition using the spectral plots of the sediments from Jupiter beach measured from the ASD (Analytical Spectral Device) spectroradiometer which will later be compared to the results obtained from them traditional methods.

Beaches in Florida are nourished every year to as part of the coastal restoration projects. The composition of the sediment placed on the beaches are very important as they need to be mimicking the natural beach sediments. Understanding of the beach sediment composition and the moisture content is also important because as it also can affect the erosion of the beaches. Sediments were collected form 9 different locations in Jupiter beach at 100 m gap. From each location surface samples from high, mid, and low beach were collected which will be used for this project.

OBJECTIVES

The objective of the project is to obtain the reflectance graphs using the ASD spectral radiometer for the sediments form he 9 different study sites in Jupiter beach to analyze the sediment grain size and also the carbonate content. Also, the results obtained are compared to the grain size and carbonate content obtained from the traditional method.

BACKGROUND

Coastal environments are considered as rich economic resources for tourism. The erosion of beaches is not good for the economy of the state. Beaches are frequently visited by tens of millions of people worldwide (Lushine, 1991). To maintain the beach width beaches are nourished every year. As Florida beaches are home for thousands of sea turtle nests every year, it is important to understand what characteristics sediments are to be placed on the beach. Evaluating the sediment characteristics is helpful for coastal management people to understand the suitable sediments to be placed on the beaches.

Several techniques are used to identify the sediment characteristics. The sediment characteristics include the grain size, sorting, and mineralogy of the sediments. The composition of the sediments is characterized by the physical features (sorting, grain size), chemical composition (carbonate, silica content etc.,) and petrographic composition (texture and minerology). The study to understand all the above mentioned features not only helps the coastal managers but also it will help to provide the information on the evaluation of geography, climate, tectonics and lithology of the sediment source areas and the patterns along the coast. (Borges and Huh, 2007). To identify these physical features, chemical composition and petrographic composition using the traditional methods is time consuming and also expensive. The alternate methods to obtain the data is using the hyperspectral remote sensing.

In contrast to the traditional methods the remote sensing techniques is less expensive, fast and now-a-days it is very often used in the study of coastal environments and to obtain the reflectance properties of the sediments (Liu et al., 2003, Power et al., 2011, Small et al., 2009, Teodoro et al., 2011, Xu et al., 2014). The sediment reflectance spectrum is influenced by the sediment's mineralogic composition, grain size distribution and moisture. There have been research previously done on using the hyperspectral graphs for the study of the beach sediment characteristics (Ciampalini et al., 2015, Selch). The former article (Ciampalini et al., 2015) stated the comparison between the traditional methods to the remote sensing methods in regard to the sediment characteristics. The study included the sediment data from few coasts in Italy. The study evaluates the hydro and Morphodynamics settings of the coast. The composition of sand samples was evaluated by means of traditional petrographic methods and grain size analysis was done. And the paper also included the data obtained from the ASD spectroradiometer. The difference between the traditionally obtained mineralogical data is then compared to the spectral library obtained from hyperspectral study. The results of the study states that the remote sensing methods can be used in order to reduce the expenses and time consuming traditional methods. The later publication was a poster on coastal sand reflectance analysis using hyper spectral remote sensing submitted by Selch. The study suggests the use of ASD spectroradiometer to differentiate the presence of the carbonate and quartz in the coastal sediments from different locations in the world. The spectral signatures were observed in the plots to identify the presence of carbonate and silica respectively.

DATA SOURCES

Jupiter Beach in Northern Palm Beach County is the study area chosen for the project. The sediment samples used for this project are the samples that were collected from 9 different locations (Figure 1) in 2019 in Jupiter Beach. Sediment samples were collected from the surface on all these locations at the high beach, mid beach, and low beach. These samples were washed, and oven-dried for further analysis. The data for the project includes surface sediment samples from mid beach (MS), which were collected in March 2019.

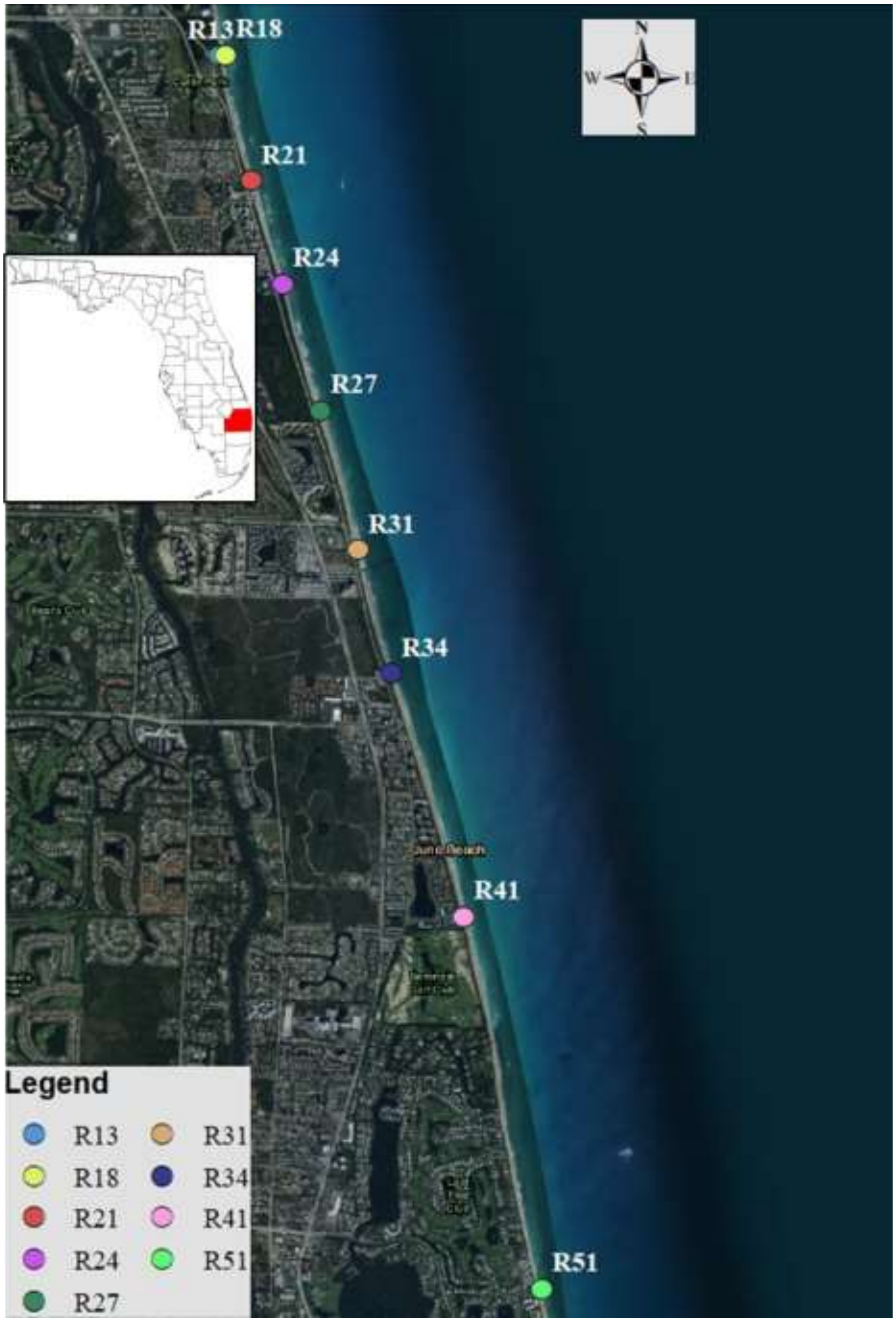

Figure 1: Study Area showing 9 different locations in Jupiter beach.

METHODOLOGY

The data was obtained from these sediment samples include sediment grain size, sorting and carbonate content. These data are used as a reference to compare with the data that will be obtained from the ASD spectroradiometer. The traditional method used to collect the sediment characteristics include sieving the sediments dry sediment in the Ro-tap sieving to obtain the sediment grain size. The sediments were also used to obtain the carbonate content by doing the carbonate burn analysis using the 10% dilute Hydrochloric acid. Later ASD spectral radiometer analysis was for all these samples. The reflectance measurements for all these samples were obtained using the ASD spectroradiometer Field Spec 3. Spectral reflectance between 300-2500nm at 1m resolution was used to get the data. Five signatures were collected for each sample and then a splice correction was performed for a noted instrument sensitivity drift at the short wave near infrared. Later the ASD binary files were converted to ASCII format. All these steps including splice correction and ASCII files exporting was conducted in the ASD Viewspec Pro software. The five signatures later were averaged in Excel in order to remove the electronic noise or any possible variations in lighting. The results from both the traditional methods and remote sensing methods were then compared.

RESULTS

The results obtained from the traditional method include grain size and sorting form Ro-Tap sieving. Results from the traditional method analysis also include the carbonate percentage of all 9 samples from 9 locations in Jupiter beach. The grain size and carbonate data is shown in Table 1. Graphs were plotted in excel for the grain size and carbonate content against the study sites. The graphs are shown in Figure 2.

Table 1: Sediment grain size and carbonate content.

MS	Mean grain size (mm)	Sorting (ϕ)	%Carbonate
R13A	0.75	1.21	76
R18	0.35	0.44	49
R21	0.49	0.76	59
R24	0.4	0.49	46
R27	0.44	0.66	47
R31	0.49	1.1	53
R34	0.43	1.08	56
R41	0.39	0.49	48
R51	0.43	0.51	52

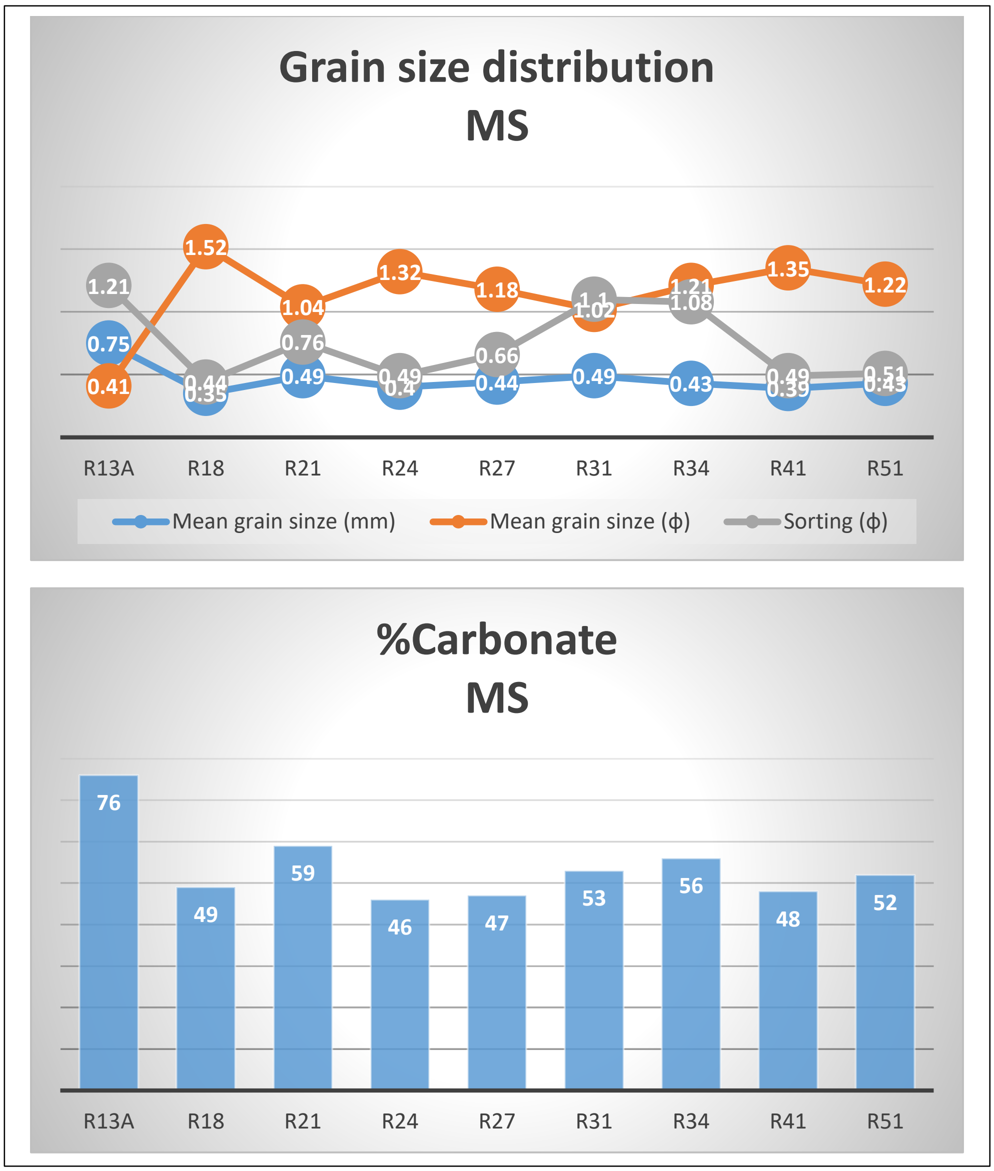

Figure 2: Grain size(top) and carbonate distribution (bottom) in all the study sites.

The results from the ASD spectral Radiometer is shown in Figure 3. The averaged reflectance values are plotted on the Y-axis and the wave length in Nano-meters in plotted on the X-axis.

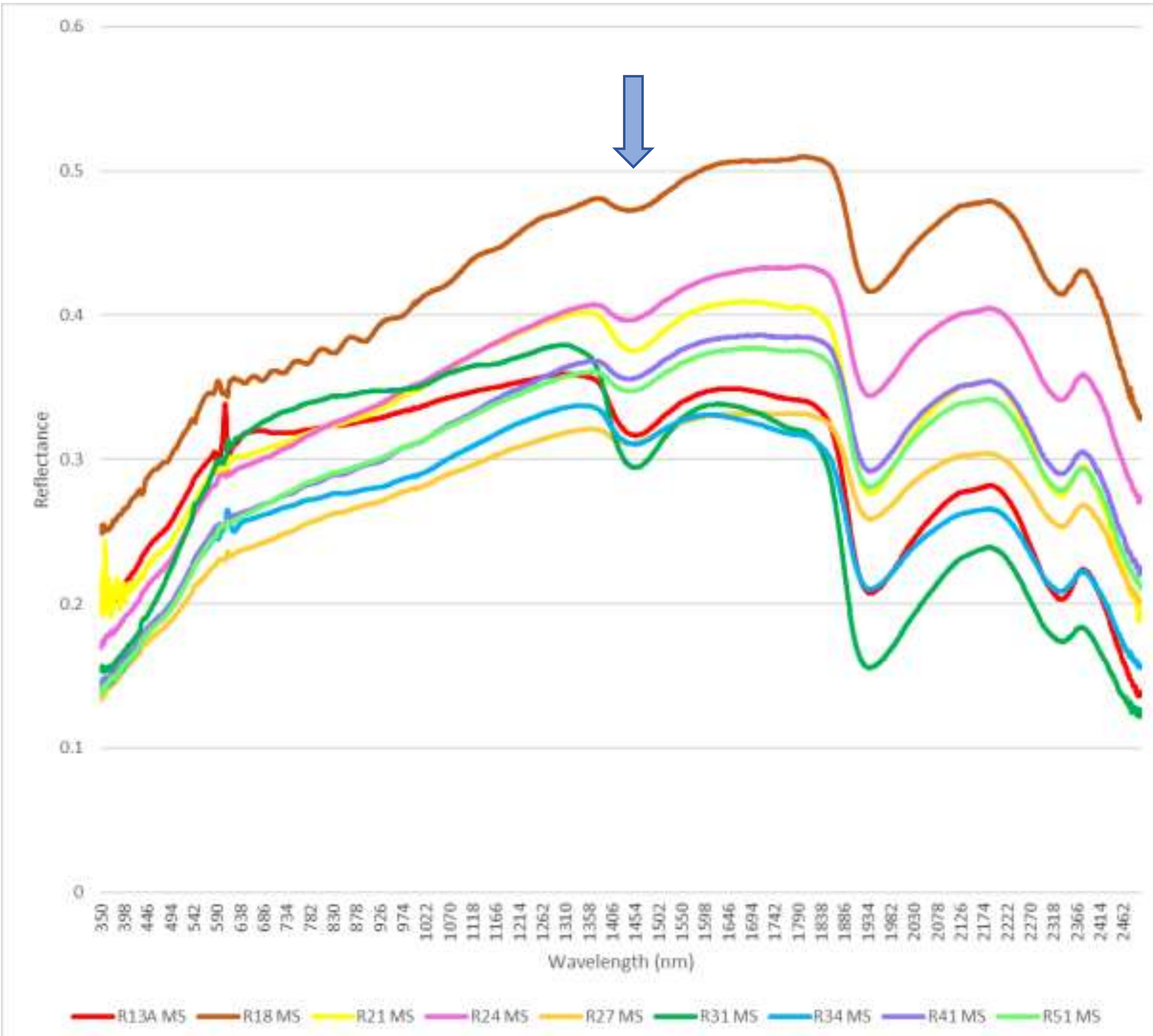

Figure 3: ASD spectral reflectance curves for the sediment samples in the 9 study sites.

DISCUSSION

The traditional method of grain size analysis shows that the highest grain size of 0.75 mm was observed in R13A which is the northern most location in Jupiter beach followed by R21, R31, R27 and R34 (Figure 2). According to Wentworth grain size classification R13A study site falls under coarser sediments. The lower grain size of 0.35mm was observed in R18 followed by R41, R24 and R51. In most of the study sites sediments with coarser grain size has poor sorting and the fine grain size has well sorted sediments. The highest carbonate content was found in R13A as well with 76% followed by R21, R34, R31 and R51. Whereas the lowest carbonate content of 46% was found in R24 followed by R27, R41 and R18.

The graphs of ASD spectral radiometer shows that the highest reflectance in R18 (Figure 3). The lowest reflectance is found in the R27, R31, R34 and R13A. The arrow shown in the graph at the 1470nm is a diagnostic absorption feature for the presence of carbonate (Clark 1999). The lowest absorption at 1470nm is found for the R24 (pink), R41 (violet) and R27 (brown) in Figure 3 and the highest absorption is found in the R31(dark green), R13A (red) and, R21 (yellow) in Figure 3.

According to Beers Law, with the increase in the grain size the reflectance decreases. The higher reflectance indicates the finer grain size. In my analysis the R18, R24 and R21 showing highest reflectance which indicates the finer grain size. The same was found from the traditional methods. Also, the lowest reflectance (R27, R13A, R34, R31) was found in those study sites where the sediment grain size is coarser. In traditional method the same locations were found to have the coarser grain size (R13A, R27, R34, R31). The amount of absorption in the reflectance lines is also proportional to the carbonate content obtained in the traditional methods. The higher the absorption the higher is the carbonate percentage. Sediment in the study sites R31, R13A and R21 was showing the more absorption which indicating the higher carbonate percentage. Whereas the study sites R24, R41 and R27 showing the less absorption have lowest carbonate percentages.

CONCLUSIONS

The comparison of the ASD spectrometer results to the traditional methods in regard to the grain size and the carbonate content are marching very well. From the reflectance graphs it is found that the lowest grain size is found in R18, R24 and R41 as the reflectance values are higher. The coarser grain size is found in R13A, R27, R34 and R31 as the reflectance values are the lowest. The grain size analysis from the traditional method is also showing the same distribution. The absorption at the 1470nm shows the presence of carbonate in all the study sites. According to the reflectance graphs the higher carbonate content is found in the R31, R13A and R21 due to the more absorption and lowest carbonate content is observed in the R24, R41 and R27 due to low absorption. The same carbonate distribution in the study area was found from the traditional method as well.

The ASD spectrometer analysis provide the first hand information on the grain size distribution and the carbonate content. The analysis provides the results in very less time which is not the case in the traditional method. However, the accurate values of the grain size and carbonate content cannot be obtained. Though the accurate values cannot be obtained from the reflectance graphs it can be still used when the analysis has to be acquired form the huge sediment data. The remote sensing results are prominent which in the future could replace the traditional method as the traditional methods are time-taking, expensive and lot of labor work.

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